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Electronics NOW

Vol. 67 No. 2

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ON THE COVER

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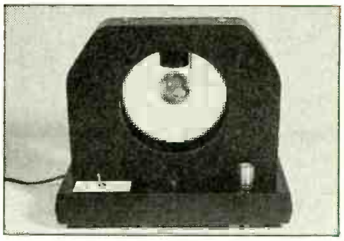
No other musical instrument is quite like the theremin. First introduced in the 1920's, the instrument soared to popularity because of its unique, pure sound. The public was fascinated by the instrument, which is played using only hand gestures. Theremins were used to produce the haunting, spooky sounds in science-fiction motion pictures, and in such box-office hits as Spellbound. They have also been used in rock-and-roll hits, including the Beach Boys' "Good Vibrations" and Led Zeppelin's "Whole Lotta Love." Theremax, a theremin for the 1990's, not only produces music — it also features control-voltage outputs that can be used to control MIDI instruments and even analog synthesizers. — *John Simonton*

BUILD THIS

33 **ELECTROMAGNETIC LEVITATOR**



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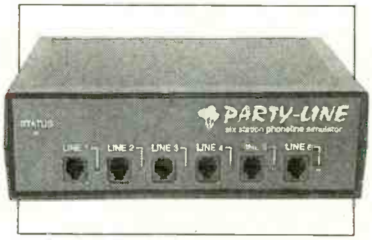

The ultimate telephone-line simulator offers six different phone extensions, and can even be used as the heart of an intercom system!
— *Thomas E. Black*

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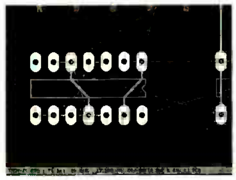

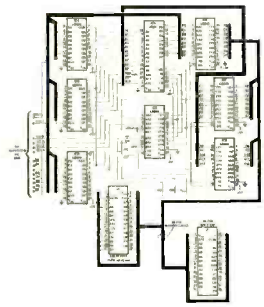

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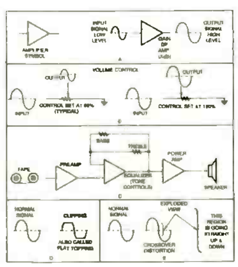

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WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

Battery-powered bus

Despite the repeated setbacks in the demand for electric-powered vehicles due to their high cost and lower performance compared with gasoline-powered vehicles, new models are being introduced. One of the latest vehicles announced is the Calstart electric transit bus, developed by APS Systems for the Santa Barbara, Ca., transit district.

The bus is powered by 100 six-volt nickel-cadmium (Ni-Cd) batteries arranged in two parallel rows of 50 each,. Together they provide 100 kilowatts. The bus is equipped with on-board chargers to quick-charge the batteries. Although the Ni-Cd batteries cost more than lead-acid batteries, they give the bus a longer operating range and weigh less than the lead-acid batteries needed to store the same energy. They also offer longer life.

To lighten bus weight, much of it is built from reinforced plastic which is lighter than steel. A lower than standard floor height is said to make the bus safer and easier to drive. The transit district hopes to prove that the improvement of air quality, especially on urban streets, will offset its higher cost of the bus and productive time lost for recharging. The Ni-Cd batteries were made by Saft America, Inc., Valdosta, Ga.

AN ELECTRIC BUS IN SANTA BARBARA, powered by nickel-cadmium batteries, will improve the air quality on downtown streets.

Who Pays for Internet addresses?

The cost of the registering Internet domain names—the addresses of computers linked to the Internet—has been borne by the National Science Foundation. Registration creates a database that "maps" the names to the numbers for Internet routing.

Under a cooperative agreement with the NSF, Network Solutions , Herndon, VA., handles registration for non-military Internet users. When the company began this service early in 1993, 400 new domains per month were being registered. By October of 1994, that number reached 2000 per month. It is estimated that by the end of 1995, more than 20,000 new domains were being registered monthly, creating a five-week registration backlog.

The explosive rise in Internet popularity has made it impossible for NSF to continue to pay for registration. In September of 1995 a $50 annual registration fee was levied for second-level domain names in each of the top-levels that Network Solutions maintains: educational, government, commercial, network, and non-profit organization (.edu, .gov, .com, .net, .org).

New commercial, network, and not-for-profit registrants will pay $100 for the first two years, then $50 per year thereafter. Those registered before September 14, 1995 will be charged the $50 annual fee on the anniversary of their initial registration.

NSF will continue to cover the registration costs in the .edu domain, and will also pay the fees for existing .gov registrants on an interim basis. This will give the government agencies time to find alternate sources for payment. Registration fees for military organizations are paid by the Department of the Defense.

Internet users who gain access through commercial services such as Prodigy, CompuServe, or America Online will not have to pay the fees. Also exempt from the fees are college and business users who access a local network from their desktop, dormitory, or home computers.

Further information about the fees is on the Internet at URL (uniform resource locator): http://rs.internic.net/announcements/index.html. EN

VIDEO NEWS

WHATS NEW IN THE FAST-CHANGING VIDEO INDUSTRY

BY DAVID LACHENBRUCH

HDTV's last hurdle

Results of tests of the Grand Alliance high-definition TV system have now been completed, and the final step—approval by the FCC—is considered only a formality. The test results were approved by the Technical Subgroup of the Advanced TV Systems Committee, which agreed that the system meets most of the criteria set by the FCC and that it is a significant improvement over any of the systems proposed before they were combined into the Grand Alliance. The Subgroup said that the system was "superior to any known alternative system" and urged FCC approval. Following approval by the FCC Advisory Committee on Advanced TV Service, the issue comes up before the full FCC, which is expected to approve adoption of the system and allocation of digital channels.

According to the FCC's timetable, action on HDTV could be complete by late this spring or early summer, with regular high-definition broadcasting to start by late 1997 or early 1998. Meanwhile, broadcasters and TV set manufacturers are planning to build a "demonstration HDTV station" to test broadcast and studio equipment and high-definition TV sets, as well as to gain experience in digital HDTV broadcasting. Details of the project have not been worked out at our press time.

Jerry Pearlman, former chairman of Zenith Electronics and major HDTV advocate, predicted that more than 2,000,000 HDTV receivers would be sold in the first year of broadcasting, even at an expected $2000 premium over comparable analog NTSC sets. By 2004, he predicted, 20% of all TV sets in use would be large-screen digital models.

Richard Wiley, former FCC chairman who heads the Advisory Committee, forecast that the new standard would lead to a "worldwide imaging revolution," affecting many industries in addition to television. He called the new standard "the greatest technical advance ever in broadcast television."

HDTV's advocates openly express fear, however, that broadcasters will choose to use the new digital standards to broadcast several standard-definition channels simultaneously, instead of HDTV, in order to compete with cable's multiplicity of channels. At first, there will be little financial incentive to transmit HDTV because of the lack of sets. That same chicken-and-egg problem delayed full-time color TV broadcasting for 10 years, from 1954 to 1964.

War of the games

"Mortal Combat" might be a good description of the hot rivalry of the various video-game systems. When Sony introduced its 32-bit PlayStation in the United States, its marketing approach so angered officials of the Japanese parent company that a few heads rolled at Sony Corporation of America. But somebody was doing something right. One of those right moves may have been pricing the hardware below cost to sell software—a practice as old as the Gillette safety razor. At $299, neither dealers nor Sony made any money. But the game has been an overwhelming success, with demand for consoles greater than Sony's capability to manufacture them. Four games are sold per console from the start, and peripherals are selling at a steady pace.

Getting clobbered by PlayStation is Sega's 32-bit Saturn, which has had to adjust its price downward to $299 in self-defense. Other game competitors—including 3DO and CD-i—have been placed in the shadow.

Nintendo, once king of the hill, has been promising its Ultra 64-bit game for some time, but delivery has been postponed several times, presumably because of an insufficiency of software.

CD-i IS ONE FORMAT that is taking a beating at the hands of Sony's PlayStation

However, there is some doubt about how long the boom even of PlayStation will last. The earlier success of 16-bit games works against the 32- and upcoming 64-bit games, as many owners of 16-bit platforms are reluctant to junk their original purchase and by new consoles, even at what appears to be a "bargain" price of $300. In addition, as the penetration of home computers increases, they are providing stiff competition to TV-based games, and that trend is bound to accelerate. As a result, virtually all game developers—including those that also manufacture

continued on page 78

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Q & A

READERS QUESTIONS, EDITORS ANSWERS

RadioShack Enlarging Timer?

Q *I have purchased a RadioShack 28-4032 timer kit which I plan to use on a photographic enlarger. Is there a way to alter this device to have time sequences from 1 to 60 seconds in one second increments? — W. B., Los Angeles, Calif.*

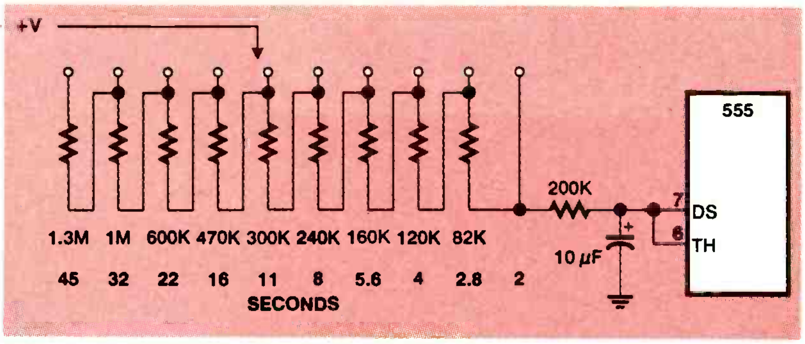


FIG. 1—A MODIFIED RESISTOR STRING gives times suitable for controlling enlarger with the RadioShack timer kit. The rest of the circuit is not shown.

A This particular timer is not a digital device; that is, it doesn't count seconds. Instead, it measures the time taken to charge a capacitor through a resistance. When built as specified, it gives you a choice of 10 different resistances and 3 different capacitances. The effects of the resistance and the capacitance are multiplied, not added, which is why changing capacitors will multiply all the times by 10 or 100 rather than adding 10, 20, or 30 seconds, or the like.

The simplest thing to do is to take advantage of the fact that an enlarging timer doesn't need 1-second increments. Instead, it needs exposures that differ by the same percentage, say 40% (one half stop, in photographic terms). For example, if a 32-second exposure is too short, you're not going to try a 33-second exposure; you'll move up to something like 45 seconds, because the difference between 33 and 32 is negligible. A 41% change in exposure time will usually be the smallest change that makes a significant difference.

Accordingly, Fig. 1 shows how to modify the timer to go from 2 to 45 seconds in 10 steps each of which is 41% longer than the previous one. Some of the resistors are not standard values; make them by connecting standard values in series (e.g., 240K = 120K + 120K). Any resistance that is within a few percent of the correct value will do.

It's no coincidence that the numbers of seconds in Fig. 1 are the same as the *f*-numbers on your lens; *f*-numbers also differ by 41% from stop to stop, but the reason is different. If you increase the diameter of a lens by 41%, you double its area because 1.41 squared is very close to 2. So apertures that differ by 41% correspond to whole-stop (factor-of-2) differences in light level.

If you still want what you originally specified, 1 to 60 (or rather 0 to 59) in 1-second increments, Fig. 2 shows how to achieve it. The first selector switch chooses between resistances for 0, 10, 20, 30, 40, or 50 seconds. (You could extend it up to 90 using a 10-position switch.) The second switch adds resistance for 0, 1, 2, 3, 4, 5, 6, 7, 8, or 9 seconds in series with the first resistance. Use precision resistors, especially for the 1-megohm units.

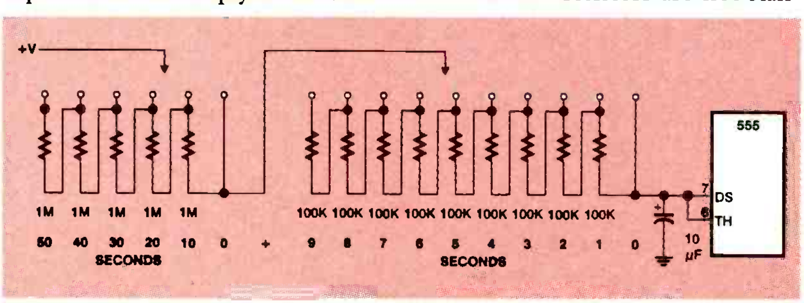


FIG. 2—HERE'S HOW TO DIAL ANY TIME from 0 to 59 seconds using two selector switches.

Simulated Lighthouse Beacon

Q *I am enclosing a diagram of a circuit from Model Railroader, July, 1978, which drives a 12-volt "grain of wheat" lamp and makes it turn on and off gradually. The object of the exercise is to replicate, in 1:12 scale, the character of the rotating lamp in a lighthouse. I have built a motor-driven cam switch to give the proper on-off cycle.*

What I would like to know is how to drive a 2-amp bulb instead of a tiny one, and still provide the delay in com-

ing to and receding from full incandescence. I have written to Model Railroader *and two other magazines for help in this project, but all to no avail. — J. H. C., Dallas, OR.*

A It's not too surprising that *Model Railroader* can't contact the author of an article that appeared 18 years ago. But here's a circuit that will do the job (Fig. 3) and is simpler than the original. It uses a TIP120 power transistor (actually a pair of transistors in one case, as shown in the diagram) as a voltage-regulating element. The voltage across the lamp is always 1.2 volts lower than the voltage across the capacitor. Closing the switch charges the capacitor gradually over a period of a few seconds, causing the voltage to go up. When the switch opens, the capacitor slowly discharges and the voltage goes down again.

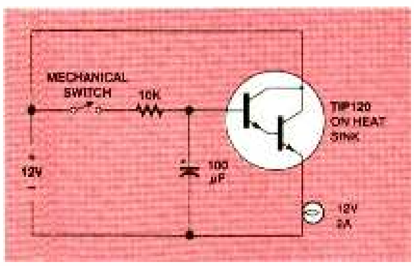


FIG. 3—THE LAMP TURNS ON AND OFF gradually, controlled by the charging and discharging of the capacitor.

You may have to experiment with component values to get the effect you want. The capacitor controls both the rise time and the fall time; the resistor controls the rise time only. In both cases, larger values make the action go slower. Be sure to mount the TIP120 transistor on a heat sink, and remember that its mounting hole is connected to the collector (and thus to +12V in the circuit).

Regulating AC Voltage

Q *I would like to build a solid-state voltage stabilizer or constant voltage transformer (110 VAC in, 110 VAC out) with a power capacity of about 200 watts for color printing with a condenser enlarger. — T. P., Rochester, N.Y.*

I have a resistive load that will accept an input voltage ranging between 0 and 90 VAC. I would like to design an AC voltage regulator circuit with an input of 120 VAC and be able to vary the output voltage from 0 to 90 VAC with 10% regulation. The output must not exceed 90 VAC. Can you help? — R. K., Los Angeles, Calif.

A AC voltages are hard to regulate because, by definition, an AC voltage is changing all the time, and it can't simply be clamped at a fixed level the way DC can. The usual way to regulate AC voltage is to use a constant-voltage transformer, which works by undergoing magnetic saturation at the desired voltage. A suitable unit, the Sola 23-23-125-8 (250 watts), lists for $320 in the Allied Electronics catalog (7410 Pebble Drive, Fort Worth, TX 76118); you may find it at local electrical (not electronic) supply houses. There's not much to build — just buy the transformer and hook it up. Some enlarger makers offer voltage stabilizers matched to their enlargers, such as Beseler's model 6731 (about $140 from Beseler dealers). Be sure to check the surplus and secondhand market.

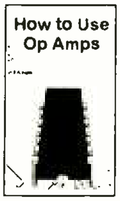
The best way to get an adjustable AC voltage at appreciable power levels is to use a transformer with a continuously variable tap position (a "Variac"). These aren't cheap either; expect to pay $50 for a 2-amp unit. Several suitable transformers are available from Allied at the address just given. Also, because Variacs are a standard item on an electronics test bench, you may be able to find one locally at dealers such as Dow Electronics in Pasadena.

If your load is resistive, it may not require pure AC. If it's something like a heating element or an incandescent light, you can power it with chopped AC from an ordinary light dimmer, or regulated DC from a DC power supply of standard design.

Line Level Audio to 68 Ohms

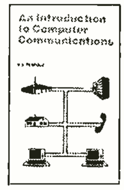
Q *I've been trying to find a voltage follower circuit that I can use to couple the output of my computer, 2.2 volts into 1000 ohms, to the 68-ohm inputs of small speakers that fit nicely on my mod-*

Electronics Paperback Books



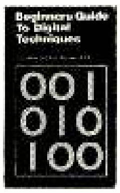
☐ **BP88—How to Use OpAmps...$5.95.** A designer's guide that covers operational amplifiers. Serving as both a source book of circuits and a reference book for design calculations. The text is non-mathematical and easy to understand by most readers.

☐ **BP113—30 Solderless Breadboard Projects-Book 2...$5.95.** Companion to BP107. Presented in exactly the same style using "Verobloc" breadboards. All the breadboard projects in this book are based on CMOS logic integrated circuits.

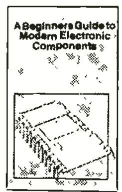


☐ **BP177—Introduction to Computer Communications...$5.95.** Details on types of modems and their suitability for specific application, plus details of connecting various computers to modems, and modems to the telephone system.

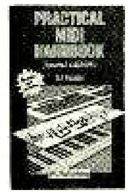
☐ **BP350—Electronic Board Games...$6.00.** Twenty novel electronic board games that you can build from the plans in this book. Some games are motor racing, searching for buried treasure or for gold in Fort Knox, — there is something for you to build and enjoy!



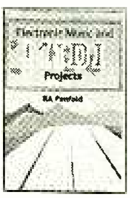
☐ **BP61—Beginners Guide to Digital Techniques...$5.00.** Covers the basics of digital techniques—decimal, binary, octal and hexadecimal numbering systems are covered plus insights on weighted and non-weighted binary-coded-decimal codes and alphanumeric codes. The basic building blocks of circuit logic, the common AND, OR, NAND, NOR and EXCLUSIVE-OR gates and bi-stables are thoroughly covered.



☐ **BP285—A Beginners Guide to Modern Electronics Components... $6.50.** It is easy for newcomers to electronics to become confused. There are a great many different types of components available often with numerous variations of each type. This book presents the reader with a vast amount of invaluable parts information to enable the right component to be selected every time for repairs and projects.



☐ **PCP103—Practical MIDI Handbook...$9.95.** The Musical Instrument Digital Interface (MIDI) is surrounded by a great deal of misunderstanding. This book is aimed at musicians and technicians who want to explore the vast capabilities of MIDI. It covers MIDI-based equipment you can use: keyboards, drum machines, sequencers, effects units, mixers, drum pads guitars. There's also a section on computer music.



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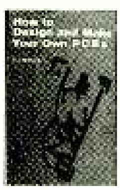
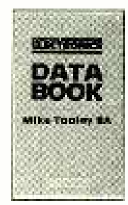
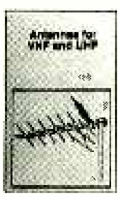


☐ **BP121—How to Design and Make Your Own PCBs...$5.75.** Simple methods for copying printed-circuit board designs from magazines and books oh to copper. Covers all aspects of simple PCB construction as comprehensively as possible.

☐ **BP44—IC 555 Projects...$5.95.** Every so often a device appears that is so useful that one wonders how life went on before without it. The 555 timer integrated-circuit chip is one such device. Included are basic and general circuits used by most hobbyists.

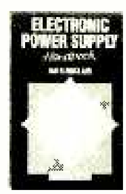


☐ **PCP109—Everyday Electronics Data Book ... $10.00.** An invaluable source of electronics information—the text contains sections that deal with the underlying theory of electronic circuits and a wide range of practical electronic uses for everyone.



☐ **BP301—Antennas for VHF and UHF...$6.00.** From installing a TV or FM antenna to setting up a multi-antenna array for shortwave listening or amateur radio, this book explains the basics of VHF and UHF antenna operation and installation. The text describes in easy-to-understand terms the essential information about how antennas work, the advantages of different antenna types, and how to get the best performance.

☐ **BP297—Loudspeakers for Musicians...$6.25.** Contains all the information that a working musician needs to know about loudspeakers: the different types, how they work, the most suitable for different instruments, for cabaret work, and for vocals. It gives tips on constructing cabinets, wiring up, available fittings, finishing and how to connect multi-speaker arrays, etc. Includes ten enclosure designs with plans.



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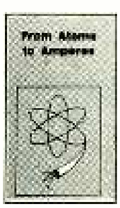

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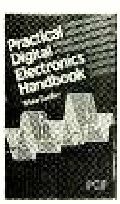

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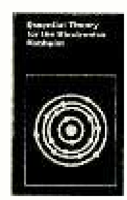

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est computer desk. The circuit on page 82 of your July 1994 issue might be satisfactory but shows no component values. What are they? — C. S., Sun Valley, Calif.

A That circuit is actually a preamp that won't drive a low-impedance output. The first stage of it is a follower, as you note, but the second stage is a common-emitter amplifier with a high impedance output, drawn upside down because it uses a PNP transistor. The reader who sent it in didn't specify component values.

To couple line-level audio to the 68-ohm powered speakers that are becoming ubiquitous, we suggest you use the LM386 headphone amplifier circuit shown on page 8 of our June 1995 issue. It will probably work satisfactorily with a 6-volt supply.

Can't find these ICs

Q *My second question is about an IC in a European-made controller for a pipe organ. The 18-pin DIP is labeled 0530 and made by Siemens. I have contacted Siemens, but they no longer make this item and they are unable to help me with a replacement. What can I do? — W. B., Los Angeles, Calif.*

I am trying to copy a touch lamp circuit and have not been able to identify the IC chip. It is labeled AMI 8816MAS C16281 6503-603 and is made by Mitel Corp, but I could not get any information from them. Where can I get a replacement? — J. M., Milldale, Conn.

A Unfortunately, some ICs just aren't available when you need them. ICs are very specialized components, and it sometimes happens that a manufacturer discontinues one without introducing a compatible substitute. That's apparently what happened with the Siemens chip, and your best bet is to figure out how the circuit works and redesign it to use currently available parts.

Other ICs are never available in small quantities because the manufacturer doesn't think there's a market for them. ICs aren't widely marketed unless there is a demand for them either in the repair industry or in industrial electronics (which often involves custom-building equipment). Touch lamps are seldom repaired on the component level, so there isn't a repair market, and a touch lamp controller isn't good for much else, so there is no industrial market either.

On top of that, the lamp controller type number, 6503-603, sounds like a "house number," a number assigned to a particular client's special order, but the chip may be equivalent to something the same manufacturer normally sells under a different number. The manufacturer is apparently not Mitel, which doesn't make lamp controllers. Could it be Mitec or another company with a similar name? If you can identify the company, write and ask for general information about their touch lamp controllers. Also write to Philips ECG, P.O. Box 3277, Williamsport, PA 17701, and see if they can suggest a replacement.

5-Band Color Code

Q *Could you please explain the color code for the 5-band 1% metal film resistors, such as 23.7K, as opposed to the 4 and 5 band, 5% and 10% resistors? — T. C., Galesburg, Ill.*

A The color code is the same except that the 1% resistors have one more digit. For example, a 10K-ohm 5% resistor will be marked:

brown	1	
black	0	
orange	000	(multiplier)
gold	5%	(tolerance)

Its 1% counterpart will be marked with five bands:

brown	1	
black	0	
black	0	
red	00	(multiplier)
brown	1%	(tolerance)

Either way, the number comes out to 10,000, but notice that the multiplier is lower when more digits precedes it — a common source of errors.

If there is yet another band, it denotes long-term stability; brown is worse and yellow is best.

The price of 1% resistors is falling, and 5% resistors may one day become obsolete just as 10% resistors did; then we'll all get used to reading five bands instead of four. EN

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

THERE'S STILL HOPE

I am writing in response to Jeff Holtzman's Computer Connections column "Abandon All Hope" (*Electronics Now*, November 1995). Mr. Holtzman states that "Given all of the above, there is little or no chance that a small entrepreneur can ever hope to build a new business in the computer industry, unless [he has] not only technical savvy, but also 20 or more years of business experience."

My comments on the column, based on my experience as an inventor, are:

1. If there is little hope for inventors in the computer field, perhaps they should be inventing in other technical fields such as agriculture that are less crowded. The column supports the view that too many people are working and inventing in the computer field.

2. I have been informed by lawyers that those corporate agreements giving inventors rights to inventions that they develop on their own time are might not stand up in court. Perhaps Mr. Holtzman should have consulted a lawyer before making broad statements about the employee-inventor's lack of rights.

3. Inventing is always a gamble, like playing the lottery. The best motivation for inventing is that the process is fun and exciting.

4. Inventing another marginally improved device, such as a slightly better operating system, is not usually worth the effort either from a commercial or intellectual standpoint. Why not go for the gold and attempt to invent something really new? Replace those boring computers with something that is really powerful and interesting.

5. If Holtzman's suggestion to "abandon all hope" applies to all of inventing, *Electronics Now* should consider ceasing publication. Why should anyone bother to learn about electronics if all the real action is limited to the corporate elite? Also, brace for a nasty political meltdown as people discover the truth about lack of opportunity.

6. I do not agree with the article's premise. A friend of mine made a decent living for many years from his own small computer components company. He started by making circuit boards in his kitchen sink and focused his business on the interfacing of incompatible computers.

In conclusion, don't sell American inventors short. We can continue to invent- including ways to limit excessive corporate power over those inventions.

NICKOLAUS E. LEGGETT
Reston, VA

Jeff Holtzman's column, "Abandon All Hope," makes a valid point that most businesses require employees to have several areas of expertise beside the engineering phase of product development. At the same time, the article is very pessimistic, heavily biased, and will unnecessarily discourage your readers, who are the entrepreneurs of the future.

There are still plenty of opportunities to succeed in the computer field, as well as in many other fields related to electronics. Obviously, Holtzman thinks that the readers of *Electronics Now* are dumb and believe that "all you have to do is build a better mousetrap, and people will come knocking."

In concluding his column by saying "there is little or no chance that a small entrepreneur can ever hope to build a new business in the computer industry," he suggests that people get jobs in large corporations and then let the management take advantage of them while they are not learning anything about running the business.

Give me a break! Holtzman should stop whining in the pages of *Electronics Now*.

I started my career as an entry-level electronic technician, and worked at some of those large corporations. Over time, I've gained plenty of practical experience in running a business, and I know many others who have also done this. No, the experience wasn't handed to me — I had to work for it.

About six years ago, a few friends and I struck out on our own, and we built and now operate a successful and rewarding business in the computer field. I am the company president. We are participating successfully in all three of the business categories listed in Holtzman's column.

Perhaps Holtzman expects things to be handed to him on a silver platter; most people know that

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seldom happens. Your readers should also know that it is possible for entrepreneurs to make money in the computer field in both small and a large companies. This obviously contradicts Holtzman's pessimism.

People should set reasonable goals for themselves and understand their own limits, as well as those of their fellow workers. People should not try to fake their way through projects that they can't handle on your own. And they should pick their associates very carefully. For example, if you are technically trained, don't choose as partners only those with technical experience. Seek help from others with different kinds of expertise such as business management, marketing, and finance. Your skills should complement those of your associates.

I found the negative tone of the column to be unworthy of your excellent magazine. It is one thing to publish a column as a wake-up call for people who think they can start a business without adequate resources, but it is quite another to publish one that would discourage anyone from trying.

If everyone had such a negative attitude, we'd never see any new products other than those from a few large corporations. This country was founded on ideals that promote individual freedom and opportunity. They encourage people to be the best that they can be. Those ideals are still valid today, and they contribute to making the United States so great. Holtzman can give up trying to succeed if he wants to, but I suggest that your readers not follow his advice that suggests "you can't make it, so you better give up."

BRAD BAKER
Los Gatos, CA

TELCO IN A BOX

Unfortunately the "Telco in a Box" circuit (*Electronics Now*, September 1995) is compatible with all telecommunications subscriber-line interface devices such as telephones, fax machines and answering machines.

I'm not writing to criticize your magazine. I want to give you some useful information on telephony from the "Bell Blue Book," as it was called when I worked for ITT and Wescom many years ago. I believe its complete title is "North American Telecommunications Signaling Standards." It was published by the Bell System and contained guidelines for North American telephony.

The information about telephone in the article was not entirely correct. That could lead to functioning equipment being falsely diagnosed as defective. Most "disposable" telephones produced today will ring at a low electrical threshold, but that is not the way that older subsets functioned. The primary reason for the increased sensitivity of the ring detect is the introduction of the electronic ringer. Here are the facts:

1. The ringing voltage from the central office is AC and can be 20, 30, 40, 50, or 60 Hz. The nominal voltage varies from 103 to 120 volts RMS (according to the Bell System, although ITT used 90-volt generators).

2. The minimum (stated in the Bell book) ring voltage was 35 volts RMS for most ringers, and 45 volts RMS for the others. Higher ringing voltages than 90 volts RMS were used to allow at least five standard subsets to be rung without causing a false ring trip. "Ring trip" is the condition that disables the ring voltage and connects the voice path. Ring trip is related to, but not the same as off-hook detection. That condition occurs when the DC voltage level changes to a predetermined level so that it either connects the voice path or gives a dial tone.

3. There were, (and still might be), places in the United States where party lines are in use. The worst party line I ever saw had 15 subscribers on a single telephone pair. There were five different ring frequencies and the ring voltages were applied either tip to ground, ring to ground, or across the tip and ring (bridge ringing).

4. The single-line subscriber has a straight-line ringer that operates between 1 and 30 Hz, in a bridged ringing configuration. Telephone operating companies avoided 60-Hz ringers because of possibilities of false rings induced by power-line 60 Hz.

5. The idle voltage in the telephone loop is -51 to -54 volts, but the design

continued on page 59

EQUIPMENT REPORTS

HEATHKIT'S INDIVIDUAL LEARNING SYSTEM.

Practice for the nationally-recognized A + Certification for competence in microcomputer servicing or just enhance your knowledge with Heathkit's Individual Learning System.

CIRCLE 15 ON FREE INFORMATION CARD

Self-study has long been a route to knowledge and success, particularly for the those who was unable to attend classes in subjects of interest or classroom instruction in those subjects is not available locally. Correspondence schools and self-study texts have met this need for many people as well as those who could not afford tuition. They have also helped where course attendance would interfere with their jobs and family responsibilities or commuting to courses (even if free) would be a burden.

Today, a knowledge of how to maintain and upgrade microcomputers and associated peripheral equipment is a requisite for advancement in many industries, and it might even be a prerequisite for getting a job in the computer industry. That makes it a fit topic for both formal and informal study.

Unfortunately, few, if any, formal courses now being offered are dedicated solely to professional computer servicing in colleges and technical schools.

Computer service self-study

Heathkit, the company that became famous for producing electronics kits, has met this need by offering a self teaching course covering the knowledge necessary to pass the nationally recognized A+ examinations. Passing those industry-sponsored exams certifies that a person possesses the knowledge, technical skills, and customer relations savvy to become a successful computer service technician.

The course, based on concepts of computer-aided instruction, frees the student from having to put together his own program and perhaps struggle with scheduling attendance at the requisite classes—assuming that they are available locally. It also permits the student to study an integrated curriculum at his own pace, either at home or on company time.

Although the introduction of the computer into the learning process has taken a lot of the frustration and wasted time out of self-education, successful study and qualification still demands initiative and determination. However, many people who do not want or need A+ Certification will be attracted to this packaged course because it gives them an incentive to study subjects they want or need to know but have put off because of the work and family responsibilities.

Who needs A+ Certification?

The A+ Certification testing program is sponsored by the Computing Technology Industry Association (CompTIA) , an organization that certifies the competency of service technicians in the computer industry. Anyone who wants to earn this certification as a competent computer service professional can take the A+ exams.

The exams cover a broad range of hardware and software technologies, but they are not tied to any specific computer products. More than 40 computer-industry organizations have contributed resources to the tests. These companies include computer hardware and component manufacturers, software publishers, distributors, and resellers.

The candidate must pass two computer-based test modules—the core and one of two specialties, either the Microsoft Windows/ DOS module or the Macintosh module. When candidates pass the core plus a specialty, they receive a certificate that states the specialty module they passed. Candidates for certification may register by phone by calling 1-800-776-4276 to schedule a testing session in any of the 50 states nationwide and in over 150 countries worldwide. Candidates who pass the exams will have demonstrated a knowledge of configuring, installing, diagnosing, repairing, upgrading and maintaining microcomputers.

How much does it cost?

The fee for taking the A+ Certification tests differs according to whether or not the candidates are employed by a member of CompTIA. Also, taking two or three exam modules at one tine saves money. For example, the fee for those employed by CompTIA member company to take a core plus one specialty module is $150, but for non-members it is $165. Obviously , interested candidates can save money and time by making sure that they pass two or more exams on the first try.

Computerized self-teaching

Heathkit developed its individual learning system to prepare people to take and pass the A+ computer service technician exams. The course requires an IBM or compatible personal computer with an Intel 386 or faster processor. It should have at least 10 Mbytes of hard-disk drive space available, a 3.5-inch floppy-disk drive, at least 640 Kbytes of RAM and a mouse. The computer monitor should be VGA or better, and MS-Windows 3.1 or higher should be installed.

Heathkit's learning system is interactive and, like the A+ exams, eliminates pencil and paper. The Windows-based format permits the practice questions to be answered as if the actual test were being taken. By answering the hundreds of practice questions the candidate can build his or her knowledge to prepare for the A+ Certification Program's five timed tests. Question formats and test-taking features are modeled on the real exams. However, these practice tests can be taken over and over without paying any exam fee.

The Heathkit program computes test answers to determine what topics the candidate knows or does not know. It then refers them to the right page in the nine-volume library of textbooks with a total of 4300 pages that is included. Students need not waste reading over material they already know.

The Heathkit course includes the test-simulation software and a nine-volume library that is actually a collection of popular Computer-related books available in bookstores. Hence, the library becomes an excellent reference resource after the exams have been passed. A tenth book, a 200-page binder, contains a study guide and sample questions and answers with textbook references An included carrying case permits the books and software diskettes to be carried and stored conveniently.

A three-step course

The Heathkit course is presented in three steps. Step 1 is a preview of an actual test intended to pinpoint areas where the candidate is weak. This step tests the student's knowledge by presenting up to 500 computerized sample questions. It permits students to work at their own pace and check their answers with the computer. The correct answers are given on-screen along with references to the textbook and pages that must be studied.

Step 2 concentrates on topics that the individual student must study. The resource library covers the core materials contained in the A+ Certification Program.

Step 3 evaluates the student's competence level and permits practicing his or her knowledge and skills against the clock, as on actual exams. If the first test is passed in less than an hour, the student is encouraged to take the four remaining tests to hone test-taking skills. Each test presents 100 questions similar to those on the A+ exams.

Whether you want to become A+ Certified, or just want an organized study program that spur you to master topics that you want or ought to know, the Heathkit Individual Learning System. However, it almost goes without saying that the coarse will be easier and more meaningful if you have mastered the basics of electricity and electronics and have some familiarity with electronic circuitry and the operation and maintenance of microcomputers. The complete course is priced at $399.00. Heathkit Educational Systems (P.O. Box 1288, Benton Harbor, MI 49023). EN

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Programmable Triple-Output Power Supply

HEWLETT-PACKARD HAS introduced its HP E3631A 80-watt, triple-output programmable power supply that includes both HP-IB and RS-232 interfaces. It provides multiple outputs (0 to −25 volts, 1

CIRCLE 20 ON FREE INFORMATION CARD

ampere , 0 to +25 volts, 1 ampere, and 0 to +6 volts, 5 amperes). 5A) and allows users to read and Program current and voltage can be read from a remote location through either interfaces with Standard Commands for Programmable Instruments(SCPI). Low noise output and 0.01 % load and line regulation are specified.

Separate digital panel meters allow simultaneous monitoring of voltage and current. The front panel has a bright vacuum-fluorescent display and a traditional knob that permits settings to be changed in one hand motion.

A personal computer loaded with the high-level SCPI language included with the HP E3631A make it easy to perform repetitive functions. Circuits and components can be powered on and off repetitively for reliability testing. Users can test circuit sensitivity to power-supply variations, and voltages for component testing can be stepped for component testing by programming the power supply with a personal computer. Software calibration eliminates the need to open the power supply case.

The HP E3631A programmable power supply with both operating and service manuals, a certificate of calibration, power cord, and a three-year warranty is priced at $995.00

HEWLETT-PACKARD COMPANY
Direct Marketing Organization
P. O. Box 58059
MS51L-SJ
Santa Clara, CA 95051-8059
Phone: 1-800-452-4844 ext. 9764

COMPUTER MONITOR VIDEO GENERATOR

THE MODEL 1280 VIDEO generator from B+K Precision can generate video patterns for the most popular computer video formats. Seven color-bar patterns are included: CGA; EGA; VGA 640×480/60 Hz; SVGA 800×600/56 Hz; SVGA 1024×768/87 Hz; SVGA 1024×768/60 Hz non-interlaced; and Mac II 640×480/67 Hz on green.

The VGA and SVGA color-bar patterns can be switched to gray scale. The VGA full-screen rasters can be set to white, red, green, or blue. Crosshatch patterns are available in three VGA formats for checking convergence: 640×350/70 Hz, 720×400/70 Hz, and 640×480/60 Hz. A "sync on green" button adds sync on green to all CGA, EGA, VGA, and SVGA patterns.

A selection of output jacks on the Model 1280 minimizes the number of cables and adapters required by users. Both CGA and EGA patterns are available through the DB9 jack. Both VGA and SVGA patterns are available on both HD15 jacks. There are separate BNC jacks for red, green, blue, vertical sync, and horizontal sync. The Mac II pattern is available on both HD15 jacks, and there are separate BNC jacks for red, green, blue, vertical sync, and horizontal

CIRCLE 21 ON FREE INFORMATION CARD

sync. Composite sync is on the green output jack.

The Model 1280 video generator with a nine-volt battery or AC adapter and instruction manual is priced at $429.00. BNC to BNC cables are options.

B+K PRECISION
6470 West Cortland Street
Chicago, IL 60635
Phone: 312-889-1448
Fax: 312-794-9740

DIGITAL STORAGE SCOPE MODULE

THE O-SCOPE II FROM Allison Technology Corporation is a compact module that plugs into a personal computer's printer port, transforming the computer into a dual-trace digital storage oscilloscope. Displayed sweeps can be frozen on the screen, printed out, or saved to disk. Operating parameters such as input range, sweep rate, and trigger level are displayed, and they can be adjusted through the computer keyboard. An external trigger is included. In the frequency spectrum mode, sweeps of a selected frequency range are presented on a calibrated graph with an averaging option.

CIRCLE 22 ON FREE INFORMATION CARD

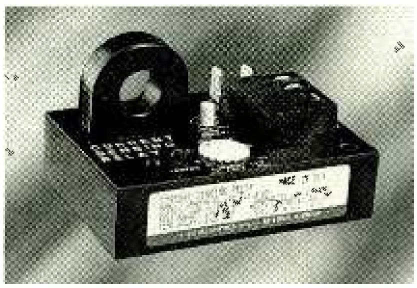
The O-Scope II's bandwidth is 250 kHz and it can sample at rates up to 1 million per second. The processor in the host personal computer should be an Intel 286, 12 MHz processor or faster.

The O-Scope II digital storage oscilloscope module is priced at $349.00

ALLISON TECHNOLOGY CORPORATION
8343 Carvel
Houston, TX 77036
Phone: 800-980-9806 or 713-777-0401
Fax: 713-777-4746
BBS: 713-777-4753

CURRENT SENSING RELAY

THE SERIES 4395 CURRENT-sensing relay from CR Magnetics has a calibrated dial that permits the setting of precise current trip points. The relay is offered with three different current sensing ranges: 1 to 10 RMS. amperes, 3 to 30 RMS. amperes, and 6 to 60 RMS. amperes.


CIRCLE 23 ON FREE INFORMATION CARD

The round calibrated dial, about 5/8-inch in diameter, extends from the top surface of the relay. A red arrow on the dial surface points to a printed scale. The relay is set to the desired AC current trip by rotating the dial to the desired trip point. It features time delays from a half second to 35 seconds, and an LED lamp lights when the relay trips.

The relay is available in two basic configurations that are energized on either high or low currents. The high-current model is suitable for motor overload detection and remote load monitoring. The low-current version is suitable for open heater coil detection. The relay design includes a voltage reference circuit for current sensing. This circuit ensures that the relay will maintain the desired trip point and that the point will not drift because of changes in ambient conditions.

The 4395 series relay is priced at $97.50.

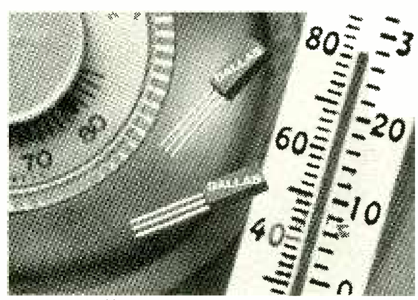
CR MAGNETICS, INC.
304 Axminister Drive
Fenton, MO 63026
Phone: 314-343-8518

DIRECT-TO-DIGITAL TEMPERATURE SENSOR

THE DS1820 1-WIRE DIGITAL temperature sensor from Dallas Semiconductor is intended for applications where multiple sensors hang from a single twisted-wire pair. Each DS1820 digital thermometer contains a unique serial number stored in a 64-bit ROM that can identify the temperature of a specific sensor. Each sensor provides 9-bit temperature readings.

Multiple chips connected to a 1-Wire bus can report back to a central processor, eliminating the need for separate wiring for each sensor. Signals on the bus can travel 300 meters. No analog circuitry is required and there is no need for shielded cable. The DS1820 takes its power from the data line so it requires no external power source. Each device has a non-volatile temperature alarm setting.

The sensor is recommended for the control of heating, ventilating and air conditioning equipment, machinery or electronic equipment control, and process monitoring. The DC1820 measures temperatures from − 55 degrees C to +125 degrees C in 0.5 degree increments (−67 degrees F to 257 degrees F in 0.9 degree F increments). Temperature to digital word conversion occurs in 200 milliseconds.



CIRCLE 24 ON FREE INFORMATION CARD

The DS1820 1-Wire digital thermometer is available in a three-lead package or in a 16-pin surface-mount package. The sensor in the three-pin package is priced at $2.77 each in quantities of 10,000.

DALLAS SEMICONDUCTOR
4401 South Beltwood Parkway
Dallas, TX 75244-3292
Phone: 214-450-0448
Fax: 214-450-0470

ATA MEMORY SYSTEM

THE FLASH CHIPSET FROM SanDisk Corporation (formerly SunDisk) is said to be the world's smallest embedded solid-state ATA data storage system. The chipset contains memory and an integrated flash controller chip. (ATA is the mobile equivalent of the industry-standard IDE desktop PC interface.)

Product developers are offered a low-power, high-capacity, miniature memory that can be integrated into mobile or hand portable electronics products such as palmtop and handheld PDAs, cellular telephones, digital PBXs, audio recorders, printers, digital cameras, medical monitors, and multifunction PC cards.

CIRCLE 25 ON FREE INFORMATION CARD

Because it can operates on only 3.3 volts, the Flash Chipset conserves the battery life of its host mobile products. It is compatible with ATA and IDE disk-drives. An integrated single-chip intelligent controller allows the chipset to perform many of the functions of a high-performance disk drive. These include defect management and error correction.

The Flash Chipset is available in 2-, 4-, and 10-megabyte capacities. (These capacities can be effectively doubled with compression software.) OEM pricing is $60 for 2-megabyte devices, $85 for 4-megabyte devices, and $195 for 10-megabyte devices.

SANDISK CORPORATION
3270 Jay Street
Santa Clara, CA 95054
Phone: 408-562-0500
Fax: 408-562-0503

EN

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Instant UNIX

by Andrew Evans, Neil Matthew & Richard Stones
Wrox Press, Inc.
2710 West Trouhy Avenue
Chicago, IL 60645
Phone: 1-800-814-4527
Fax: 312-465-4063
E-mail: http://www.wrox.com/
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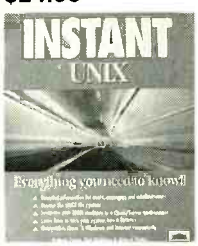


CIRCLE 337 ON FREE INFORMATION CARD

This book is intended for those who want or need to learn about the UNIX multitasking, multiuser 32-bit operating system. UNIX has a reputation as an operating system that is difficult to use. Nevertheless, despite competition from other operating systems it still has its strong points and advocates. It has become the dominant operating system for the server in the client/server environment. Sybase-, Oracle-, and Informix-based systems all require UNIX.

Many hardware and software designers and network administrators familiar with other operating systems now find that they have a need to learn UNIX quickly and efficiently to keep up professionally. This book makes that possible.

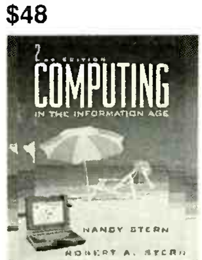
Encompassing the whole UNIX spectrum from simple user commands and logging-in to complex administration and configuration issues, the book covers every important aspect of UNIX. This includes E-mail, security, and file systems. It also provides information on X Windows, PC-to-UNIX connectivity, and how to access the Internet from UNIX.

An in-depth discussion of the user environment is included, covering, shell programming, UNIX systems administration, networking, the Internet, and E-mail. It also includes information on how to obtain the free form of UNIX, Linux, how to install it, and how to configure it to a computer system.

Computing in the Information Age

Second Edition

by Nancy Stern and Robert A. Stern
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Phone: 1-800-CALL-WILEY
$48



CIRCLE 338 ON FREE INFORMATION CARD

This second edition of a book on computers can serve as a self-teaching or classroom introductory text. It explains how computer work, store information and solve problems. Essentially non-technical, the book explains why certain hardware and software are especially useful, and it discusses all kinds of computers from personal computers to workstations, servers, and mainframes.

The four basic elements of computing are covered: hardware, software, networks (connectivity), and the people who work with them. The first chapter is an overview of those four basic elements, and each of the next four chapters goes into detail on each of the four topics. Other chapters in the book explain the ways in which all of the four elements are integrated. The authors focus on how networking, the information superhighway, and the Internet have changed personal computing.

While concentrating on business applications for computers, adequate coverage is also given to computers and data processing in industry, science, and global affairs. education. Although much of the discussion is based on the IBM personal computer and compatible machines, the authors also discuss the Macintosh and the Power PC, explaining their similarities and differences with the IBM compatibles.

1996 Amateur Radio Mail Order Catalog and Resource Directory: 5th Edition

edited by David L. Thompson, K4JRB
The American Radio Relay League
225 Main Street
Newington, CT 06111
Phone: 203-666-1541
Fax: 203-665-7531
$15.95

CIRCLE 339 ON FREE INFORMATION CARD

This catalog and directory is intended to answer the question Where do I buy it? It lists sources for most requirements for the amateur radio operator and electronic hobbyist from electronic components, computer software, and books to accessories and test equipment. Dealers and vendors are listed for more than 220 categories of goods and services. These include used amateur radio equipment, digital signal processors, CD players, antique radios, meteorological instruments, electronics-related clubs and associations, and antennas.

A comprehensive index and table of contents help to locate desired products and services quickly and easily. The Resource Directory section of the book includes listings of more than 100 free catalogs, an amateur radio glossary, advice on obtaining amateur radio licenses and, a Q-signal list.

Programmable Microcontrollers Catalog

Blue Earth Research
165 West Lind Court
Mankato, MN 56001
Phone: 507-387-4001
Fax: 507-387-4008
E-mail: 739-0298@mcimail.com
Free

CIRCLE 340 ON FREE INFORMATION CARD

This 28-page catalog from Blue Earth Research describes the company's product line of microcontrollers, peripherals, accessories, and development software. Emphasis is given to the Micro-440e and Micro-485 families of programmable controllers and the Xplor Series of personal digital controllers(PDC).

The Micro-440e is a microcontroller with an advanced 8051-style central processor , 32 Kbit EPROM, 32 Kbit RAM, real-time clock/calendar, and an 8-bit A/D converter. The Micro-485 has additional features and capabilities. The same software can be used for system development for both microcontrollers.

The Xplor Series PDCs include features not usually included in the same price range as these controllers. They are sold as part of a complete starter package that includes a cable, power supply, user's manual, and optional development software.

The catalog also describes available Micro-440e accessories and expansion modules as well as humidity, temperature, and pressure sensors that are compatible with all of the controllers or with an analog interface module. An overview of the company's custom-design facilities is included with the catalog.

Step Into Virtual Reality

by John Iovine
Windcrest/McGraw-Hill
Blue Ridge Summit, PA 17294-0850
Phone: 1-800-233-1128
Fax: 717-794-2103
$32.95, including disk

CIRCLE 341 ON FREE INFORMATION CARD

Iovine's book on virtual reality (VR) not only explains the subject and describes how the reader can build a complete VR system economically based on a personal computer and standard off-the shelf software. The complete system is not available commercially.

To simplify the system construction task, the author has broken down the system into a dozen simple projects which can be built separately. The reader will decide which of the projects to build in any order to form a customized system.

The projects include a head-mounted display unit; liquid-crystal display stereoscopic shutter glasses; a data glove; tactile actuators, and a VR exercise bicycle. The telepresence robot (T-bot) project allows the reader to enter a mobile robotic device based on a radio-controlled model car equipped with a microminiature video camera and sound system.

A companion floppy disc contains 3DBENCH, a program to evaluate the personal computer that the reader intends to use as the "brains" of the VR system. Another program, 3DV, allows the builder to move and rotate three-dimensional models in real time. The BIKE program is the software for an independent VR system based on the VR bike. Finally, the GIF program provides two stereographic pairs of .GIF images that can be viewed with the liquid-crystal shutter glasses. EN

BY ALVIE RODGERS, CET*

Troubleshooting horizontal start-up circuits

WHEN A TV RECEIVER COMES INTO YOUR SERVICE CENTER AND THE CUSTOMER BRINGING IT IN DESCRIBES THE PROBLEM AS "DEAD" — NO PICTURE, NO RASTER, NO SOUND — ONE POSSIBLE CAUSE could be a problem in the horizontal circuits. Before you can repair the set you will have to go through the following four checks to determine the cause of the problem.

- Check the operation of the horizontal drive circuit.
- Check the operation of the horizontal output circuit.
- Check the operation of the horizontal start-up circuit.
- Check the operation of the shutdown circuit.

There are many different horizontal start-up circuits that are used in modern TV receivers. In this article we will look at one specific circuit. It is used by Hitachi in a variety of its color TV receivers, and is in its M1CLXU chassis. Because it is found in Hitachi's larger screen direct-view receivers your customers will want to have these receivers repaired. This circuit provides four different sets of power to the TV receiver — 200 volts (for RGB driver collectors); 56 volts, 12 volts (regulated to 5 volts by Q741), and 26 volts. When the circuit does not operate, these voltages are not produced and the set appears dead.

*Courtesy *Hitachi Hi-Lite*. National Service Division, Hitach Home Electronics (America), Inc.

Table 1, is a listing of the specific Hitachi TV receiver model numbers that use this circuit.

Before discussing the operation and troubleshooting techniques for this circuit, consider these important safety precautions that you should observe while repairing the receiver.

- While it is being tested, the set must be powered through an isolation transformer. The chassis is hot. Using the transformer is the only reliable way to protect yourself against electric shock.
- The set does not have to be turned on by the power switch before you can perform the horizontal drive/horizontal output tests.
- Always observe "hot grounds."
- Always replace parts with substitutes that are identical in quality and rating to those used by the manufacturer.

TABLE 1
HITACHI TV's USING THE M1CLXU CHASSIS

27A×3B	31D×21B
27A×4B	31D×22B
27A×5B	31D×31B
27C×0B	31K×39K
31D×11B	31K×41B

How the start-up works

The Hitachi M1CLXU start-up circuit is interesting. The timed

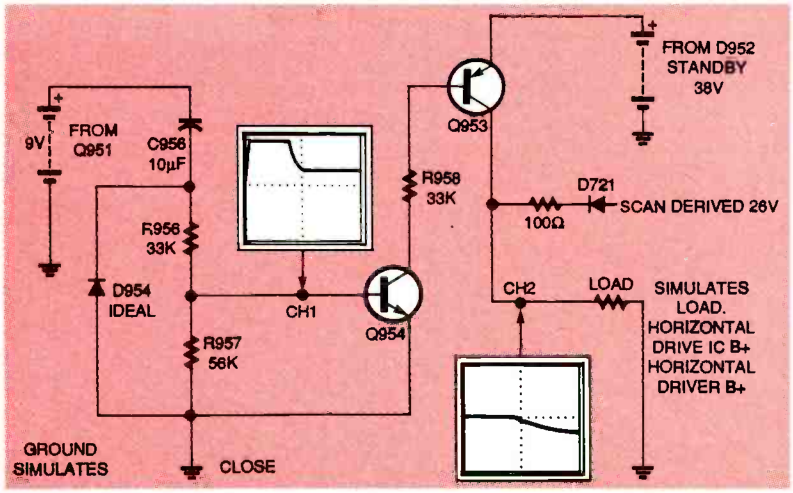


FIG. 1 — A SIMPLIFIED DIAGRAM OF THE HITACHI M1CLXU horizontal start-up circuit. The oscilloscope is set to 0.2 seconds. All of the start-up activity takes place within 1.2 seconds.

26-volt output provides both initial start-up B+ and the collector current for the horizontal drive transistor. When the set is switched on, start-up activity lasts for about 1.2 seconds. Following start-up, as the flyback transformer begins to develop secondary scan-derived voltages, the start-up circuit automatically turns off to allow the scan-derived 26-volt source to provide the needed B+ to operate the horizontal circuit.

Figure 1 is a simplified schematic of the start-up circuit. It illustrates the activities of the start-up circuit when the power relay closes (represented by the ground symbol at the junction of R957, D954, and the emitter of Q954). The 9-volt battery represents the voltage derived from a step-down transformer, rectified and regulated by Q951. A second B+ source is also derived from the step-down transformer through D952. It is shown as a +38-volt battery. Finally, the load resistor simulates both the horizontal drive B+ and the horizontal driver B+.

Looking back at Fig. 1 again, you will see that the oscilloscope's channel 1 is connected to the base of Q954, while the oscilloscope's channel 2 is connected to the simulated load resistor, and it is set to the transient mode. The trace represents a total time duration of approximately 2.2 seconds, more than adequate to represent the 1.2-second start-up time and to allow for the startup of the +26-volt scan-derived supplies.

As the relay driver goes to logic low, and the power relay closes, the junction of D954, R957 and Q954's emitter is effectively grounded. At this point, Channel 1 of the oscilloscope indicates a logic high at the base of Q954, and the transistor conducts. Simultaneously, C956 begins to charge.

Because Q954 is now conducting, Q953's base is pulled to logic low, causing it to conduct and directing the +38-volt source to the load (Channel 2 of the oscilloscope). Capacitor C956 continues to charge, and in about 1.2 seconds it disables Q954. During this time, the horizontal circuit began to operate, producing the necessary scan-derived voltages that are needed to sustain the operation of the horizontal circuits. Now Q954 turns off, disables Q953, and the scan derived +26 volts developed by the sweep circuit is delivered to the load.

However, when things go wrong, the circuit shuts down without starting the horizontal circuits and the TV receiver will not work and appears to be dead.

Figure 2 is a troublehooting chart for checking the horizontal drive circuit. It helps guide you through the circuit to find possible problems.

If everthing checks out in the horizontal drive circuit, your next step is to look at the horizontal flyback and horizontal output circuits. Start by connecting a +40-volt variable DC supply to the circuit. The negative end of the supply goes to the hot ground on the TV chassis. The positive output goes to pin 9 of the flyback transformer. Now connect your oscilloscope to the collector of the horizontal output transistor (Q711). The scope's negative terminal to the

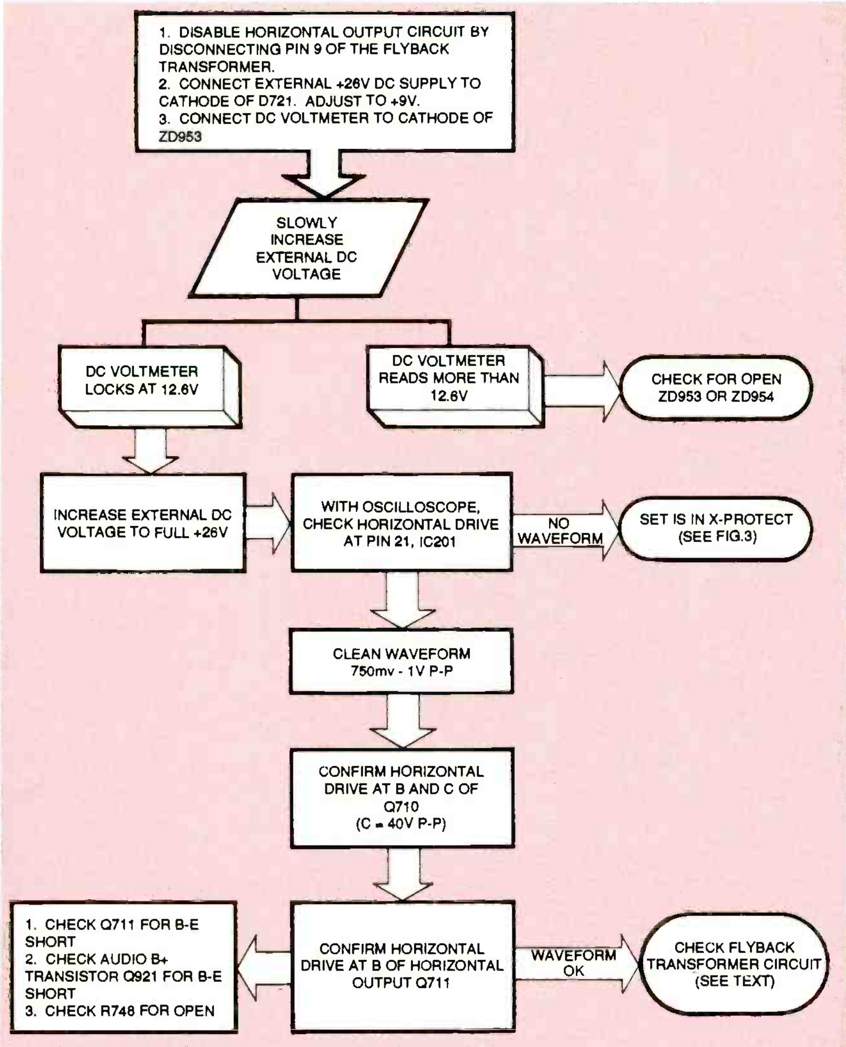


FIG. 2 — TROUBLESHOOTING CHART helps guide you through the horizontal drive circuit to find possible problems here.

hot chassis of the TV. Now slowly increase the output from the external power supply to +40 volts while monitoring the waveform on the scope. If the waveform is normal, you know that the flyback transformer and its related circuits are OK. If the waveform is distorted, look for excessive loads on any of the scan-derrived power supplies. Then look for defective scan diodes. The last possibility is that the flyback transformer itself is defective and must be replaced.

If all is ok here, you can go on to check the horizontal start-up circuit. First disconnect the collector of Q711, the horizontal output transistor. Then connect your oscilloscope to the base of Q954. Set the scope to DC, 1-volt per division, with the trace at the bottom of the display. Now plug in the TV and press the power switch. The trace should rise to the top of the display and then fall. If it does, the start-up circuit is OK. If it does not there are six possible sources of trouble. First, confirm that there is +9 volts at the positive end of C956. Then make sure that Q954's emitter goes low when the relay closes. Next, check both R956 and R957. Continue and confirm that B voltage on Q953 is +38 volts before the relay closes. Now confirm that B voltage on Q953 is 0.68 volt below emitter voltage when the relay closes. Last confirm that Q953's collector goes high for 1.2 seconds.

The last place to look for problems is in the shut-down circuit. Figure 3 shows you what to look for here. Although horizontal start-up circuits are complicated, we believe that this article and the accompanying troubleshooting charts will help guide you through to a successful repair when a "dead set" problem is caused by faults in these circuits.

If you enjoyed this story and would like to see more of this kind of article, please let us know. Write to Servicing Editor, Electronics Now Magazine, 500 Bi-County Blvd., Farmingdale NY 11735. Also tell us about other servicing subjects you would like us to cover. EN

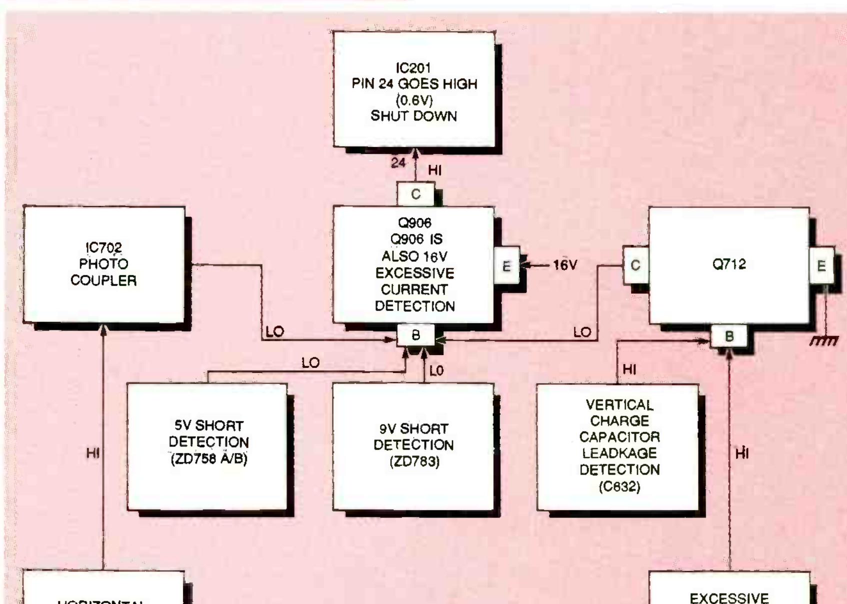


FIG. 3 — EASY GUIDE TO TROUBLES in the shut-down circuit helps spot faults rapidly.

BY JEFF HOLTZMAN

A better processor than the Pentium?

FINALLY, INTEL HAS SOME SERIOUS COMPETITION. IN OCTOBER 1995, CYRIX CORPORATION INTRODUCED ITS 6X86 CPU, FORMERLY KNOWN AS THE M1. EARLY BENCHMARKS (BY ZIFF-DAVIS) SHOW THAT A 100--MHz 6x86 outperforms a 133-MHz Pentium. Predictions are that it should perform better than a 150-MHz Pentium Pro. Hear hear!

Cyrix attributes its performance gain to a new kind of architecture that effectively puts multiple Intel-compatible CPU's on a single substrate, and minimizes the communications, hence connections, among them. (The architecture is outlined in Fig. 1.) Fewer connections means simpler designs and higher manufacturing yields. Redundant CPU's also simplifies design over RISC-based emulators, which break Intel instructions down into separately executable instructions.

IBM is manufacturing the processors for Cyrix, along with the French firm SGS-Thomson. The initial process creates 100-MHz chips with a 0.6-micron trace width in three layers, with a 150-MHz, 0.5-micron, five-layer design in the works. As part of the manufacturing deal, IBM gets to

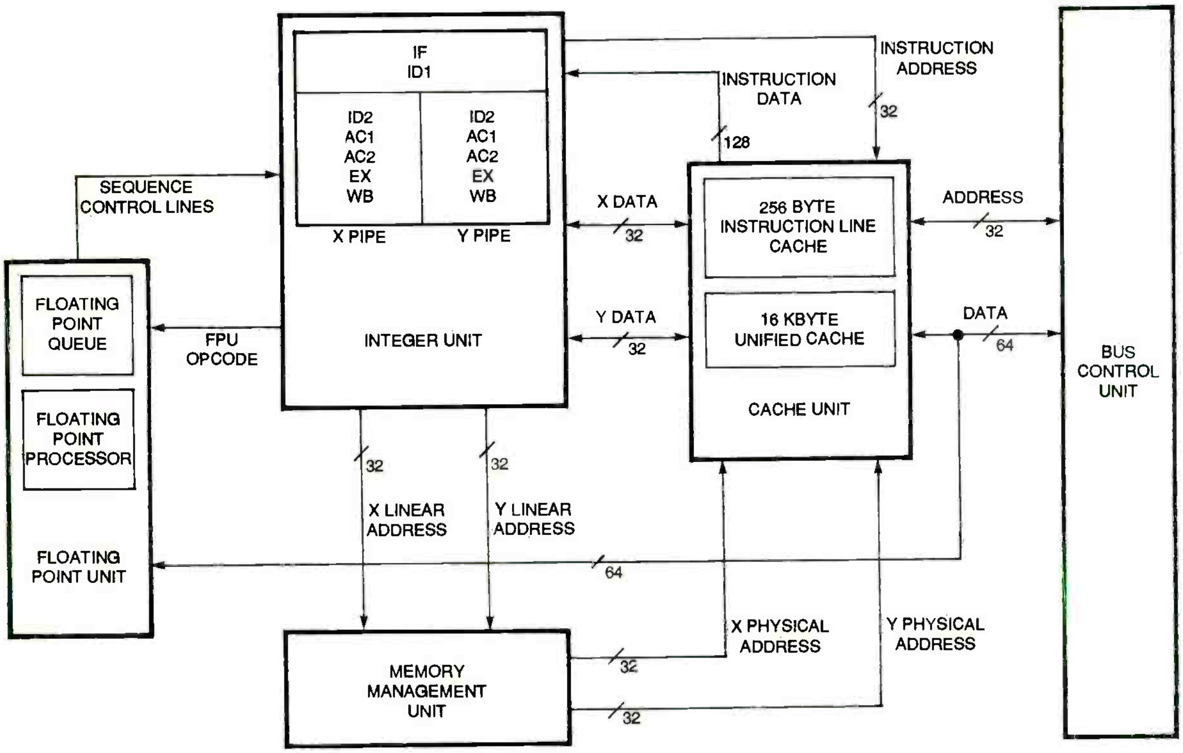


FIG. 1—CYRIX'S 6x86 ARCHITECTURE consists of five basic elements: integer unit, floating-point unit, cache unit, memory management unit, and bus control unit.

keep one of every three wafers manufactured. Presumably Big Blue is not just going to sit on those chips.

If it can happen to Intel, it can happen to Microsoft. Is "a better Windows than Windows" waiting in the wings?

Don't fence me in

I just don't get it. I've been using telecommunications almost as long as there have been facilities for doing so. E-mail and file transfer were all I needed. There was nothing particularly flashy or sexy about it; it was just an efficient way to communicate.

Now everybody and their aunt Minnie talks about the Internet, and worse, uses it. Although I don't want to sound like an elitist, the resulting congestion is really getting on my nerves. Transfer speed has slowed dramatically the past few years; even logging on is getting more and more difficult. My local service provider never used to be busy; now it's busy a good 50% of the time.

I feel like a rancher 150 years ago in the Old West. I was among the first, and it was great. But now the settlers are moving in, towns are springing up, and barbed wire is getting strung. Maybe it's time to move on?

Maybe it's better to look at it in a different light, say that of TV. Which reminds me of a comment by a former chairman of the FCC, way back in 1961, in which he described it as: "a vast wasteland—a procession of game shows, violence, audience participation shows, formula comedies about totally unbelievable families. . . blood and thunder. . . mayhem, violence, sadism, murder. . . and cartoons. . . and, endlessly, commercials—many screaming, cajoling, and offending."

he current state of the Internet is not that different—and the advertising is already there. However, unlike broadcast TV, Internet bandwidth is limited. In other words, if twenty million people are tuned into *Roseanne*, that doesn't prevent me from watching *Nova*. But if twenty million people are spewing packets (such as vanity Web pages) across the Internet, it has an impact on my ability to communicate.

The solution may turn out to be "premium" access suppliers, who provide net access with guaranteed connectivity and throughput.

HTML and Java

Web "pages" are really nothing more than tagged ASCII files that are transferred from a Web server to your computer, where a local interpreter, or browser, displays the file according to the contents of the tags. The tagging language is called HTML (hypertext markup language); it is a subset, although not a proper subset, of an ISO-standard text-markup language called SGML (standard generalized markup language). HTML was originally created by the authors of Mosaic, the first Web browser. HTML is evolving fast, and it's interesting to watch the Web-tool vendors scramble in this area. Basically, it seems that whatever Netscape does, everyone else copies. There is a real standards effort afoot, but even there Netscape dominates.

As a language, HTML is pretty lame, but it's simple enough that Aunt Minnie can do it. So here's Aunt Minnie's chance to show the world that she too can do something with computers. In that sense, HTML is the BASIC of the Internet.

Of course, shipping around big chunks of ASCII text is not very efficient in terms of network traffic, nor is it very secure. Nor is it "intelligent." That's where Java comes in. Java (like Visual Basic) is a partially compiled C-like language that can be shipped around the net more efficiently than HTML. And because it's a real programming language, it can do things itself, in contrast to the HTML model of being passively interpreted.

Java was created at Sun Microsystems, a vendor of Unix workstation hardware and software. By the time you read this, Java systems should be available (free of charge) from Sun for most major platforms, including Windows. Netscape and the other browser companies have already pledged support for Java; this means that Netscape will be able to run Java programs, called "applets," much as it now uses external engines to display audio and video.

(To digress for a moment, Sun's corporate motto has always been "The Network is the Computer." What does that mean in an era of tens of millions of Internet users?)

Some see Java as revolutionary, with the same capacity to wreak change as the original personal computers. Could be, but I doubt it.

Others see the emergence of a new class of device that would provide Internet connectivity for everyone, but without the baggage of a full-blown computer system. These boxes would be like cable-TV converters, but interactive. They would run mini Java programs downloaded as needed from the net itself, thereby doing away with the need for lots of persistent storage (hard disk). The vision is not that the box would replace the computer; rather it would be yet another communications device alongside the radio, TV, snail-mail, and so forth. Why can't we have one Newton-like device that does it all (including cellular communications)?

Visual Basic 4

Some people argue that Basic is a horrible, unstructured, unobject-oriented, performance-challenged language. That's all true. But it does meet a market need. Microsoft's Visual Basic is king of the roost in Basic-land. The latest version is 4.0; it comes on a CD and with six inches of printed documentation, about twice the volume of the previous version.

Visual Basic 4 is two products in one. The first is a 16-bit version that both runs in and produces executables for the Windows 3.x environment. Both the development environment and the executables it produces can also run in 32-bit environments such as Windows 95 and Windows NT. The second product is 32-bit-only—Windows 95 and NT, but not OS/2, Macintosh, or Unix—for both target and development environments.

Why would you even want to run the 16-bit version? If you're developing for users still running Windows 3.1. Why would you want to run the 16-bit version in a 32-bit environment? Because the environment is more robust. For example, when Visual Basic 4 crashes under Windows 3.1, it gobbles about 10% of system resources. But when it crashes under Windows 95, it takes only about half that! Is that impressive or what?

Here are some initial impressions based on several weeks of intermittent use.

- The Visual Basic 4 development environment is marginally better than previous versions, but still can't hold a candle to Borland's Delphi.
- The collection of components (mostly screen widgets such as check boxes, command buttons, data grids, and the like) included with Visual Basic 4 is much richer than in previous versions, but most of the interesting ones are 32-bit only.
- Visual Basic 4 goes object-oriented. Microsoft seems never to want to push the technology envelope for development tools very far. Thus Visual Basic 4 has weak (but certainly better than nothing) support for creating your own objects. You can't compile them (as you can in Delphi), they can't have their own events, and they don't support inheritance. But they do support encapsulation, so you can increase the robustness of your modules.
- There are a few new language constructs, including a For Each ... Next mechanism, and a With clause borrowed directly from Pascal.
- Database functionality and performance have both increased dramatically.

The biggest architectural change is in the ability to build OLE (object linking and embedding) servers. For example, major Microsoft applications such as Word and Excel are OLE servers whose functions can be controlled by external programs. With this approach, you could write a data-logging and display program using Access database tables, Microsoft Graph charts, and numerical analysis performed by Excel. Your Basic application would programmatically tell each of the other applications what to do, and gather the results. With Visual Basic 4, you can create your own OLE server programs that other custom—and off-the-shelf—applications can, in turn, use. Performance issues remain cloudy at present, but I should have more data next time.

On the bookshelf

If you do any Visual Basic programming, but need to dig deeply into the Windows API, check out the *PC Magazine Visual Basic Programmer's Guide to the Windows API*, by Daniel Appleman. It's good stuff.

201 Principles of Software Development, by Alan M. Davis, is a must-have book of pithy "fortune cookies" for any programmer working on programs longer than one line of code. The book could have been titled *201 Principles of Software Engineering*, because it is not concerned with the details of data structures, algorithms, and programming languages. It is really concerned with designing, planning, organizing, and managing software-development projects. Each of the 201 principles is presented in a paragraph of two of text; each is also backed by a reference to a textbook or journal article. The principles can be read in bite-sized gulps; nonetheless, they represent a great deal of distilled thinking. Although many principles are specific to *software* engineering, many others are applicable to *systems* engineering in general.

As a sample, here's an extract from Principle 196, concerning software "entropy:"

"Any software system that undergoes continuous change will grow in complexity and will become more and more disorganized. . . . all software systems . . . change . . . and change causes instability, [so] all . . . software systems . . . migrate toward lower reliability and maintainability."

Think about that, Bill Gates, in relation to your favorite operating system or multi-decamegabyte application. (No, decamegabyte is not really a word. It just seemed convenient to express the tens-of-megabytes concept.) If you read only one book on software (or systems) engineering, this should be it. I wish the "designers" of HTML had read this book beforehand.

E-mail

My November column ("Abandon All Hope"), which concerned the possibility of entrepreneurial success in the computer business, has generated some controversy, to say the least.

Allan Unrau writes, ". . . while you are correct about the realities of launching a new product, your conclusions couldn't be further from the truth. I submit to you that the computer industry offers the *best* hope of building a successful new business, not the worst. The computer industry is still relatively young, and very dynamic, offering opportunities everywhere for those who care to look. You are correct in saying that the technical end of things won't build a successful business on its own. But without an innovative product, there is nothing to base the business side of the company on."

Allan is 100% correct. I purposefully wrote that column with its negative slant for two reasons: 1) As a challenge to those tough enough to stick it out, and 2) As a warning to young dreamers about what's really involved.

In a similar vein, Tom Honaker writes "You're dead on the money in everything you said. It's hard, it's risky, it's unstable, it's maniacally competitive, it's not for the timid or the uninformed—and it's a blast."

On the other hand, Randy C. is an inventor who grudgingly acknowledges the truth of what I said, but would like to see a more positive outlook. If I had written an article gushing about how great the computer business is and the wonderful opportunities it presents, nobody would have noticed, and no thought would have occurred. I think the article as presented had the intended effect.

I enjoyed hearing from Palacios Aristarco at the University of Mexico. Like me, Palacios refuses to give up old tools just because new ones come along. For example, he still uses DOS SideKick 2.0. Palacios recently bought a Commodore 64 for experimentation, but the machine began displaying only garbage on reboot. If you can help, contact him at felec3@speedy.coacade.uv.mx. Contact me at jkh@acm.org. EN

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5963 Corson Ave., Ste 140
Seattle, WA 98108

Wyoming

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Build this Theremin

Build Theremax, a theremin for the 90s!

JOHN SIMONTON

SINCE IT'S INTRODUCTION TO THE general public in the late 1920s, the image and tone of the theremin has captured the imagination. Eyes widened at the sight of a musician producing sound using only a conductor's gestures. And the theremin's pure tones, able to stand out without distortion against even the full fortissimo of a symphony orchestra, were like nothing anyone had ever heard before.

Was it a hit? You bet! Theremin concerts were performed in front of standing-room-only crowds in halls where audiences were ordinarily sparse. The place of the theremin in a "modern" orchestra was a given for such maestros as Leopold Stokowski, who used one or more in numerous concerts of the Philadelphia Orchestra during the late 1930s. RCA thought that every cultured home would have a theremin, but things didn't work out that way for a lot of reasons.

We'll talk more about these things shortly and also look at how to build a theremin that is based on the same heterodyneing principles that were key to the original. Theremax produces the classic sound while adding embellishments made possible by the economy of transistors and integrated circuits. It can function as a stand-alone instrument or as a gesture-sensing controller for other musical instruments or in performance art applications.

The theremin Zeitgeist

The *aetherphon* that Lev Termen showed to a Russian physics conference in 1920 was an adaptation of his earlier invention, the Radio Watchman. What has this to do with our story? Just this: Lev shortly moved to New York, Anglicized his name to Leon and began calling the instrument by his new American surname of Theremin. And this: Both the Aetherphon and the Radio Watchman, which emitted a squeal in a pair of headphones when a person entered a protected area, were among the earliest applications of heterodyneing, a principle that in one form or another underlies all forms of electronic communication. In fact, if Theremin's work did not precede the invention of the superheterodyne by Edwin Armstrong in 1918, it was at least happening at the same time.

You likely already know that when two signals are combined in a mixer the result is a signal with new frequency components that are the sums and differences of the frequencies that were in the originals, as well as the original themselves. This is the basic principle behind AM radio. For example, if 100 kHz and 99 kHz sine waves are combined in this way, the result will be a new waveform that also has 1-kHz and 199-kHz components. There are a couple of neat things about this, the first being that while the two original frequencies are both well above the range of human hearing, as is the sum frequency of 199 kHz, the 1 kHz difference frequency is right in the middle of what we hear best. The second neat thing is that relatively small changes in either of the source signals will produce a relatively large change in the difference frequency. If the 100 kHz signal changes by ½%, to 99.5 kHz, the output signal will halve (an octave change) to 500 Hz.

All of this is important in Radio Watchmen and Aetherphons because the presence of a human body can easily produce a few picofarad change in the capacitance of a piece of wire hanging off in space. If the capacitance of the wire is part of a tuned circuit the result is a small change in the resonant frequency. In much electronic equipment, such parasitic capacitance is a flaw that must be overcome through shielding, buffering oscillator circuits, and so on. Here, however, it's the whole point.

Here you have your basic theremin: A pair of high frequency oscillators are running at essentially the same frequency, one fixed and the second connected to a sensing antenna. As the hand of the performer approaches the antenna the frequency of the sensing oscillator goes down, so the frequency difference between the two oscillators increases. The outputs of the oscillators are combined and a low pass filter used to allow only the lower difference frequency to pass, which is the sound you hear. The original Aetherphon was little more than this: a foot pedal was used to control the volume and a switch was provided to mute the tone completely.

But on the way to becoming a theremin, some changes were made. By the time the design was licensed by RCA in 1929, a circuit had been added so the performer controlled the volume and could articulate notes with movements of his left hand relative to a horizontal "volume"

Clara and Leon

Lev Termen, who later changed his name to Leon Theremin, was born in St. Petersburg Russia at the turn of the century. So was Clara Reisenberg, who later took her husband's name of Rockmore. Although destiny was to join their lives, the two didn't meet one another until after they both had emigrated to the US in the late 1920s.

Leon began his studies of physics and music composition at the University of St. Petersburg. While continuing his study of physics at the Petrograd Physico-Technical Institute in 1919, he became director of the Laboratory of Electrical Oscillators. In this environment, he was able to combine his interests in music and physics to produce what is generally accepted as the first electronic musical instrument. He began demonstrating the aetherophone, as he originally called the instrument, in 1920, and it is known that Lenin, the revolutionary father of communism, was among those who saw a demonstration. Lenin may have been responsible for Leon's trips to western Europe and the USA in search of cultural acceptance of the revolution and capital for Leon's many inventions.

Clara was a musical prodigy who began playing the violin at the age of 4 and the following year was the youngest student ever admitted to the Imperial conservatory of Music in St. Petersburg. It is difficult to reconcile the time lines of various accounts, but by 1927 she and Leon were both in New York after successful independent concert tours.

During this time, Clara's hand muscles began to show the devastating effects of childhood malnutrition, which was wide-spread in Russia during the transition from czarist to Bolshevik control. It appeared that her career as a concert violinist would soon be over. She realized that the theremin was her only hope of continuing her musical career and over a period of several years she worked closely with Leon to develop an instrument that would allow her the expressive control needed for concert work. To the end of his days, Leon was never able to provide her with her greatest wish, a polytonic theremin capable of playing more than one note at a time.

While it is said that there was a romantic relationship between the two, Clara eventually married a prominent impresario of the time to become Clara Rockmore. This arrangement had a very beneficial effect on her career and, consequently, on the the exposure that the theremin received. Leon married a dancer and established an acoustical laboratory in New York where he continued the development of various electronic musical instruments.

Clara spent the rest of her life in New York and gave many coast-to-coast concert tours, but in the late 1930s Leon disappeared. It isn't known whether he was responding to the pressures of his inter-racial marriage and yearning for his homeland, or if his homeland was yearning for him. Following the purges of the 1917 revolution, Russia was short of technical talent and some sources say he was taken involuntarily. It is typical of the romanticism of the theremin mythology that by some accounts he was kidnapped by the KGB, an organization that did not exist until 1954. In any case, one morning in 1938 he was missing from his New York apartment and never again contacted his wife and children or any of his associates. Now it is known that he did return to Moscow and was involved in electronic research for the government until 1964 when he retired to became a professor of acoustics at the University of Moscow.

In 1991, as a consequence of glastnost and with permissions obtained by John Chowning of Stanford University, Leon was able to return to the US for lectures and to participate in the filming of Steven Martin's "Theremin: An Electronic Odyssey." At one of the lectures where Leon was only to speak, he gave a spontaneous solo concert that was a moving performance for a man in his 95th year. Clara, always proud of her appearance, is said to have had great reservations about seeing him again in her old age, but she finally agreed and they were reunited on this trip.

After a brief stay in the US, Leon returned to Moscow where he died in 1993.

antenna which, interestingly enough, was *not* part of a heterodyne circuit. The right hand controlled pitch by its proximity to a vertical "pitch" antenna. There were several different package configurations for the theremin including one that looked like a music stand with antennas and a massive "U" shaped case with antennas on the vertical arms of the U. The most common was the lectern style case like we've used.

One of the more unusual configurations was the Terpsitone, a dance platform with theremin antennas spread around it so that the dancers would create the music as they danced to it. That seems to be a pretty cool idea even when compared to today's world of hip performance art. Theremax has control-voltage and gate outputs that make it even more appropriate for these kinds of applications.

For a number of reasons the theremin never replaced the spinet in the parlors of America; the depression was not a good time to be introducing new musical instruments. But also, the RCA design was one that was deemed unplayable by the leading thereminist of any age, Clara Rockmore. In that design, volume, and consequently articulation, were controlled by varying the power to the filaments of a tube. Thermal lag of the filaments meant that everything had to be played glissando—it was essentially impossible to add quiet spaces between notes played quickly. The theremin used by Clara Rockmore in all of her concerts was a unit custom made by Leon Theremin that used a different approach to controlling volume. After a single run of a couple of hundred units, RCA discontinued theremin production.

Yes, and let's be honest: The biggest reason that theremins have never become overwhelmingly popular is that, spooky sci-fi noises aside, they are much more difficult to play than you might think—despite's RCA's claim that "anyone who can hum can play one."

Well, actually, riffs like the theremin lick in Brian Wilson's "Good Vibrations" aren't too bad, and the one in Led Zeppelin's "Whole Lotta Love" won't take forever to master either. The common complaint is that there is no tactile feedback, no keys or frets, and the pitch response to hand position is nonlinear. That attitude might not get you much sympathy from violinists, but they do at least have a fingerboard to touch.

You've been warned. Let's see about building one of these beasts.

Design analysis

The main Theremax schematic is shown in Fig 1. Its power-supply section is shown in Fig. 2. At the heart of the circuitry are four oscillators, two of which are mixed to produce the pitch signal, and two of which are mixed to produce the volume-control signal. If it occurs to you that one oscillator could

Continued on page 56

ELECTROMAGNETIC LEVITATOR

Build this electromagnetic levitator, and you can defy gravity and make objects float in mid air!

DAVID WILLIAMS

MAGNETISM AND A CLOSED-LOOP control system are the secrets to the stunning presentation produced by this electromagnetic levitator.

An electromagnet creates a magnetic field that attracts a hollow steel globe or similar object upward. The globe doesn't crash against the magnet, however. Instead, as it draws near, the magnet's intensity weakens, letting the globe drop slightly. As it drops, the magnet's intensity again increases, pulling the globe up again. The process is so smooth, however, that the globe appears to float, held in space by invisible forces.

An infrared emitter and detector mounted across from each other create an invisible beam that passes slightly below the coil. As the object rises towards the electromagnet, it begins to block the beam. When the beam becomes blocked, the output of the detector is reduced which in turn reduces the current in the electromagnet's coil. The reduced current weakens the magnetic field, the object begins to drop and the detector once again sees more of the beam. This causes the circuit to increase the magnetic field and the cycle repeats as the object is attracted upwards again.

The circuit is designed so that eventually an equilibrium is reached where the magnetic attraction exactly balances the force of gravity pulling on the object. The object then remains perfectly suspended in the infrared beam's path with no visible means of support!

Basics of closed-loop control

Open- and closed-loop control systems surround us. An open-loop system is one in which the signal that controls the output

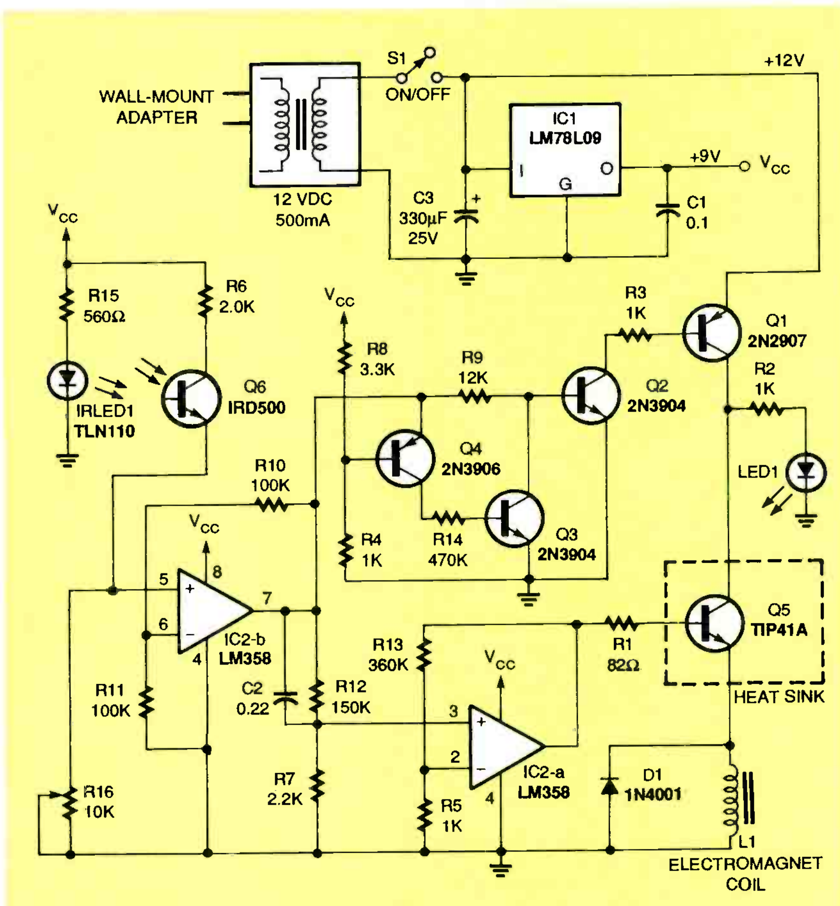


FIG. 1—THE LEVITATOR CIRCUIT. IRLED1 and photodetector Q6 are used to sense where the globe is in relation to the electromagnet.

is independent of the output itself. By contrast, the signal controlling the output of a closed-loop system is dependent on the system's output.

A space heater or table-top fan are examples of open loop control systems. They are controlled by a switch, and once they are turned on, their output remains constant regardless of how hot or cold it gets.

A home furnace and air conditioner are examples of closed-loop control systems. Both monitor their outputs—the hot or cold air—with a thermostat, and regulate their outputs accordingly. The thermostat closes the loop by feeding back an *error signal* to the furnace or air conditioner.

Circuit details

Figure 1 is the levitator's schematic. Power is supplied by a wall mounted AC/DC adapter with an output of 12 volt DC at 500 milliamperes. The electromagnet coil draws most of the current in this circuit, so it is powered directly from the 12-volt output of the power adapter. Stable voltage for the rest of the circuit is obtained by regulating the adapter's output to 9 volts with IC1, a LM78L09 voltage regulator that is capable of supplying up to 100 milliamperes of current. Capacitors C1 and C3 provide additional voltage filtering.

IRLED1 is an infrared light emitting diode, much like those used in infrared remote controls for consumer-electronics equipment. Resistor R2 limits the forward current to IRLED1 to about 15 milliamperes. The IRLED emits a constant, invisible beam whenever switch S1 is turned on. Phototransistor Q6 detects the infrared beam; it is wired with R6 and potentiometer R16 to convert the infrared beam into a DC voltage. Potentiometer R16 adjusts the output voltage of Q6, which is fed to pin 5 of IC2-b, one half of an LM358 operational amplifier.

The op-amp, which is configured for a gain of two, [(R11 + R10)/R11] buffers and amplifies the output of Q6. The output of IC2-b is fed to a second amplifier stage, IC2-a through C2 and R12. The output signal from IC2-a drives transistor Q5 to vary the current to the electromagnet coil. Because Q5 gets very warm during operation, it requires a good heat sink. Diode D1 protects Q5 from reverse voltage spikes from the coil.

Mylar capacitor C2 plays an important role in this circuit. It forms a differentiator with IC2-a. The capacitor blocks slow voltage changes, but passes any rapid changes in the input signal and allows them to be amplified by IC2-a. The slow voltage changes are attenuated by R12 and R7 before being amplified by IC2-a.

The purpose of this part of the circuit is to perform closed-loop control using a combination of proportional and derivative modes. Both modes are needed to insure that the levitation is stable.

The rest of the circuit functions as a voltage-level detector that uses Q1 to switch the 12-volts to Q5 on or off. The level detector keeps the electromagnet powered off when there is no object in the beam. This is to prevent overheating of the coil. The level detector also turns the electromagnet off if the object rises too far and completely blocks the beam.

When nothing is blocking the infrared beam, the output of IC2-b will be greater than 2.7 volts. This causes Q4 and Q3 to

Continued on page 67

PARTS LIST

All resistors are ¼-watt, 5% unless otherwise indicated.

R1—82 ohms
R2, R3, R4,R5—1000 ohms
R6—2000 ohms
R7—2200 ohms
R8—3300 ohms
R9—12,000 ohms
R10,R11—100,000 ohms
R12—150,000 ohms
R13—360,000 ohms
R14—470,000 ohms
R15—560 ohms, ½ watt
R16—10,000 ohms, panel-mount potentiometer

Capacitors

C1—0.1 µF, ceramic disc
C2—0.22 µF, 50 volts, polyester film
C3—330 µF, 25 volts, electrolytic

Semiconductors

IC1—LM78L09, 9-volt DC regulator (TO-92)
IC2—LM358N, dual op-amp
Q1—2N2907 (or MPS2907) PNP transistor
Q2,Q3—2N3904 (or 2N4401) NPN transistors
Q4—2N3906 (or 2N4403) PNP transistors
Q5—TIP41A, NPN power transistor
Q6—IRD500 infrared photo detector (Jameco No. 112168 or equiv.)
D1—1N4001 (or 1N4004) silicon diode
LED1—Red light-emitting diode
IRLED—TLN110 infrared LED (Jameco No. 106526 or equiv.)

Other Components

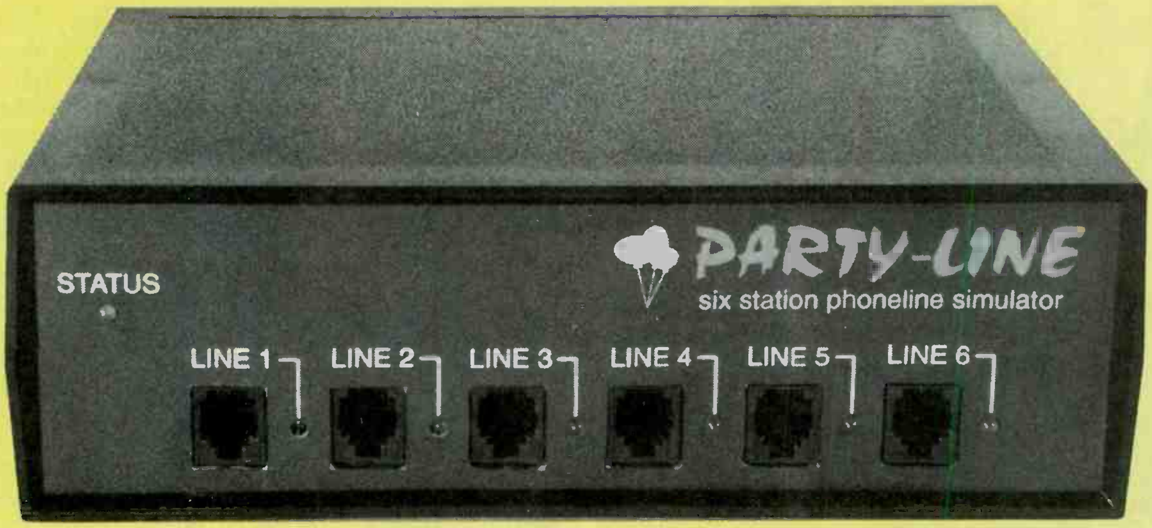
L1—Electromagnet coil—relay coil, 6-volts (P&B: KUP11D15—see text)
Adapter—12 volts DC, 500 mA
S1—SPST sub-miniature toggle switch

Miscellaneous: etched printed-circuit board, heat sink for Q5 (TO-220), plastic enclosure (PacTec K-HPL), hollow metal globe, aluminum bracket, LED panel bezel mount (2 ea.), plastic LED clip mount, knob for potentiometer, No. 6-32 × ⅜ inch screw, No. 6-32 × 1.0 inch screw (2 ea.), No. 6-32 × ¼ in. screw (2 ea.), No. 6 hex nut (2 ea.), No. 4-male/female, ¼ inch hex standoff (4 ea.), No. 4-40 × ¼ inch screw (5 ea.), No. 4 hex nut (5 ea.).

Note—The following items are available from: LNS Technologies, 20993 Foothill Blvd, Suite 307R Hayward, CA 94541-1511 Phone: 1-(800)-886-7150.

• Complete kit of parts for the Levitator (LEV-KIT), including etched and drilled circuit board, relay coil, wall transformer, aluminum bracket, enclosure, metal globe and all other components listed above: $75.00
• Etched and drilled printed-circuit board (LEV-PCB), $10
• Electromagnet coil (LEV-COIL) $10.
• Drilled aluminum bracket (LEV-BKT), $5.

Please add $5.00 shipping and handling charges to all orders. California residents add local sales tax. MC/VISA orders accepted. No C.O.D. orders.



BUILD THE PARTY LINE

Construction and configuration details for a super-slick phone-line simulator.

THOMAS E. BLACK

LAST TIME WE PRESENTED AN OVERview of Party Line, an inexpensive phone-line simulator that provides authentic dial, ring, and busy signals, supports Caller ID and Distinctive Ringing, and can even be used as the hub of a six-line intercom system. For a detailed description of features and functions, as well as an overview of how it works, see last month's issue.

This month we'll dive right into the details of how it works. Recall that the circuit consists of five major sections: Input, step-up, microcontroller, DTMF decoder and call-progress generator, and power. Also, there are three separate grounds (analog, digital, and high-current), which unite at the power supply.

MCU circuit and software

Figure 3 shows the microcontroller (MCU) portion of the circuit. A PIC16C57 provides all system intelligence. The PIC is a member of Microchip Technology's family of high-performance, low-cost, 8-bit microcontrollers. Features include 2K of ROM, 72 bytes of RAM, 20 digital I/O pins, and very low power consumption—all in a compact 28-pin package. For more information on the PIC family, contact Microchip Technology, Inc., 2355 West Chandler Blvd., Chandler, AZ 85224-6199. Tel: (602) 963-7373, Fax: (602) 899-9210.

The MCU's internal ROM holds the software—more accurately, *firmware*—that controls Party Line. (Firmware is nonvolatile, which means that it isn't lost when power is turned off). Firmware-controlled functions such as Ring Generation, Tone Detection, and Relay Control are event-driven, so all features work together seamlessly. Unlike simple loop-controlled programs, Party Line's design uses a time-based task scheduler to control hardware operation.

Programming the microcontroller with the Party Line firmware requires special equipment. If you don't have access to the requisite equipment, pre-programmed MCUs are available as mentioned in the Parts List.

The firmware is copyright protected and is not public domain—it cannot be freely copied or distributed. However, you can use the PL6.OBJ software in your personal project at no charge just by downloading it from the Gernsback BBS. You will find it under the name PL6.ZIP. Please review the Hobbyware information included in the companion README.TXT file for full details about using the firmware in your personal project.

Time and date

Time information broadcast by the Caller-ID function comes from a software-maintained 24-hour clock. Unlike your personal computer, Party Line does not use a dedicated chip to maintain time. Instead, a one-second counter is obtained using the MCU's internal counter and dividing the oscillator frequency. The hour and minute data is derived from the counter. The real

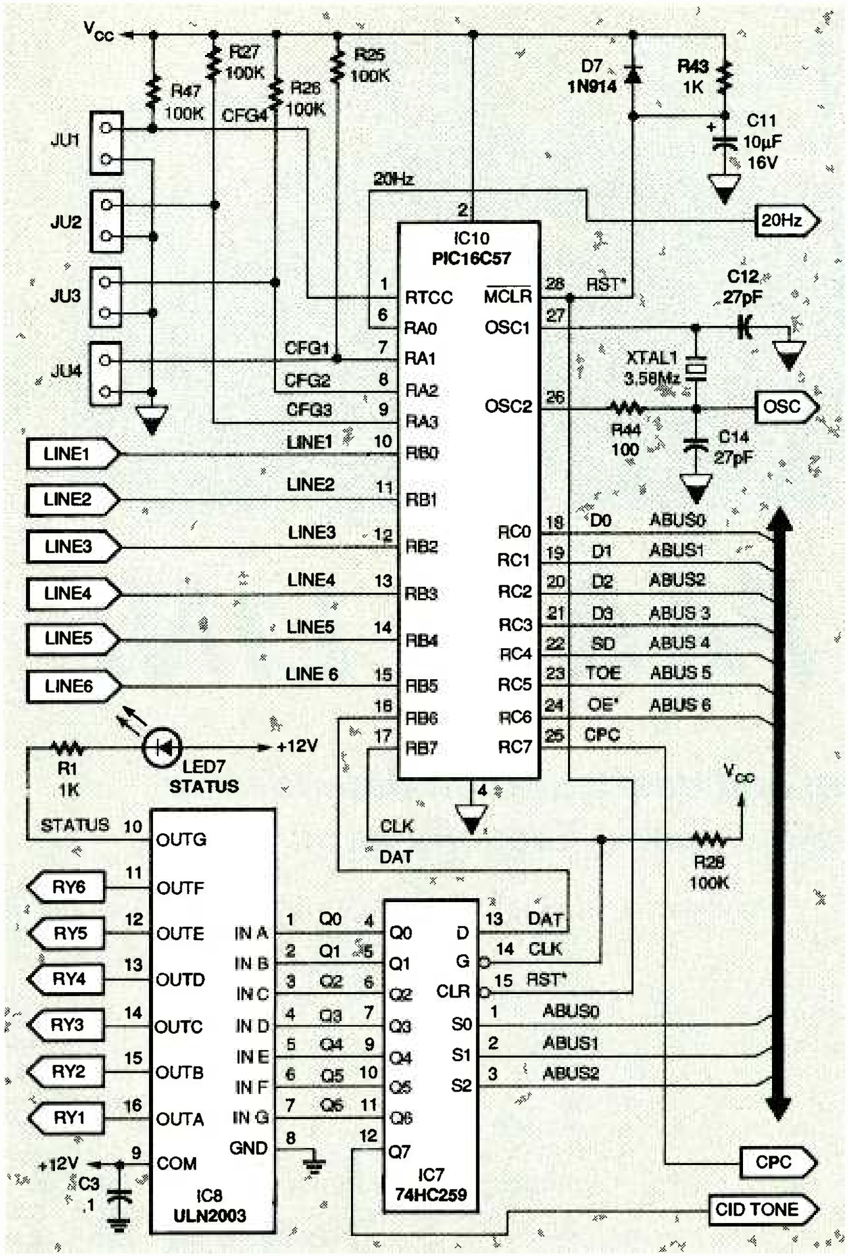


FIG. 3—THE MICROCONTROLLER reads line status from all six stations and controls their connections to the talk and ring circuits.

time clock function has been included so that you can experiment with Caller-ID products, but the clock is not designed as a precision timepiece; it may gain or lose a few seconds each day.

Unfortunately, because of limited ROM space, we were unable to include a date-tracking function. Thus, if you want the Called-ID date display to show the correct date, you must manually update the date on a daily basis.

Because the time (and date) information is stored in the MCU's volatile RAM, it will be lost whenever the MCU resets, such as when AC power is lost. The default date is Jan 1, and the default time is 12:00 am.

I/O control

The MCU's I/O lines monitor the hookswitch- and DTMF-decoder signals, operate the six line relays, and control the call-progress tone generator.

The twenty I/O lines consist of three port groups, A, B, and C. Ports B and C have eight lines apiece (RB0–RB7 and RC0–RC7, respectively), and Port A has four lines (RA0–RA3). The software configures RA0, RB6, RB7, and RC5–RC7 as outputs; RA1–RA3, RB0–RB5, and RC4 as inputs; and RC0–RC3 are used bidirectionally. A special MCU input signal, RTCC, is normally used as a counter input, but a software trick allows it to be used as an additional input port for configuration control.

In conjunction with RTCC, the RA1–RA3 inputs determine start-up configuration values, and RB0–RB5 monitor the optoisolated loop detectors that indicate when a phone goes off-hook.

The RC0–RC3 lines form a miniature data bus for reading DTMF codes from IC15 (Fig. 7), writing call-progress tone codes to IC14, and writing relay codes to IC7, an eight-bit addressable latch. In addition, MCU outputs RB6, RB7, RC5, and RC6 form the control signals for the bus; their job is to ensure that the correct data is read from or written to the right place at the right time. For example, to output a bit to the addressable latch (IC7), you would place data (0 or 1) on MCU signal RB6, the address (0–8) of the desired latch on RC0–RC2, and then toggle RB7 low.

Control line RC5 triggers a read of DTMF values from IC15, and RC6 latches call-progress tone codes into IC14. The RC4 input is normally low; the DTMF decoder drives it high when it detects a valid signal.

The last I/O bit to discuss is RA0. Its job is to provide the 20-Hz ring signal used by the step-up circuit. Low-end telephone simulators often use a 60-Hz ring signal because it is easily derived from the AC power line. However, some phone equipment will not operate correctly with a 60-Hz signal. To ensure compatibility, we use an accurate, software-generated ring signal.

The ring signal generated by the MCU must be isolated and stepped up to drive the telephone line talk circuit. As shown in Fig. 4, the high voltage is generated by push-pull

Continued on page 71

LOW-COST SOFTWARE for PC-BOARD DESIGN

You can design professional-quality printed-circuit boards on your desktop PC.

TJ BYERS

LAST MONTH, WE LOOKED AT LOW-cost software solutions for creating printed-circuit boards on your PC. We continue this month with packages that link the board-creation process with schematic capture.

It used to be that when you linked a PC-board layout program with schematic capture software, you could expect the price to go through the roof. Fortunately, that's no longer true. In fact, you can buy PC-boards, a DOS-based PC-board layout program which accepts netlists from programs like SuperCAD, OrCAD and Tango, for as little as $99.

However, when shopping for netlist-supported PC-board software, you have to be aware of the extra options available—which may add extra cost. For example, one of the benefits you can gain from this coupling is a ratsnest, a "diagram" of where the traces should be placed. Other benefits are autorouting and circuit simulation. Do you want it or not, and at what cost? These are but a few of the topics highlighted in these reviews.

Product:	DC/CAD
Version:	6.09
Price:	$295
Platform:	DOS
Publisher:	Design Computation, Inc.

DC/CAD is a DOS-based, fully integrated schematic capture program with linked PC-board layout program. Without the optional autorouter, DC/CAD sells for a low $295. Unfortunately, the autorouter is a $995 option—when it's on sale! (otherwise it costs $1495)—which places it way outside our $350 limit, never mind the basic package needed to support it. DC/CAD supports board sizes up to 32 inches square, and an unbelievable 64 layers.

Unlike most combination programs, DC/CAD has only one screen that's used to create both schematics and PC-board layout, but not at the same time. (See Fig. 10.) The PC-board layout mode is actuated from the same opening menu used for schematic capture. Going into the PC-board layout mode via a keyboard command simply turns off some menu commands and activates others. However, you may find DC/CAD quite hard to learn and use, because the commands, which are easily activated from a menu or the keyboard, aren't like any others in the industry. For example, instead of save, you use the Put command. Get means load a drawing, and Create turns on the macro recorder.

The transfer of data from schematic to PC-board layout is totally seamless. DC/CAD is unusual among programs in this price range in that it has a built-in autoplace tool that extracts the device's physical description from the schematic netlist and places the part on the circuit board—after you've defined the board's shape, of course. However, you'll need to do a lot of manual cleanup after automatic placement, but it's better than having to manually pull the parts from a library list. Parts can be rotated or flipped to the other side of the board, but the ratsnest doesn't become available until the placement process is complete, so you have to guess at the best placement positions. Forward and backward annotation, where changes in the schematic or in the circuit board layout are automatically reflected in the other program's netlist, is provided.

Fortunately, a dynamic ratsnest is visible during the routing procedure. As connections are made, the ratsnest lines disappear one by one, which makes it easy to see your progress. The edit functions are plentiful, powerful, and easy enough to use once you get the hang of using them. Rubber-banding is supported, as is group editing. Both zoom and part rotation have virtually infinite resolution. Once a command is selected, it can be executed as many times as you wish without going back to the main menu. And while there's an Undo command, it only undoes deletions—that is, it won't undo a symbol move or rotation.

A wide range of printers and plotters are supported, and you can size the drawing to fit the sheet. You also get support for DXF (AutoCAD), Gerber, and N/C Drill files. Component, solder, and silk-screen masks are also available.

WHERE TO BUY

BoardMaker I
Ohio Automation
7840 Angel Ridge Rd.
Athens, OH 45701
(614) 592-1810

CADPAC II
R4 Systems Inc.
1100 Gorman St.
Suite 11B-332
Newmarket, Ontario, Canada L3Y 7V1
(905) 898-0665

Circuit Layout
PC Logic
11 Brook Hollow
Pittsford, NY 14534
(716) 248-9800

DC/CAD
Design Computation
1771 State Highway 34
Farmingdale, NJ 07727
(908) 681-7700

Easy-PC
Easy-PC Pro
BSoft Software, Inc.
444 Colton Rd.
Columbus, OH 43207
(614) 491-0832

Easytrax
Protel Technology, Inc.
2675 Stevens Creek Blvd.
Santa Clara, CA 95051
(408) 243-8143
ftp://protel.com/http/protel/dostools/easytrax.zip

EZ-Route Std
Advanced Microcomputer Systems, Inc.
1460 SW 3rd St.
Pompano Beach, FL 33069
(800) 972-3733

PCAD
Micronics Technology
7709 Skylake Dr.
Fort Worth, TX 76179
(817) 236-5049

PCBoards
PCBoards
2110 14th Ave. South
Birmingham, AL 35205
(800) 473-7227

SuperPC-board for Windows
Mental Automation Inc.
5415 136th Place S.E.
Bellevue, WA 98006
(206) 641-2141

TurboCAD
IMSI
1938 Fourth St.
San Rafael, CA 94901
(415) 454-7101

DC/CAD has been around for quite some time, and has survived many of its competitors. However, it takes a bit of getting used to, and it's not easy to learn. But it's the only program here to manage 64 layers, which is a juggling act all by itself. And if your pocketbook can afford it, it's one of the few under-$1000 circuit design programs with autorouting and error checking. It fills the widening gap between under-$1000 and over-$3500 CAE software.

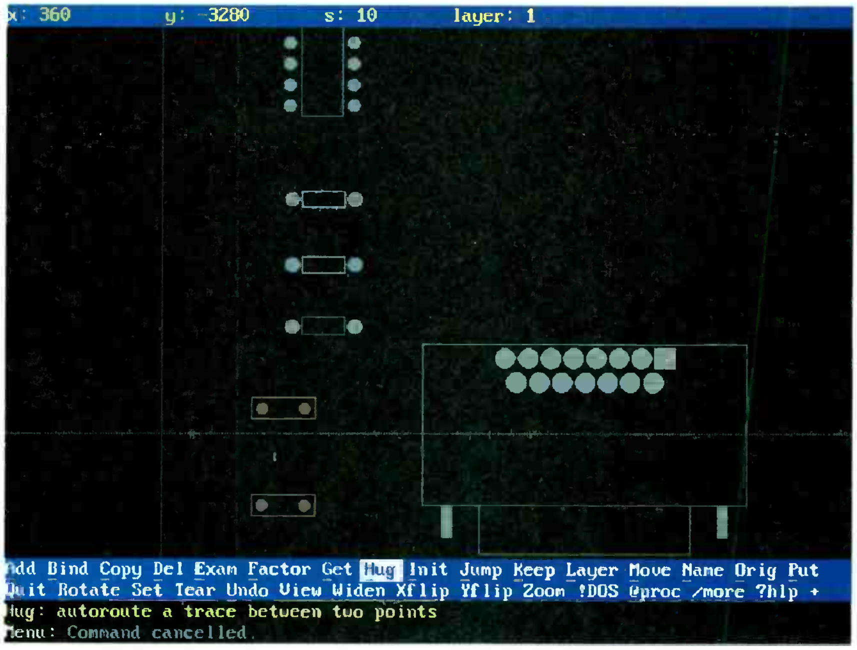


FIG. 10—DC/CAD IS A COMPLETELY INTEGRATED SCHEMATIC CAPTURE and PC-board layout package in one. Without the autorouter, the package sells for $295.

Product:	Easy-PC Pro
Version:	N0444
Price:	$349
Platform:	DOS
Distributor:	BSOFT Software, Ohio Automation

It's really a shame that Easy-PC Pro has such a weak schematic capture program for its front end, because the PC-board layout section is dynamite. In addition to supporting 14 copper layers and board sizes up to 32 by 32 inches, Easy-PC Pro has a seamless interface with its schematic capture companion and a link to an optional analog/digital simulation. Easy-PC Pro is a DOS-based program which costs $349. For an extra $298 ($647 total), you get the circuit simulation packages and a capable autorouter.

Because the schematic capture program is so flaky, we tested the Easy-PC Pro using two benchmarks. The first was a modified Easy-PC Pro example (where all the schematic parts were defined) and used the ratsnest (Fig. 11) Next, we manually built the *Electronics Now* benchmark circuit board using symbols from the PC-board library. We're happy to report that in both instances, not a single part for the benchmark was missing from the Easy-PC Pro symbol library.

When you build a board manually, the parts are easily accessed from a pull-down menu. Once a footprint or outline is selected, it can be used repeatedly—if you don't mind a little mousing around (or using the keyboard equivalents). Parts can be mirrored and rotated during placement, and zoom and pan are active. When doing manual placement, which includes adding new parts to an existing design, the part designations are automatically annotated, as in R1 followed by R2, etc. Moreover, if you delete a part, that part number is removed from the data base to maintain the sequence—not a small feat, and one seldom found in a low-cost program.

The best feature of Easy-PC Pro is the ease in which the program moves the schematic to

Continued on page 43

JEFF ORTHOBER

EPROM EMULATOR

Build a 2764 fake EPROM project for the IBM PC.

THEY SAY THAT NECESSITY IS THE mother of invention. Sometimes, however, convenience is. This article describes an EPROM emulator for an IBM PC. When you're designing a new project, you can save a lot of time by using a "fake" EPROM instead of going through the usual program and erase cycle.

This project uses static RAM on an IBM PC plug-in card to emulate the 2764. Since the 2764 is an 8K × 8-bit EPROM, the 6264 8K × 8-bit static RAM IC will work fine. To use the emulator, you must download the bits to the RAM. Then plug a cable from the emulator in the EPROM's socket of the project you're developing.

The emulator was built on an IBM PC prototyping board from JDR Microdevices, part number JDR-PR2. (Similar prototyping boards are available from several manufacturers.) Only the necessary buffering and cabling had to be added to complete the project. The IBM PC bus lines that are provided by the prototyping board are lines A0 through A9, AEN, RESET, -MEMR, MEMW, -IOR, and -IOW, and lines D0 through D7. All of the lines are buffered, and the data lines are fully buffered—that is, they are three-stated.

The prototyping board is activated when its I/O read or write line is high, DMA address enable is low, and the on-board comparator's output is high. The comparator on the board defaults to hexadecimal address 300 through 31F. The ports are subdivided eight times by a 3-to-8 decoder, providing lines -SEL0 through -SEL7 on the board. The default settings are shown in Table 1.

TABLE 1

Select Line	I/O Port (hex)
-SEL0	300 - 303
-SEL1	304 - 307
-SEL2	308 - 30A
-SEL3	30C - 30F
-SEL4	310 - 313
-SEL5	314 - 317
-SEL6	318 - 31B
-SEL7	31C - 31F

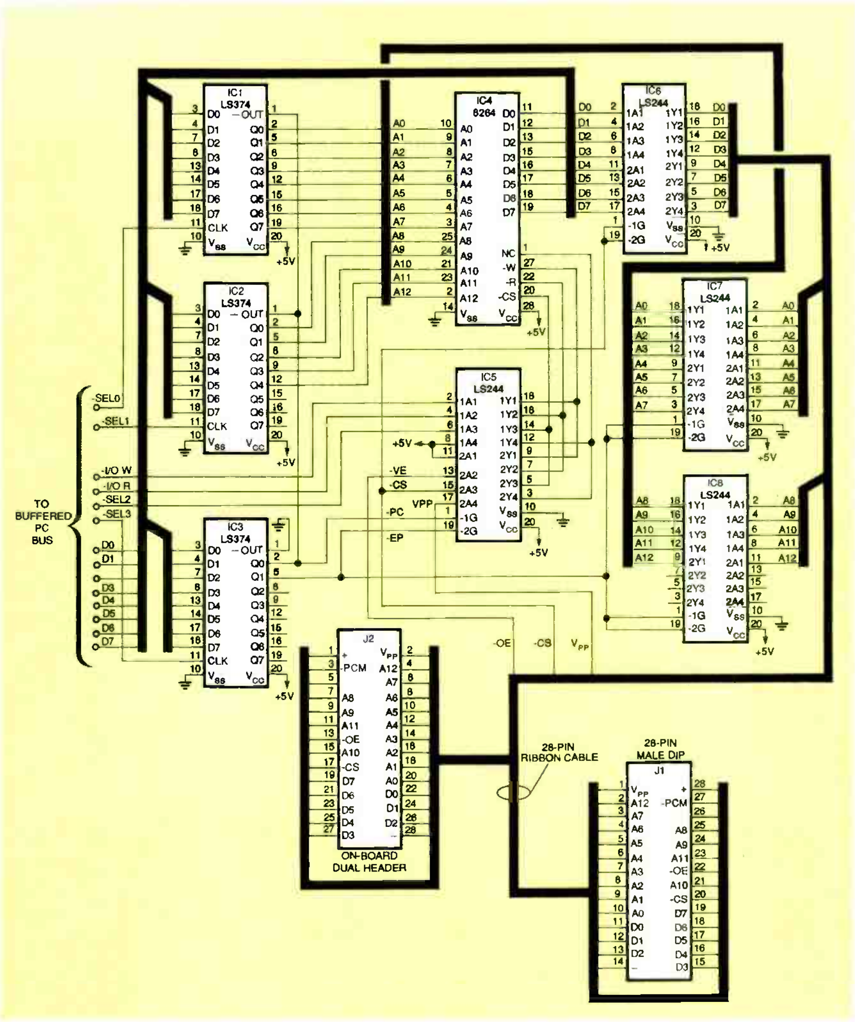


FIG. 1—STATIC RAM AND AN IBM PC can emulate a 2764 EPROM.

Circuitry

Figure 1 is the schematic of the EPROM emulator. Data from the IBM PC bus is latched on different select lines; -SEL0 is for the lower 8 bits of the address to the 6264. -SEL1 is reserved for the upper address bits, -SEL2 is to read or write data to the 6264 (reading is for verifying), and -SEL3 latches the control lines to IC3. Bit 0 from IC3 (-PC) enables the buffers for IBM PC communication and bit 1 (-EP) enables EPROM communication.

On the PC side, three 74LS374 latches (IC1–IC3) input the fully-buffered address and control lines and a 74LS244 buffer (IC5) inputs the control lines that aren't fully buffered. Three 74LS244 buffers (IC6–IC8) allow communication with the target project. A ribbon cable with a 28-pin male DIP on the end (J1) plugs into the target project's EPROM socket. The EPROM signals are accessed from a 50-pin header on the prototyping board.

Listing 1 is a Turbo Pascal program that takes a binary file that has been assembled for the target project and loads binary data into the 6264 using I/O commands.

Construction

The prototype was built by mounting all parts on the prototyping board and by point-to-point wiring them together. You must fabricate the cable that connects the prototyping board to the EPROM socket in the device you want to control. The cable should be no longer than three feet. Install a 28-pin dual-row female header connector on a 28-conductor ribbon cable and connect pins 1 through 28 of the other end of the ribbon cable (wire by wire) to a 28-pin male DIP. You can solder the wires directly to the female side of a 28-pin IC socket or you can install a 28-pin male IDC (insulation displacement connector) DIP. Note that the prototyping board contains a 50-pin male header, but only pins 1 through 28 are used. Be sure to connect the female header connector only to pins 1 through 28 of the header.

The fake EPROM is now ready to trick a circuit into thinking that a real EPROM is in place. Ω

PARTS LIST

- IC1–IC3—74LS374 8-bit latch
- IC4—6264 8K × 8 static RAM
- IC5–IC8—74LS244 8-bit buffer
- J1—28-pin male DIP (see text)
- 28-conductor ribbon cable (three feet, maximum), 28-pin dual-row female header connector, prototyping board.

LISTING 1

```
program feprom (input, output);
(this program will test and load the Eprom simulator 6264 8k
memory. The first parameter if specified will be the load file
and program will terminate, if no parameter is specified, then
the program will go into interactive mode. Uses Turbo Pascal V3.)

const
        port_add_low  - $300;     (6264 low byte address register)
        port_add_high - $304;     (6264 high byte address register)
        port_data     - $308;     (6264 data register)
        port_control  - $30C;     (buffer control register)
                                  (bit 0 - pc, bit 1 -eprom)store
        control_pc    - $02;      (buffer control setting, pc)
        control_eprom - $01;      (buffer control setting, eprom)
        max_mem       - $1FFF;    (max size of eprom (0 - 1FFF)  )
type
        str = string [80];
        arr = array [0..max_mem] of byte; (pc array to store file)
(set the buffers to communicate with pc)
procedure set_pc;
begin
        port [port_control] := control pc;
end;
(set the buffers to communicate with cable)
procedure set_eprom;
begin
        port [port_control] := control_eprom;
end;
(write proper hi and low byte address to latches)
procedure write_address(add : integer);
var
        high : integer;
        low  : integer;
begin
        low  := add and $FF
        high := (add and $FF00) div $0100;
        port[port_add_low]  := low;
        port[port_add_high] := high;
end;
(check the ram bit wise)
procedure bittest;
var 1 : integer;
    p : integer;
begin
        writeln ('Bit test');
        i := 0;
        while (i <= max_mem) and (not keypressed) do
begin
        write_address(i);
        port[port_data] := $00;
        if port[port_data] <> $00 then
          writeln('0 Error at ',i:0,' ',port[port_data] :0);
        port[port_data] := $FF;
        if port[port_data] <> $FF then
          writelin('FF Error at ',i,' ',port[port_data] :);
        i := i + 1;
end;
writeln('Bit test done');
end;
(check the ram locations)
procedure numbertest;
var i : integer;
         c : integer;
begin
```

```
  writeln('Number test');
  c := 0;
  for i := 0 to max_mem do
        begin
          write_address(i);
     port[port_data] := c;
          c := c + 1;
          if c > 255 then c := 0;
end;
writeln('Last number was ',c:0);
c := 0;
for i := 0 to max_mem do
  begin
        write_address(i);
        if port[port_data] <> c then
          writeln('Number Error at ',i:0,' ',
            port[port_data],' should be ',c:0);
        c := c + 1;
        if c > 25 then c := 0;
end;
writeln('End Number test');
end;
(check the buffers)
procedure buffertest;
begin
        writeln('Buffer test');
        write_address (0);
        port[port_data] := 55;
        set_eprom;
        if port[port_data] = 55 then
          writeln('Buffer error');
        writeln('End Buffer test');
end;
(verify that the ram has the same as the array)
procedure verfile(var a : arr);
var c : integer;
begin
        writeln('Verifying file');
        for c := 0 to max_mem do
          begin
            write_address(c);
            if port[port data] <> a[c] then
              writeln('Load file error at ',c:0,' ',
                 port[port_data] :0, should be
',a[c]:0);
     end;
end;
(load array from file)
procedure loadafile(s : str; var a : arr);
var f : file of arr;
begin
        writeln('Reading file',s:length(s) );
        assign (f,s);
        reset(f);
        read (f,a);
        close(f);
end;
(load array and transfer to ram)
procedure readfile(s : str);
var c : integer;
    a : arr;
begin
  loadafile(s,a);
  set_pc;
  writeln('Transferring file ',s : length(s) );
  for c := ) to max_mem do
        begin
          write_address(c);
          port[port_data] := a[c];
        end;
  verfile(a);
  writeln('File Load done');
  set_eprom;
end;
(get filename and transfer file to ram)
procedure loadfile;
var s : str;
begin
        writeln;
        write('Enter filename ---'); readln(s);
        readfile(s);
end;
(get filename and verify against the ram)
procedure verifyfile;
var s : str;
    a : arr;
begin
        writeln;
        write ('Enter filename ---'); readln(s);
        loadafile(s,a);
        verfile(a);
end;
(mainline)
procedure main2;
var c    : char;
    done : boolean;
begin
  while not done do
    begin
      writeln;
      writeln('A) Bit test');
      writeln('B) Number test');
      writeln('C) Buffer test');
      writeln('D) Load and verify binary file');
      writeln('E) Verify against binary file');
      writeln;
      writeln('Z) to quit');
      writeln;
           write ('Enter choice ---'); readln (c);
           set_pc;
           case c of
             'A', 'a' : bittest;
             'B', 'b' : numbertest;
             'C', 'c' : buffertest;
             'D', 'd' : loadfile;
             'E', 'e' : verifyfile;
             'Z', 'z' : done := true;
         end; (case)
    set_eprom;
        end;
end;
(See if parameter, if so then load the file and
exit.
If not then go into interactive mode)
begin
  if paramount = 1 then
    readfile(paramstr(1))
  else
    main2;
  end.
```

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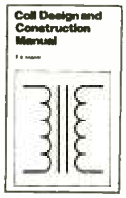

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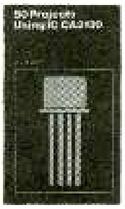

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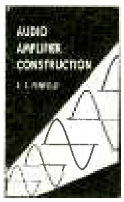

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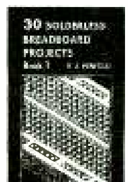

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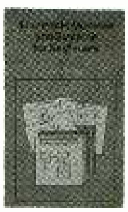

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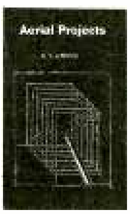

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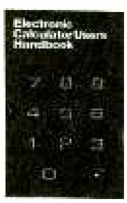

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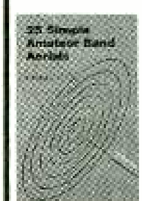

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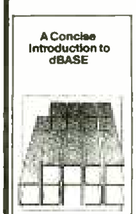

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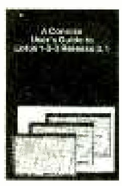

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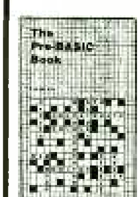

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continued from page 38

the circuit board. To do this, simply open the finished schematic and run the "Translate to PC-board" option. This operation compiles the netlist, checks it for errors, matches the schematic parts to their physical outlines, starts the PC-board layout program, and places the parts on a printed circuit board. All that's left for you to do is lay down the tracks.

Before you start mapping out traces, though, you'll need to do a better job of locating the parts than the translator, which simply places the parts on the printed circuit board diagonally in the order they are received from the netlist. Such placement means it is highly likely a resistor that feeds an LED may land halfway across the circuit board instead of next to it. Parts are easily moved by placing the cursor over the target device, pressing F7, and then using the mouse button to relocate it. If you need to move several parts at a time, there's a block function, which will also mirror, rotate, or copy everything within the marked area.

Sixteen track widths are available per layout, and they can be set to widths between 0.001 inch and several inches. You can see the track as it's laid down, and switching layers is as easy as pressing a key; through-hole vias are automatically added when you switch layers. A nifty feature is the ability to draw freehand tracks as well as ortho and chamfered corners. And while it's unlikely you'll need to add pads unless doing the layout manually, they, too, come in a wide range of sizes and shapes.

Output can be sent to dot-matrix, LaserJet, and PostScript printers, plus HPGL and DMPL penplotters. Gerber and N/C Drill files are also supported. Essentially, it's the same support you find in Easy-PC.

The real strength of a schematic capture/PC-board layout program is in the seamless transfer from schematic to printed circuit board. In this respect, Easy-PC Pro is a champ. It's too bad that the entire application looses face because there's such a poor schematic capture program ahead of a worthy PC-board layout program. Fortunately, the performance of the schematic capture engine can be bolstered—but only if you're willing to spend extra bucks on any or all of the three optional components libraries. The three new libraries contain SMD devices, 74LS chips, and analog components. But at $99 each, their total cost is nearly that of the package itself—hardly a bargain.

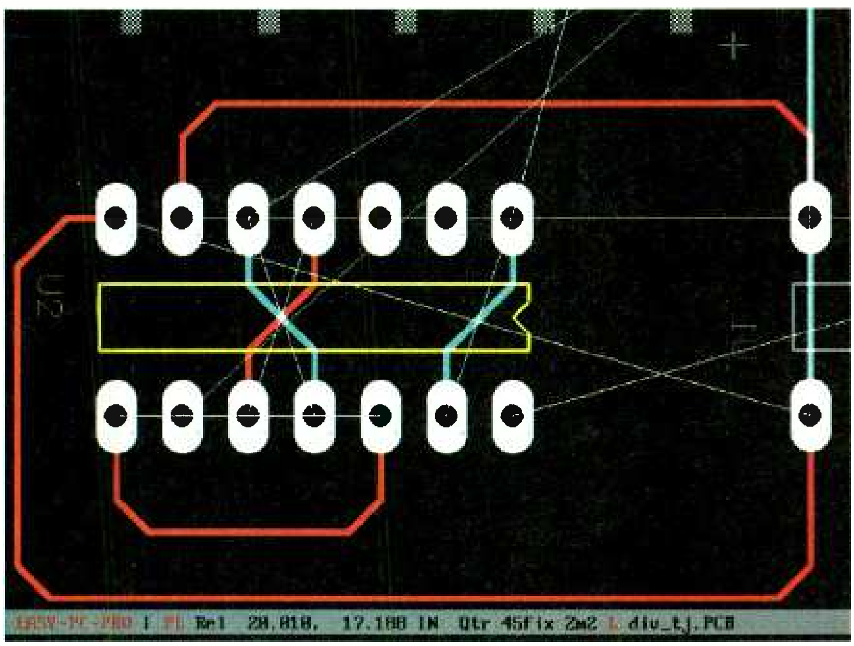


FIG. 11—THE THIN WHITE LINES YOU SEE in this partially-routed Easy-PC Pro screen aren't tracks. Instead, they are a ratsnest that show you where the missing tracks need to go.

Product:	EZ-Route
Version:	2.2
Price:	$249
Platform:	Windows
Publisher:	Advanced Microcomputer

Individually, the components of EZ-Route aren't anything special. The schematic-capture program, EZ-Logic, is just mediocre. EZ-Board, the PC-board layout program component of EZ-Route highlighted in this review, is slightly better than average. And the interface between the two is not totally seamless. But put all three elements together, and you have a package with a value greater than the sum of its parts—a package that's well worth the $249 it commands. EZ-Board is a Windows program that supports six conduction (copper) layers, any two of which can be used for power or ground (see Fig. 12). While the maximum board size is just 8 by 10 inches—big enough for any home or small business project—and the program supports blind vias as well as surface-mounted devices.

Although the transfer of data from schematic capture to circuit-board layout isn't seamless, it's a whole lot better than not having an interface at all. Specifically, the *Electronics Now* benchmark uses two DB15-15 connectors, one male and the other female. On the schematic, there isn't a designation between the two, because electrically they are identical. Physically, though, they are quite different, and EZ-Board stops compiling when it hits this snag. The fix is simple enough: Edit the netlist file with a text editor and specify male or female on the required lines. The User's manual tells you how.

During the transfer process,

TABLE 1

	BoardMaker I	CADPAK II PCB II	Circuit Layout	DC/CAD	Easy-PC	Easy-PC Pro	Easytrax	EZ-Route Std EZ-Logic	PCAD	PCBoards	SuperPCB for Windows	TurboCAD
Price	$95	$159	$80	$295	$145	$349	Free	$249	$65	$99	$299	$129
Format	DOS	DOS	DOS	DOS	DOS	DOS	DOS	Windows	DOS	DOS	Windows	Windows
RAM required	512K	640K	512K	640K	512K	640K		512K	640K	512K	4MB	2MB
Hard disk required	N	2MB	5MB	5MB	N	5MB	N	3MB	N	N	2MB	4MB
Maximum board size (inches)	17 x 17	30 x 30	16 x 10	32 x 32	17 x 17	32 x 32	32 x 32	8 x 10	20 x 9.8	6 x 13	16 x 8	
BBS file		ISISDEMO.EXE				EASY-PC.ZIP	EASYTRAX.ZIP				SUPERCAD ZIP	
Schematic capture												
Included	Y	Y	N	Y	Y	Y	N	Y	N	N	Y(4)	Y(4)
Linked	N	N	N	Y	N	Y	N	Y	N	Y(3)	Y	N
Design rule check	Y	N	N	Y	N	Y	N	Y	N	N	Y	N
PCB Layout												
Automatic part placement	N	N	N	Y	N	Y	N	Y	N	N	Y	N
Repeat part placement	Y	Y	Y	Y	N	Y	Y	Y	Y(1)	N	N	Y
Rotate part prior to place	N	N	Y	Y	N	Y	Y	Y	Y(1)	N	N	Y
Zoom on-the-fly	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	Y
Auto pan	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	Y
Routing Features												
Autorouter available	N	N	N	Y	N	Y	N	Y	N	Y	Y(5)	N
Ratsnest	N	N	N	Y	N	Y	N	Y	N	N	N	N
Pad-to-pad router	N	N	Y	N	N	N	Y	N	N	N	Y	N
Mixed track widths	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y
Freehand tracks	N	N	N	N	N	Y	Y	Y	N	N	N	N
Camfered corners	Y	Y	N	Y	Y	Y	N	Y	Y	N	Y	Y
Curved tracks	Y	N	N	N	N	Y	Y	Y	N	N	Y	N
Neck down	Y	Y	Y	N	N	Y	N	N	N	N	Y	Y
Number of copper layers	8	2	2	64	8	14	8	6	2	2	2	16
Auto vias	Y	Y	N	Y	Y	Y	Y	Y	Y	N	Y	N
Blind vias	Y	n/a	n/a	Y	Y	Y	Y	Y	n/a	n/a	n/a	N
Buried vias	Y	n/a	n/a	Y	Y	Y	Y	Y	n/a	n/a	n/a	N
Ground/power planes	N	n/a	n/a	Y	N	N	Y	Y	n/a	n/a	n/a	Y
Library												
Screen directory	Y	Y	Y	Y	N	Y	Y	Y	Y	Y	Y	Y
Part preview	Y	N	N	N	N	N	Y	Y	N	N	Y	Y
Editing Features												
Modify track width	Y	Y	Y	Y	N	Y	Y	Y	N	Y	Y	Y
Change pad size/style	Y	Y	N	Y	N	Y	Y	Y	N	Y	Y	Y
Block												
Copy	Y	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y
Move	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Rotate	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y
Save	N	Y(2)	N	Y	N	N	Y	Y	Y	Y	N	Y
Output formats												
Dot-matrix printer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Laser printer	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
HPGL plotter	Y	Y	N	Y	Y	Y	Y	Y	N	Y	Y	Y
Gerber	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N
N/C Drill	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	Y	N
1) DIP ICs only												
2) Route tracks only												
3) Has netlist conversion utility												
4) Extra cost												
5) Included												

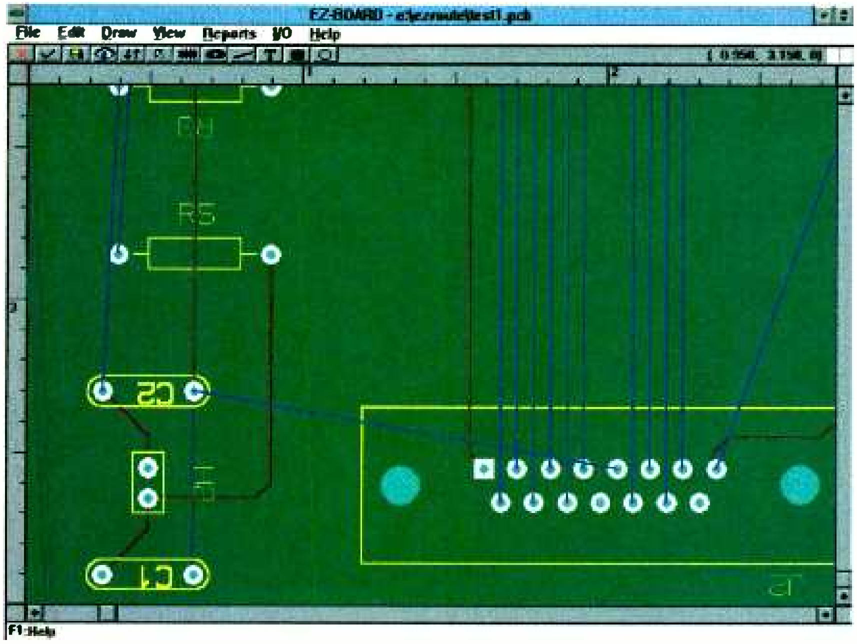


FIG. 12—EZ-ROUTE IS A VERY FLEXIBLE, multi-layer schematic capture/PC-board layout program with an optional autorouter. A nice feature is that you can pick any layer for power and ground, which is a big plus when designing high-speed PC boards.

EZ-Board places the components along the left side of the screen in the order they are accessed from the netlist. Now this isn't the board itself; that's defined later. After the parts are transferred, you need to place them manually—which is the norm for most PC-board layout programs under $1500. The trick is to move all these parts into a cluster before specifying the size of the board. Because if you don't move them first, they simply fall off the screen. No, they're not gone; but you don't have access to them for placement afterwards.

EZ-Board has a ratsnest that's equal to those found in PC-board layout programs costing a whole lot more. The ratsnest actually calculates the best route for the tracks according to your initial placement. Better yet, the ratsnest is dynamic. So as you change a part's location you can see how far the wires have to stretch, and therefore minimize track length before actually laying copper down. As you lay the tracks down, the ratsnest lines disappear, giving you an indication of your progress. If you want to see an actual count of how many tracks are left to place, EZ-Board provides that, too. As expected of a program of this caliber, EZ-Board supports automatic and blind vias.

Despite a weak schematic capture front end, EZ-Route has a lot going for it—not the least of which is a low $249 price tag. The autoplace utility saves a lot of time, and the dynamic ratsnest is a real help when routing the board. The only thing missing is an autorouter, but that, too, is available as a $200 upgrade option. EZ-Route is perfectly suited for virtually any project you'll find in the pages of *Electronics Now*, plus a whole lot more.

Product:	PCBoards
Version:	2.0
Price:	$198
Platform:	DOS
Publisher:	PCBoards

While ratsnest and pad-to-pad routers are helpful, nothing compares to a true autorouter. Unfortunately, the cost of an autorouter generally pushes the cost of the circuit design package beyond the means of most users. So when we discovered that PCBoards autorouter costs just $99, it was like a breath of fresh air. The basic program is PCBoards, a $99 DOS-based PC-board layout program that's easy to learn and easy to use. It supports boards up to 6 by 13 inches with two copper layers and a silk screen layer. The optional autorouter adds another $99, which brings the total cost to just $198—by far the cheapest PC-board layout/autorouter package available. Although PCBoards is a stand-alone package, it can import a netlist from several different schematic capture programs, like SuperCAD and Tango. But like most low-cost PC-board layout programs with netlist support, you have to manually place the components board before you can import the netlist.

The PCBoards component library contains over 160 devices, consisting of several DIPs, SIPs, and PLCC footprints, as well as a good assortment of resistor, capacitor, and diode sizes. The parts are easily accessed from a pull-down menu. While you can't actually see the part outline before selection, a description of the device selected is shown at the bottom of the screen. In the screen shown in Fig. 13, the selected device is a 14-pin DIP. Different DIP footprints are selected by successively pressing the <F1> key, which causes the outlines to scroll from 6-pin to 40-pin devices. The same procedure is used for all the other devices listed in the menu—except for the pad. Only one pad is available, a 0.010-inch square pad. The autopan function is engaged during parts placement, which is fortunate because PCBoards has only two zoom magnifications: The one you see in Fig. 13, and a postage-stamp overview of the entire board.

Missing from the parts library is any form of a mechanical connector, like the DB15 needed for the benchmark circuit. That was constructed from pads found in the User menu. Unlike the Parts menu, the User menu supports three different pad types, a large and small round pad, and a large square pad. Once the pads are positioned out in the desired pattern, the part is saved and becomes available as a User option in the

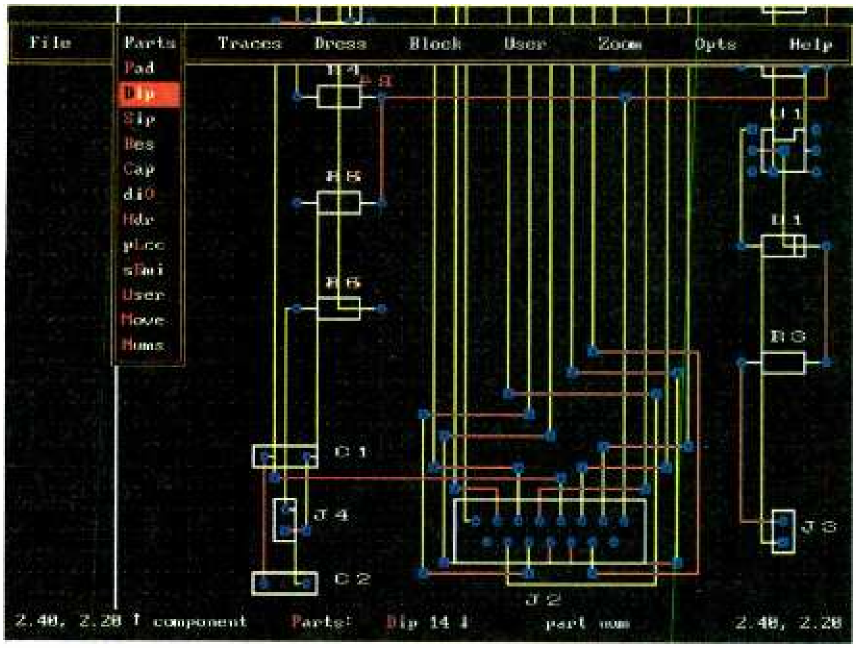


FIG. 13—AT $99, PC-BOARDS isn't the least expensive PC-board layout program here. But when coupled with its optional $99 autorouter, this $198 combo is the lowest priced package with netlist support.

Parts menu.

While you can route the circuit manually, there's no reason to. Despite its low cost, the PCBoards autorouter is quite a capable performer. In our benchmark test, it achieved 100 percent completion in just over three minutes. We used the SuperCAD+ netlist for the input source. However, the conversion wasn't without human intervention. For example, it caught a V_{cc} net error in the original netlist that SuperPC-board (below) missed—a move that earned it a lot of brownie points. On the other hand, PCBoards, which doesn't have support for LEDs, converted the LED reference incorrectly. Both errors were easily fixed using a text editor. Although the routing process went smoothly, we were dismayed that the autorouter only supports a 50-mil grid, which means it won't do well with a tightly-packed circuit board or SMD parts.

PCBoards supports a wide range of video modes, including EGA, VGA, 800 by 600, and 1024 by 768. It generates DXF, Gerber and N/C Drill files, and can print negatives of the artwork for use with PC-board contact art, like that from DynaArt Designs and Techniks Inc. If you don't mind working from a DOS prompt, you can save a lot of bucks and still have a quality autorouter package.

Product:	SuperPC-board for Windows
Version:	1.5
Price:	$299 (with autorouter)
Platform:	Windows
Publisher:	Mental Automation

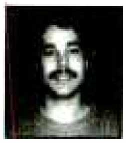
Standing alone or with its companion schematic-capture program, SuperPC-board for Windows is one class act. It's easy to learn, easy to use, and easy on the pocketbook. SuperPC-board for Windows is a Windows program that seamlessly interfaces with SuperCAD. It supports surface-mounted devices, and blind vias. But best of all, it's one of only two under-$350 PC-board layout programs reviewed to include an autorouter. (See Fig. 14.)

SuperPC-board for Windows comes in several different flavors, depending how much you're willing to spend. For just $149 you can buy a two-layer version (MA8505) with a 90-part component library and support for printed circuit boards up to 8 inches square. Spend $299 (version MA8510), and you get all that plus an autorouter and support for boards as large as 8 by 16 inches. At the top of the line is the MA8500 package, which sells for $499 and supports 32-by-32-inch circuit boards with up to 16 layers; it, too, comes with an autorouter plus a larger 320-component library. When you purchase the MA8510 version with SuperCAD for Windows, reviewed in the October 1995 issue of *Electronics Now*, you save $49 (total cost: $399). In this review we'll look at the MA8510 module.

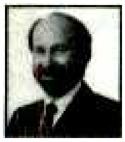
The first step is to outline the shape of the printed circuit board, then manually place the devices on the board. Components are selected from a menu, which has a viewer that lets you see what the device looks like before placement. Parts are easily moved using the mouse to drag and drop them. After a part is placed, it can be rotated and mirrored. Unfortunately, pan and zoom aren't in effect during placement. An optional $75 autoplace utility extracts the parts from the netlist and automatically places them on the board.

After all the devices are placed on the board, you can wire them together using the manual router or the autorouter. The manual router is an incremental router which lets you place a trace between two pads. You can choose to keep all the traces on one side of the board, or have it switch sides when changing directions; vias are automatically placed when this option is selected. In the autorouting mode, the circuit board is autorouted on one or both layers. The batch router setup menu lets you choose the layers for routing, the size of the grid, and the width of the trace. Like most autorouters, there's no guarantee it will be able to route all tracks because the first route may block some signal traces and reduce the routing success ratio. With the grid size set to 25 mils, SuperPC-board for Windows was able to completely route the benchmark circuit; using a 50-mil grid, the rate dropped to 90 percent. As al-

Just like these Fully Trained Electronics Professionals

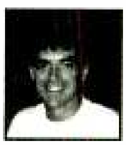


"Thanks to CIE I have tripled my previous salary, and I am now in a challenging and rewarding new field where only the sky is the limit."
Daniel Wade Reynolds
Industrial Electrician
Ore-Ida Foods

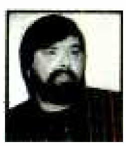


"CIE was recommended to me by my boss. It was appealing since I could study at my own pace at home and during business travel."
Dan Parks
Marketing Manager/Consumer Products
Analog Devices, Inc.

"I loved the flexibility CIE offered. It was the only way I could continue both school and my demanding job."
Britt A. Hanks
Director of Engineering
Petroleum Helicopters, Inc.



"I liked the way the school was set up with laboratory assignments to enforce conceptual learning. The thing which impressed me the most about CIE's curriculum is the way they show application for all the theory that is presented."
Daniel N. Parkman
Missile Electro-Mechanical Technician
U.S. Air Force



"Completing the course gave me the ability to efficiently troubleshoot modern microprocessor based audio and video systems and enjoy a sense of job security."
Tony Reynolds
Service Manager/Technician
Threshold Audio & Video

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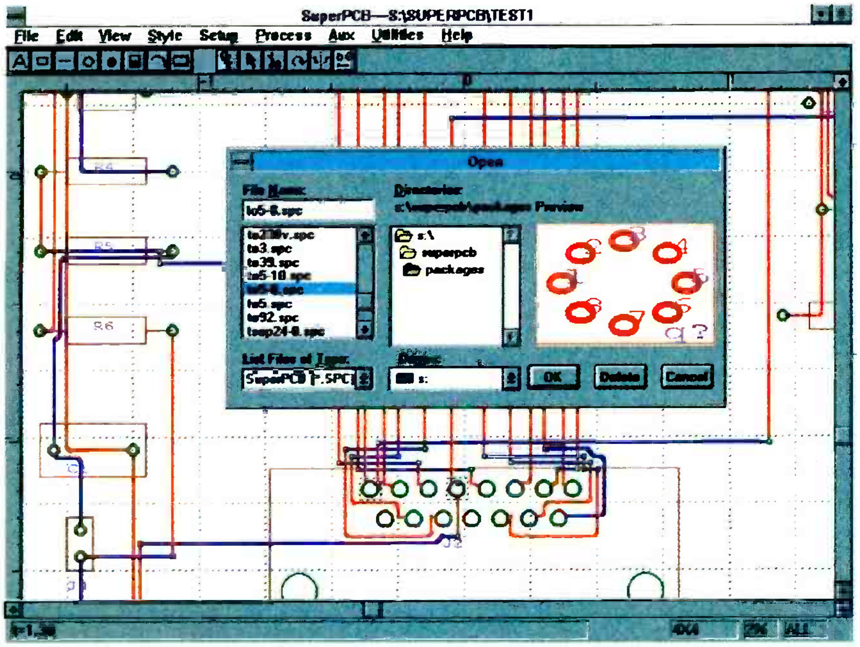


FIG. 14—SUPERPC-BOARD HAS AN ABUNDANT PARTS LIBRARY with a previewer. This Windows PC-board layout program sells for $149; if you're willing to spend $299 total, you get an autorouter.

ways, the unrouted tracks have to be routed by hand.

Two nifty routing features really enhance the power of the SuperPC-board for Windows autorouter. The smooth operation replaces 90-degree corners with either arcs or a 45-degree chamfer, thus reducing RFI emissions and crosstalk. The neck operation automatically thins wide traces so that it can pass between the pads of a DIP. Both features are used after an initial track layout.

Once a net is routed, the number of vias may be reduced by running the optimizer utility. The optimization is set as a separate step so that you can route different netlist to take advantage of regular placement of memory chips without interference from the power tracks. After autorouting our benchmark board, the optimizer was able to identify and remove 73 superfluous vias.

While it's highly recommended that you couple SuperCAD with SuperPC-board, it can work with netlists from several schematic capture programs, like OrCAD and Tango. It also generates Gerber and N/C Drill files, in addition to flux, silk screen and solder masks. Now consider all this for as little as $149, and you see why SuperPC-board is so highly recommended. Ω

BY DON LANCASTER

Reverse engineering

Plus Invention marketing firms, and exploring a bilateral switch telephone network interface

SEVERAL HELPLINE CALLERS HAVE ASKED ME WHAT I THOUGHT OF CERTAIN INVENTION-MARKETING FIRMS. WELL, I FIRMLY BELIEVE THAT *IF YOU HAVE TO ASK, YOUR PRODUCT IS DOOMED TO FAILURE!*

Asking this question proves to me that you remain an industry outsider. Almost always, industry outsiders are fruitlessly laboring on non-solutions to non-problems. They always make one or more laughingly absurd assumptions about marketing, demand, patents, competition, sales channels, or the value of any totally undeveloped and unproved concept.

Even if I ignore the sad history of invention-marketing scams and the 100% complaint rate that I've gotten about these outfits on my help line, it all boils down to this: *An invention marketing firm is extremely unlikely to ever generate a worthwhile long term net positive cash flow for you.*

But it turns out that there are useful alternates known as *Product development assistance providers.* Here's how you tell the two apart: A product assistance provider should (A) *always* be hard to find because he will never have to advertise; (B) *never* use *any* sales techniques, let alone high pressure ones; (C) repeatedly and pointedly tell you up front that your concept has major flaws and monumental risk factors; (D) offer you low cost services on an exactly stated cash-and-carry basis; and, of course, (E) gladly provide a satisfied client list.

I've posted a long list of product development assistance providers as INVENORG.PDF on my *GEnie* PSRT. Other good sources for this type of information are the superb annual freebie directories published by *Batelle Pacific Northwest.*

The really sad thing about industry outsiders is that they don't realize how easy it is to become an industry insider. You accomplish this by aggressively subscribing to the free industry trade journals, sending for all the

0. Your best information *always* comes from *outside* the device itself.
1. Seek out all available documentation. Thoroughly study it.
2. Try to contact the original manufacturer. Use the *Electronic Industry Telephone Directory*, The *EEM Master* or CD ROM phone disks.
3. Try to get in touch with user groups, known users, or known buyers and sellers for more information. Check surplus listings. Also subscribe to relevant trade journals. Place classified ads. *Rochester Electronics* and similar obsolete semiconductor houses can also be of help.
4. Make aggressive use of the online resources. Such as GEnie's RADIO RoundTable or the Internet.
5. Do a thorough visual inspection.
6. Use dental X-rays to view through sealed epoxy or to second guess mystery integrated circuit chips.
7. Try to identify chip part numbers by using the *I.C. Master.* Other useful resources here are the *ECG, NTE*, and the *Radio-Shack* directories. Be sure to get data sheets and ap notes for all chips.
8. Trace out the schematic by doing a resistive matrix. Do *not* use an ordinary ohmmeter on its X1 range. Generate a complete schematic.
9. Avoid any and all preconceived notions of how something "has" to work. Wait on the hard parts and let your subconcious work for you.
10. Fill it with water and see where it leaks. Do this by applying reasonable and *current limited* voltages to supply pins, and reasonable test signals to inputs. Then observe the output behavior.
11. If software is involved, excercise it. Two extremely useful software debugging tools are a print-to-disk routine and an I/O comm recorder.
12. Carefully document and record your results.

FIG. 1—PRACTICAL WORKING GUIDELINES for reverse engineering.

available technical literature, attending shows or seminars, and making full use of *Dialog* and the other online resources. Becoming an industry insider should *immensely* improve your chances of success.

Above all, *never* call yourself an inventor or behave like one! To do so sets you up for every rip-off and scam in the book—plus bunches that have not yet made print. Instead, you should position yourself as a *purveyor of risk reduction.* You'll do many of the same things as an inventor, but in workable and proven ways that dramatically improve your final results. More details on this in RISK-DOWN.PDF.

Your best source for ongoing information on effective product development is *Midnight Engineering* magazine. And much more on your own small scale tech venture appears in my book *Incredible Secret Money Machine II.*

Reverse engineering

Reverse Engineering is the process of taking apart some existing device to see how it works. You might want to do this as an intellectual challenge, to restore missing documentation, to make improvements or modifications, or to repair a broken unit.

Reverse engineering is totally and completely legal as long as it is not used *in any manner* for the theft of any services or intellectual property. Most reverse engineering is also a lot of fun and a great learning tool.

For this month's sidebar, I have gathered together a few of the more important reverse engineering tools that I've found handy along the way. I've also shown a few major reverse engineering steps in Fig. 1—at least the ones that work for me.

Let me go step by step through a recent example. I've just acquired a large pile of the *Northern Telecom* #2960 network interface devices. Or, more formally, the *Remote Isolation Device/Maintenance Termination Unit, or RID/MTU* for short.

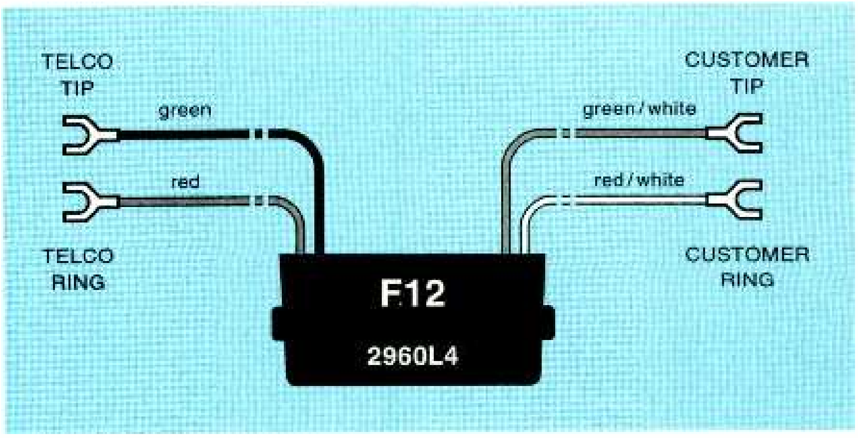


FIG. 2—THE NORTHERN TELECOM 2960 NETWORK INTERFACE is installed between your phone and the telephone company's lines.

I had hoped that it was a Part-68 interface. It turns out it isn't, but it still appears to be a highly useful and valuable component—one with a lot of non-telecommunications uses.

Out of the bag, it's a small epoxy block with a large "F12" on the side (see Fig 2). Four wires come out of it: green, red, green/white, and red/white. The outside shipping cases seemed pretty badly flood-damaged, but I did manage to salvage a bill of lading that, wonder of wonders, included the barely legible device installation data sheet with a 1988 release date—but no schematic.

The printed telephone number was no good, so the next step was to look in the *Electronic Industry Telephone Directory* to find the current supplier. Those CD ROM phone disks are also super handy for this kind of hunting. *Select Phone* is one of many. Sadly, the supplier is still being chased at column deadline.

The next step was to disassemble the part. Since I had a lot of them, I was willing to sacrifice one or two.

Sealed units are rare, but the usual method to get started reverse-engineering a sealed unit is with dental X-rays. These can even be free if you know a curious dentist. Besides the obvious use of seeing through potting compound, dental X-rays can also tell you the chip size and complexity. Even if you are not an IC expert, it is fairly easy to spot the difference between optocoupler and op-amp, or distinguish a CPU from ROM.

In my case, the X-ray revealed a small circuit board, an 8-pin minidip, a fuse, two diodes, five resistors, and four tantalum capacitors.

It was fairly easy to carve up the potting compound. But, in hindsight, I should have let the dentist do it. You can also obtain epoxy-dissolving chemicals from *Master Bond.*

At any rate, the IC was identified as part number "1060". Now, most functions of most integrated circuits should be easy to sort out. But in a telecommunications part, it could be anything. I next went to the *IC Master.* There were a dozen different IC's with 1060 in their name, but the LB1060AB *loop termination switch* from *AT&T* leaped out as the most obvious choice.

Well, calling the local distributor revealed that this chip was stock at $4.40 each. But both the local rep and AT&T insisted the chip was obsolete, with the specifications no longer available. In other words, they would still sell you the part, but not tell you what it is or how to use it.

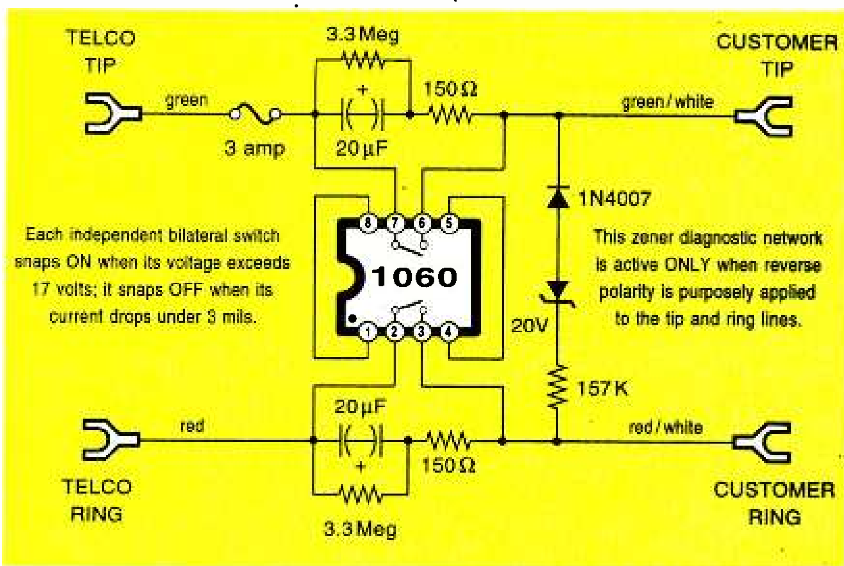


FIG. 3—SCHEMATIC FOR THE 2960 INTERFACE. Normally, both bilateral switches are on when the usual telco line voltage is present. They stay on as long as something is off-hook. For diagnostic tests, the line voltage is dropped to zero, turning both switches off. Special test signals determine if the problem is with the telco or customer equipment.

Fortune 500 strikes again

I then checked the surplus route. *The Mart* is the leading magazine of used telecommunications stuff in the country. It gave me the list of Northern Telecom buyers which I am currently mining. Even better, Marvin Birnbom from *Surplus Traders* maintains a hot buy and sell surplus phone fax list. By the most amazing of coincidences, there were 300,000 of the LB1060AB chips offered for immediate sale—all with full specs available.

The next reverse-engineering step is a circuit trace. This is *infinitely* easier if you have the full specs for all the parts involved. Your optimum starting point is a *continuity matrix,* where you check connections between *every* point in the circuit.

Your best possible checker would apply no more than 0.1 volt and a milliampere or so maximum current. It should respond *only* to 0.1 ohm or less or, better yet, offer a changing tone with resistance. This prevents you from forward biasing semiconductor P-N junctions and giving you misleading results.

If you must use an old fashioned ohmmeter instead, *never* use the 13× range, as it applies dangerously high currents. *Always* be certain to check continuity in *both* directions. Any difference tells you a PN junction is involved in the path.

Do remember that IC chip pins go *counterclockwise* from the top. And that all pins *reverse* when you flip the board over. A strong light source and a good magnifier are essential.

A "fill it with water and see where it leaks" step is next. I chose a *current limited* power supply to fake the phone line and see when and how the device opens and closes. Doing so reveals the 2960 turns on when the supply voltage exceeds plus or minus 34 volts. The 2960 stays on as long as there's three milliamperes of load current. There is more information on nailing down any unusual supply sources (and similar reverse engineering tools) in my *Resource Bin* reprints as well as on *GEnie* PSRT.

A closer look

A circuit for the 2960 appears in Fig. 3. The 1060 data magically showed up just as I finished up the preliminary trace.

Here is what the device does: This is a solid state relay that is placed between the telco tip (green) and ring (red) and the customer's tip (green-white) and ring (red-white) lines. Should a problem occur with the customer's your phone, the telephone company can use the 2960 to make a simple test to find out if it is your problem or theirs. It can be done right from the phone company's office—no field service call is needed!

The 1060 chip contains two totally separate bilateral switches. Without any supply voltage, each switch will normally remain *off.* If the voltage across *either* switch exceeds 17 volts, the switch will turn on and conduct heavily. Steady state currents of one ampere can be handled, with pulses to ten amperes. Forward drop is around one volt. The switch stays on as long as current remains above three milliamperes.

Normally, 48 volts DC is present on the phone line when all devices are hung up. Since that is above the 34 volts of both bilateral switches in series, *both* switches are normally *on*. This connects phone lines to the customer. As soon as a device goes off-hook, it provides the holding current to *keep* the switches turned on. So far, so good.

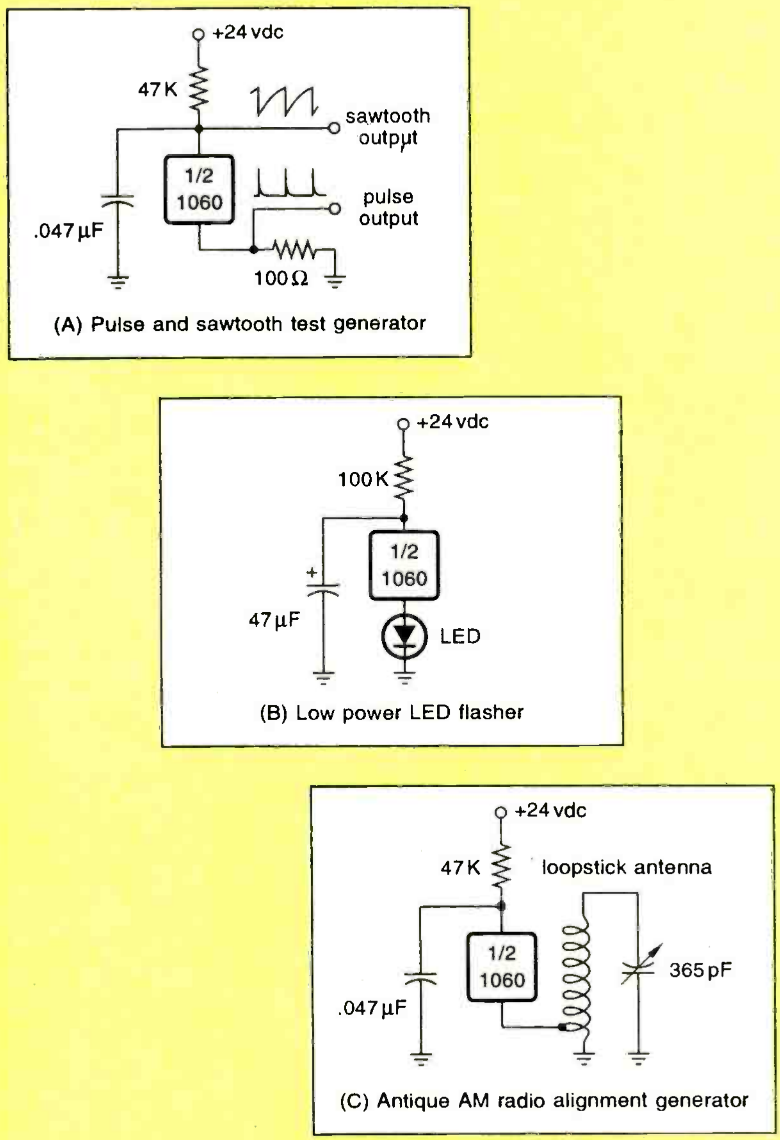
Now, suppose you have a phone problem. You notify the phone company, who temporarily drops the line voltage to zero. The bilateral switches snap off, disconnecting anything of yours from the phone line.

Between those coupling capacitors and that diagnostic Zener network on the output, various tests can quickly be run for opens, for shorts, or line degradation. In most cases, the phone company can immediately determine whether the problem is with its equipment or yours.

Note that the Zener only conducts with high *reverse* line polarity. This diagnostic network effectively stays out of the circuit during normal use. The 2960 also includes an internal fuse to block you from sending nasty currents into the phone line. This fuse also gives lightning protection.

Other uses

Just what good are these beasties? What can we do with them that does *not* involve the telephone company? Basically, you have a pair of rather decent bilateral switches. They can be used together or separately.



(A) Pulse and sawtooth test generator

(B) Low power LED flasher

(C) Antique AM radio alignment generator

FIG. 4—BILATERAL ANALOG SWITCHES have lots of uses. These three ideas should get you started using the 2960.

REVERSE ENGINEERING RESOURCES

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Twinsburg, OH 44087
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Encyclopedia Associations
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Detroit, MI 48226
(313) 961-2242

IC Master
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The Mart
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Richardson, TX 75081
(800) 864-1155

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(800) 237-8931

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Batelle Pacific Northwest
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Richland, WA 99352
(509) 372-4274

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King of Prussia, PA 19406
(610) 277-2910

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Colorado Springs, CO 80915
(719) 570-7833

Fluid Power Bookstore
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Cleveland, OH 44114
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Rockville, MD 20850
(800) 638-9636

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New York, NY 10022
(800) 242-7737

Home Power
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(916) 475-3179

Luke Systems International
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Ste 101
Agoura Hills, CA 91301
(818) 991-9373

Midnight Engineering
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Snaptron
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Loveland, CO 80537
(303) 663-2820

The unneeded diagnostic parts can be removed and used elsewhere, or you can disable them by clipping the 150-ohm and 157-kilohm resistors. They could also be drilled out. Use the red wires for one switch and the green ones for the other.

Once again, the rules are: Switch goes *on* above 17 volts, and it stays on with 3 milliamperes or more of current. The switch works equally well with either current polarity.

Obviously, this is an ideal crowbar for a power supply or an overvoltage detector. You can build a set-reset flip-flop memory or latch. All sorts of AC phase-control possibilities come to mind. A doorbell, HVAC, or alarm voltage easily power your circuits. And there's also a bunch of possible home automation uses.

Figure 4 does show several variations on the classic *relaxation oscillator*. Figure 4-a is a simple sawtooth frequency generator. Figure 4-b has an LED added in the loop to make a low- power flasher. The average current is reduced depending on the selected duty cycle of the lamp flashing.

In Fig. 4-c, a loopstick antenna and a tuning capacitor are added, making up a shorter range AM radio transmitter—one that is also handy for test and alignment of antique radios.

HELP LINE

Phone or write all your Hardware Hacker questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher, AZ, 85552
(520) 428-4073

For fast PSRT access,Modem (800) 638-8369. On prompt, Type JOINGENIE. When asked for the offer code, enter DMD524.

US Internet email access link:
SYNERGETICS@GENIE.GEIS.COM.

Let me know if you want some of these 2960 units to play with. There are all sorts of possibilities here.

This month's contest

Better yet, let's make a contest out of it. Dream up some new use for a remotely contollable, snap action analog switch. Or else find me some market for a few of these beasties.

As usual, there'll be a dozen or so *Incredible Secret Money Machine II* books going to the dozen or so best entries. Along with an all expense paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best. Be sure to send all your *written* entries to me here at *Synergetics* and not to the *Electronics Now* editorial offices.

More good reads

Be sure to read *The H-P Way* by David Packard. Subtitled "How Bill Hewlett and I Built our Company". Yeah, it's a tad dull and overly yea-team, boom-rah. And his claim that a LED taillight can improve gas mileage by one mile per gallon is a tad hard to swallow. Uh, beyond that, though, this is a must read if you are developing a small tech business. It's from *Harper Business Press*, $17 list in hardback.

Wings of Giants, mentioned in last month's column, appears to have badly missed a key point: The first man-powered flight happened in New Zealand. And did so years ahead of the Wright Brothers.

More on sunflowers and Fibonacci sequences in *Nature's Numbers* by Ian Stewart. Subtitled *The Unreal Reality of Mathematics*. See pages 127-144 for additional info.

For a hilarious alternate take on Microsoft, try out *Microserfs* by Douglas Coupland. And published by *Regan Books*.

A great solar CD

Karen Perez of *Home Power* just sent me her latest *Solar II Renewable Energy CD ROM*. A labor-of-love project that offers "the best info available in the fields of renewable energy, home scale energy systems, sustainable technologies, resources, and communications." $29.50.

continued on page 70

THEREMIN

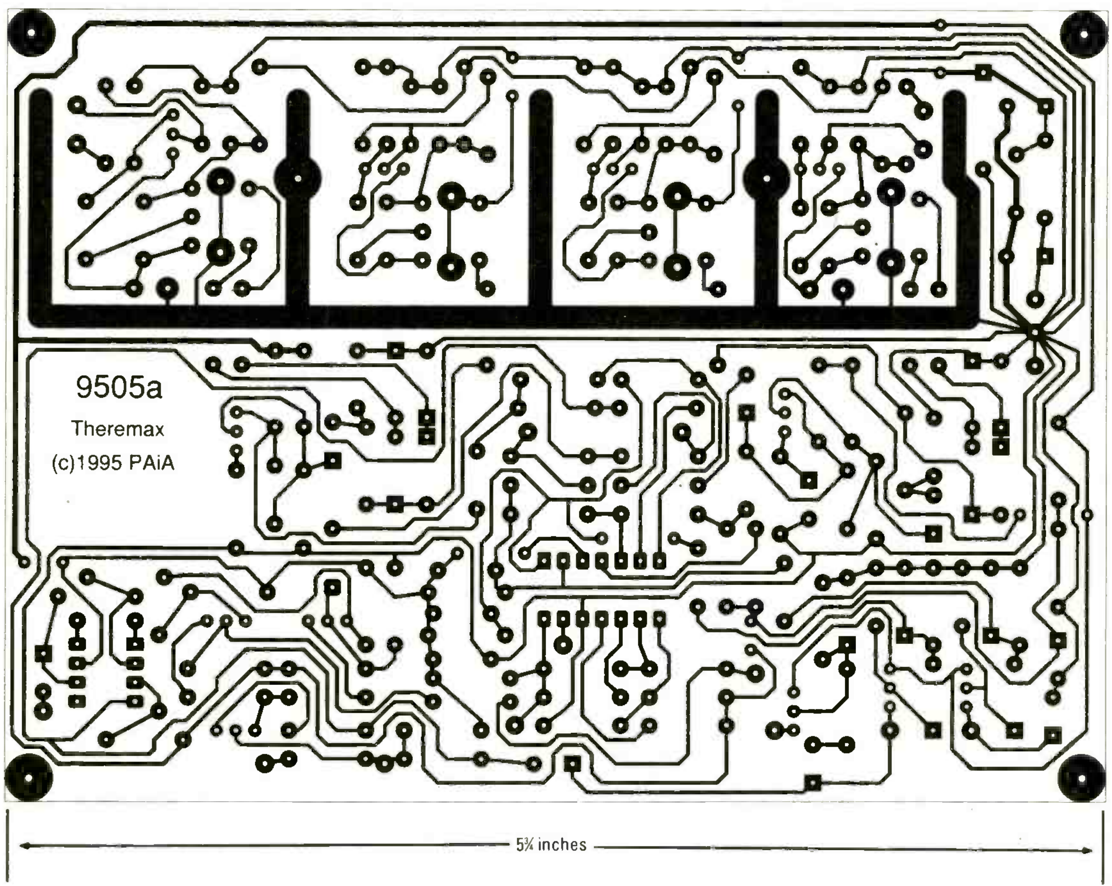
continued from page 32

serve as reference for both pitch and volume sensing you have a good designer's instincts—it would be more economical. Unfortunately, multiple oscillators operating near the same frequency have a tendency to "pull" and lock to exactly the same frequency—just like the swing of multiple compound pendulums will tend to synchronize. It's not too difficult to minimize this tendency in a single pair of oscillators by physically isolating them from one another, putting guard bands around them on a circuit board and decoupling them from their common power supply, but three oscillators, all heading for essentially the same frequency is considerably more difficult.

If the oscillators lock, there is no more difference frequency, so the output goes to zero. It would be bad enough if at the lowest notes the sound suddenly stopped, but the worst part is that just prior to locking, the oscillators go through an unstable region where the synchronization is chaotic. Instead of just suddenly going quiet, you first hear a burst of noise. These are very unmusical characteristics. Having four oscillators allows us to offset the frequency ranges of the pairs so that they do not interact.

The basic oscillator is a classic Hartley type as typified by transistor Q2 and associated circuitry. The primary winding of oscillator coil L2 and capacitor C10 form a resonant tank circuit load for the transistor, which is configured as a common-base amplifier stage. A tap on the coil is coupled by C11 to the input of the amplifier (the emitter of Q2) for feedback. Resistors R7 and R10 set the operating point of Q2 to provide the gain necessary to maintain oscillation. R8 and C8 provide decoupling between the power supply and the oscillator to minimize unwanted interactions between the four oscillators. In this oscillator, and the identical one built around Q3, the frequency is set solely by the combination of C10 and the inductance of the primary winding of L2 and is adjusted by varying the ferrite slug in the oscillator coil.

The sensing oscillators, typified by the one for pitch comprising Q1 and associated components, have a couple of tweaks. The capacitive reactance of the tank has the additional component of the pitch-sensing antenna, which is effectively in parallel with capacitor C6. The parasitic capacitance of this antenna is greatly affected by the presence of objects, particularly flesh-and-blood objects. As an object approaches the antenna, capacitance increases causing the resonant



FULL-SIZE PRINTED CIRCUIT board foil pattern.

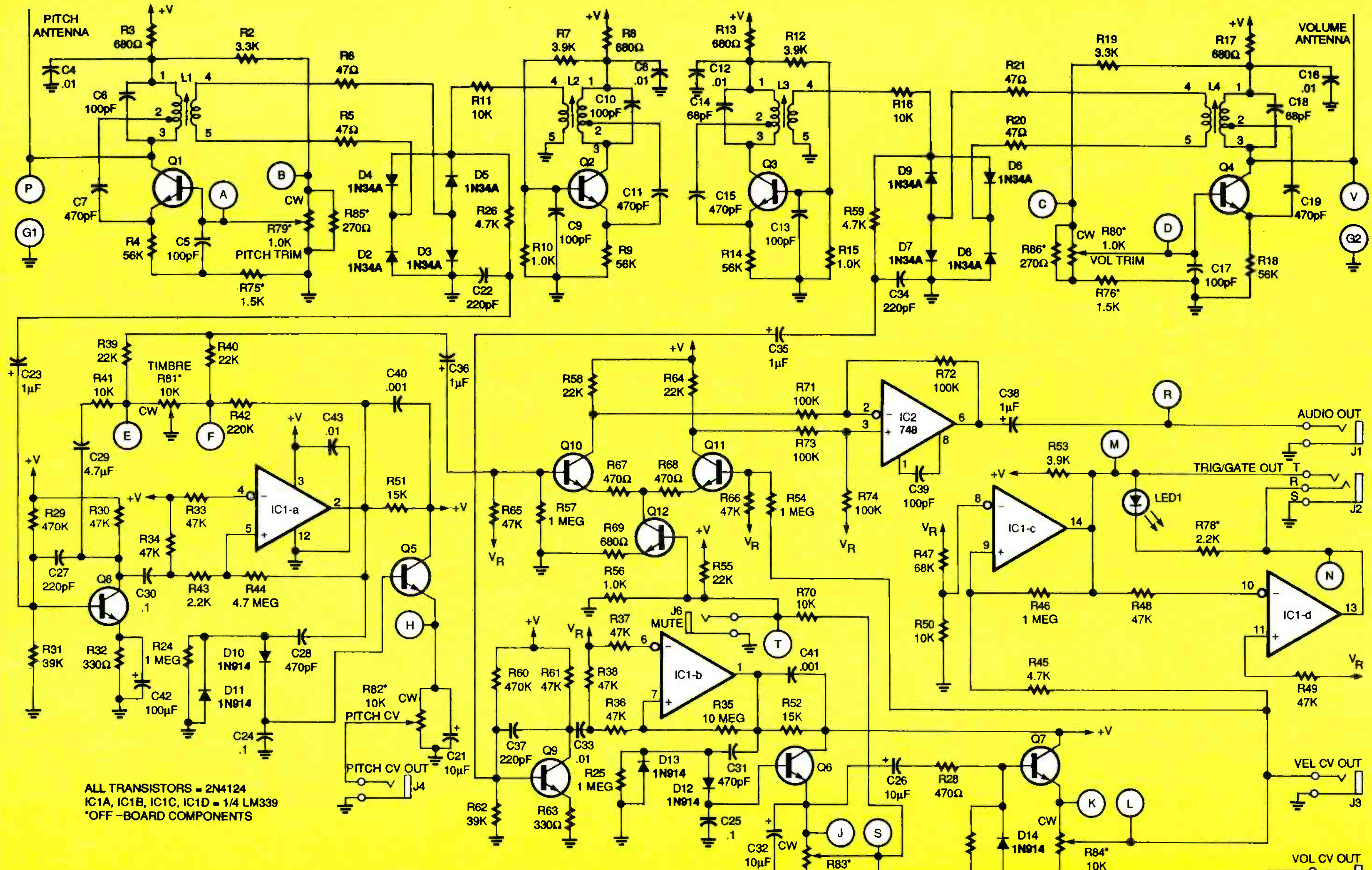


FIG. 1—MAIN THEREMAX SCHEMATIC. All components marked with an asterisk mount off the circuit board.

frequency of the circuit to go down.

The sensing oscillator also provides for vernier control of frequency using potentiometer R79, which allows a variable setting of the operating point of Q1. Varying the operating point changes frequency by increasing or decreasing the DC current flow through the Primary of L1, which changes the permeability of the core slightly and consequently the reactance of the inductor. The volume sensing oscillator (built around Q4) follows this same design.

For both pitch and volume, the outputs of the reference and sensing oscillators are taken off the secondary windings of their respective transformers to buffer them from the effects of loading by the rest of the circuitry. Taking the pitch circuitry as typical, the oscillators are mixed in the ring modulator consisting of D2-D5. The output of the modulator consists almost entirely of the sum and difference frequencies with some small leakage at the frequencies of the oscillators. The higher frequencies are rejected by the low-pass filter consisting of R26 and C22, and only the audible difference frequency passes. Transistor Q8 and associated components comprise a single-stage amplifier that boosts the output of the modulator to a more usable level with C27 providing a second pole of filtering for further suppression of the higher frequencies. The comparable circuit elements in the volume-sensing side of the circuit should be apparent from inspection of the schematic.

Pitch and volume control voltages are produced in the same way: A comparator converts the sine wave difference frequency to square waves, which are differentiated to a string of pulses, which are then integrated to a control voltage (CV). Taking the pitch CV as typical, the output of the amplifier Q8 is coupled by C30 to the Schmitt trigger wired around IC1-a. The inverting input of the comparator is tied to a half-of-supply reference, V_R, that comes from R22 and R23. R38 ties the non-in-

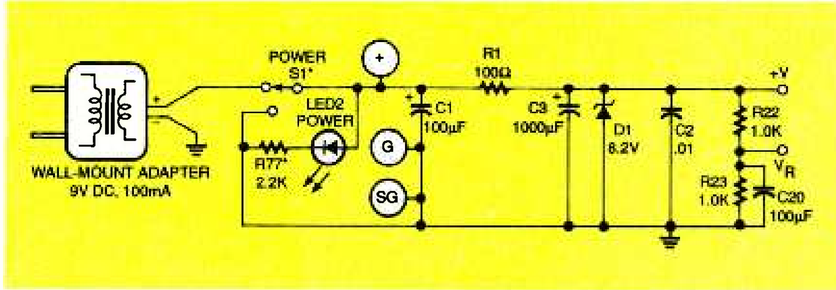


FIG. 2—THEREMAX POWER SUPPLY. A 9-volt DC adapter provides power for the circuit.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.
R1—100 ohms
R2,R19—3300 ohms
R3,R8,R13,R17,R69—680 ohms
R4,R9,R14,R18,R48,R49,R61, R65,R66—56,000 ohms
R5,R6,R20,R21—47 ohms
R7,R12,R53—3900 ohms
R10,R15,R22,R23,R56—1000 ohms
R11,R16,R41,R50,R70—10,000 ohms
R24,R25,R54,R57—1 megohm
R26,R45,R59—4700 ohms
R27,R29,R60—470,000 ohms
R28,R67,R68—470 ohms
R30,R33,R34,R36,R37,R38—47,000 ohms
R31,R62—39,000 ohms
R32,R63—330 ohms
R35,R46—10 megohms
R39,R40,R55,R58,R64—22,000 ohms
R42—220,000 ohms
R43,R77,R78—2200 ohms
R44—4.7 megohms
R47—68,000 ohms
R51,R52—15,000 ohms
R71,R72,R73,R74—100,000 ohms
R75,R76—1500 ohms
R79,R80—1000 ohms, panel-mount potentiometer
R81,R82,R83,R84—10,000 ohms, panel-mount potentiometer
R85,R86—270 ohms

Capacitors
C1,C20,C42—100 µF, 10 volts, electrolytic
C2,C4,C8,C12,C16,C33,C43—0.01 µF, ceramic disc
C3—1000 µF, 10 volts, electrolytic
C5,C9,C13,C17,C39—100 pF, ceramic disc
C6,C10—100 pF, NPO, ceramic disc
C7,C11,C15,C19,C28,C31—470 pF, ceramic disc
C14,C18 —68 pF, NPO, ceramic disc
C21,C26,C32—10 µF, 10 volts, electrolytic
C22,C27,C34,C37—220 pF, ceramic disc
C23,C35,C36,C38—1 µF 10V, electrolytic
C24,C25,C30—0.1 µF, Mylar
C29—4.7 µF, 10 volts, electrolytic
C40,C41—0.001 µF, ceramic disc

Semiconductors
D1—8.2 volts, 400 milliwatts, Zener diode
D2–D9—1N34A germanium diode
D10–D14—1N914 silicon diode
D15,D16—red LED
IC1—LM339 quad comparator
IC2—748 op-amp
Q1–Q12—2N4124 NPN transistor

Other components
J1,J3,J4,J5,J6—¼-inch phone jack
J2—¼-inch stereo phone jack
S1—SPST switch
P1—DC wall-mount adapter, 9 volts, 100 mA.
L1,L2,L3,L4—796 kHz. (nom.) oscillator coil

Miscellaneous: knobs, circuit board, wire, solder, hardware, case, etc

Note: The following are available from: PAiA Electronics, Inc., 3200 Teakwood Ln., Edmond, OK 73013; Tel: 405-340-6300; Fax 405-340-6378; Online: http://www.paia.com/paia:

• Complete kit of all electronic parts including power supply, circuit board and knobs less antennae and case (#9505K): $88.75

• Case kit with pieces cut from white pine and drilled for assembly. Includes hardware, formed antennae, bottom plate and punched, anodized and legended control panel (#9505C): $77.25

Please add $7.00 for shipping and handling with each order.

verting input to V_R, and R43 and R44 combine to provide a slight hysteresis that speeds switching and prevents "chattering" when the Schmitt trigger fires.

The output appears across the load resistor R51, and it is coupled by C28 to R24 so that the rising edge of the square wave produces a positive-going pulse. On falling edges of the square wave, D11 becomes forward-biased and quickly charges C28 for the next pulse while also clamping to ground the negative spike that would be produced. As the frequency increases, the constant-width pulses come closer together so the equivalent DC value of the pulse train increases. The average value of the pulse train is recovered by charging C24 through D10. The voltage on the capacitor is "read out" by the high-impedance emitter follower consisting of Q5 and R82, which is also the panel control that sets the control voltage available at the PITCH CV jack. The volume CV is generated in the same way using the comparator built around IC1-b.

Potentiometer R81 allows either the sine wave at the collector of Q8, the square wave at the output of the IC1-a, or a mix of the two to serve as the audio signal. At the counterclockwise end of the rotation of R81, its grounded wiper shorts out the junction of R40 and R42 allowing only the sine wave to pass to the next stage through C29, R41 and R39. At the other end of its rotation, the wiper shorts out the sine wave. At intermediate settings, the two are mixed. This audio signal is coupled by C36 to the voltage-controlled amplifier or VCA.

In the VCA, the gain of a differential pair of transistors (Q10, Q11) is controlled by setting the current flow through them with a third transistor, Q12. The volume CV, as set by front-panel control R83, is converted to a current by R70. This current sets the collector current of Q12. As this current increases, the gain of Q10 and Q11 increases as well. The significant shift in DC voltage at their collectors is canceled out in the differential amp built around the 748 op-amp IC2. The output of IC2 is coupled by C38 to J1.

The volume CV is also used to derive a velocity CV. Natural instruments are sensitive to how hard you play them. With MIDI instruments, this quality has come to be know as velocity. In Theremax, velocity is proportional to the rate of increase of volume—the "velocity" with which you hand approaches the volume antenna. Changes in the volume CV are coupled by C26 through current-limiting resistor R28 to the base of the emitter-follower Q7. When the volume CV is decreasing, D14 forward biases to clamp the velocity CV to ground and provide a high-current recharge path for C26. Panel-mounted potentiometer R84 serves as a load resistor for the emitter follower and an attenuator for the CV.

The velocity CV is available at the front-panel jack J3. It also routes to the base of Q11 in the VCA differential pair, where it makes the response non-symmetrical, which adds even harmonics to the output to give the sensation of being played hard. The velocity CV also is routed to the Schmitt trigger consisting of IC1-c and associated components. When velocity exceeds a threshold, the Schmitt changes state to provide a triggering pulse to external equipment. Since many vintage analog synthesizers initiate musical events with a switch closure to ground (or "S" trigger), the final comparator in IC1 is used as an open collector to ground turned on by the gate. Both of these signals appear at the stereo phone jack J2, with the gate connected to the tip and the open collector to the ring. A mono plug may be used to access the gate since the open collector tied to the ring can be grounded with no problem.

The 8.2-volt Zener diode D1 stabilizes the voltage from the wall-mounted DC adapter so that power-line transients don't cause pitch glitches.

Next month, we'll show you how to build, test, and tune Theremax. Ω

LETTERS

continued from page 14

voltage is -48 volts. However, because of the float voltage of the batteries in the standby power systems, the idle voltage is higher. That voltage also varies due to the type of battery in use.

6. The ring lead supplied the -48 volts and the tip provided the return path. The return path is referenced to a ground field at the local central office.

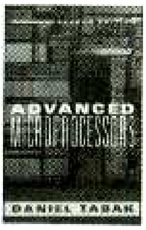
7. The voltage that can be measured across the line (tip to ring) will vary depending on the subset internal resistance (typically 200 ohms), the line loop resistance (the length of the telephone wire from the main distribution frame to the subscriber), the internal resistance of the subscriber line interface, and the bias voltage in use.

Telecommunications signaling works because the resistance between any two points on the earth approaches zero ohms. However, it has been found that direct-connect signaling offices are seldom more than 100 miles apart. Ohm's law applies here: The finite, but very large resistance of the earth's constituents paralleled by an almost finite number of particles approaches zero ohms.

Most people call the earth ground, but what ground is it? Why is ground seldom explained? Better terminology would be "return" and "reference." Return would apply for the leg of the circuit that completes the power path and reference would apply to the point where different circuit returns are connected. References are only needed if different circuits share functionality.

RICHARD A. KUNKEL
Huntsville, AL

EN



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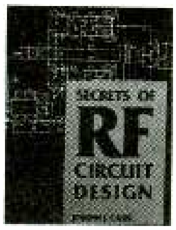

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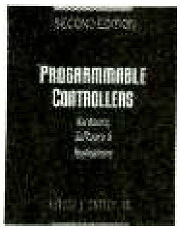

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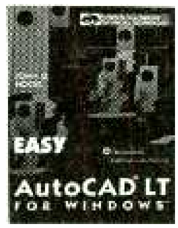

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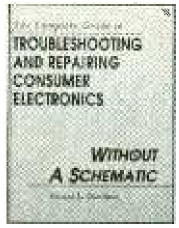

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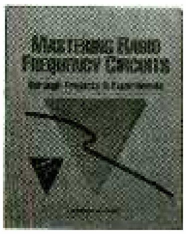

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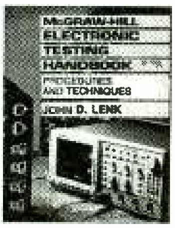

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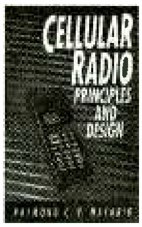

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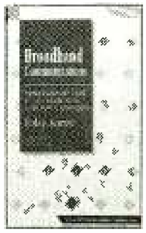

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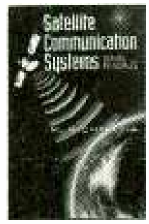

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BY FRANKLIN J. MILLER

Hum and noise in professional audio systems

THE PRESENCE OF HUM AND NOISE CAN BE A REAL PROBLEM IN VIRTUALLY ANY AUDIO SYSTEM. SOMETIMES YOU MIGHT GET LUCKY AND FIND THAT THE FIX IS AN EASY ONE — A CONNECTING CABLE MIGHT have come loose or broken, for example. The problem can be solved with a physical inspection of the cables and connectors that run between all of the elements of your system.

Unfortunately, the causes of hum and noise are not always so easy to find. It can seem as though it might take a miracle to get rid of it. However, every hum and noise problem can be repaired. All you need to do is to take the time to break each one down into its basic elements. That's what we are going to do here. So next time your are faced with a hum or a noise problem in audio equipment remember that the first step is to step back, and think coolly and calmly about how you are going to solve it.

That 60-hertz hum

Once you have eliminated loose or broken cables as the cause of hum, you need to remember that hum is usually the result of a ground-loop in the audio system. To avoid hum, all the grounds in an audio system should be connected together. Normally, if you plug the ac cords of all your equipment into the same outlet, everything should be OK. While that works in simple systems, it is common to find multiple equipment plugged into a number of different outlets. And when the electrical system doesn't have all the grounds at the same potential (a more common problem than you might think or believe) you will have a ground loop — and hum in the system. This happens because the slight difference in ground potential results in a small AC voltage running through the ground wire. Figure 1 is a block diagram that demonstrates how this problem can occur.

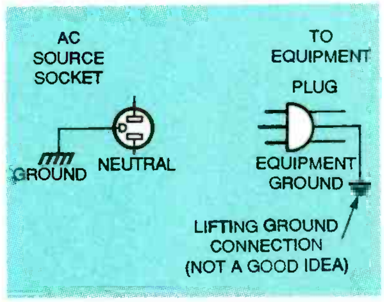


FIG. 2 — SOME TECHNICIANS LIFT AC grounds to eliminate hum. Dangerous idea, and should NEVER BE DONE.

There are solutions. First and best, try to correct the electrical system. This should be done only by a licensed electrical contractor. Although this is the best solution, it is not always the most practical or the least costly. If your installation is a temporary one—for example when setting up a temporary sound system at some remote location—you might not have enough time to get the wiring repaired.

Some people try to solve hum problems by cutting the ground-pin off the power plugs for their equipment or by lifting the ground

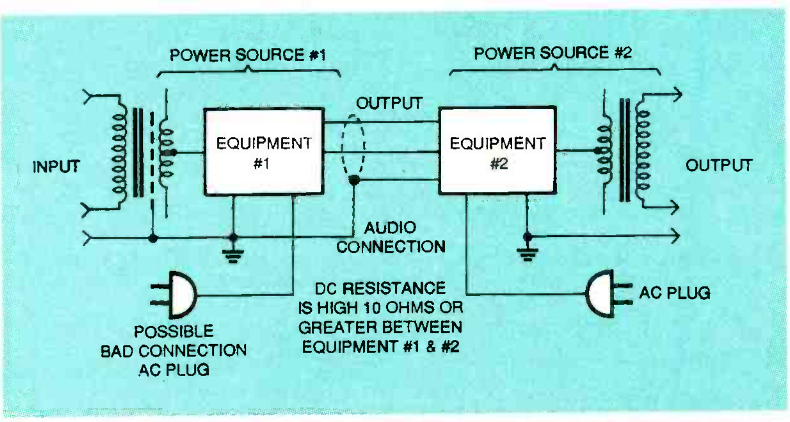


FIG. 1 — SOURCES OF HUM IN A TYPICAL AUDIO SYSTEM. Bad connectors, cables, or small DC resistance in the AC ground at power outlets can all cause this problem.

amplifier: a device that increases the level of a signal (by increasing the voltage or the current). Some amplifiers are used to isolate or control and signal and may not increase the level — or may actually decrease the level. (See Fig. A.)

attenuate: to reduce the level of an electrical signal, usually with a volume control. (See Fig. B.)

block diagram: a drawing that illustrates the main circuit blocks and signal flow in an electronic device or system, but does not show all specific wiring details. (See Fig. C.)

channel separation: the degree to which signal on one channel is not picked up by an adjacent channel; electrical isolation. Separation is measure in decibles (dB). Good separation implies very little crosstalk or leakage. The higher the number the better the separation.

clipping: occurs when the capabilities of an amplifier are exceeded. The result is very audible distortion, also visible on an oscilloscope. (see fig. D.)

crosstalk: undesired signal appearing in a channel as a result of leakage from another channel. Usually specified in -dB. The lower the number the better, and the crosstalk usually increases with high frequencies.

distortion: an unwanted change that occurs to an audio signal causing frequencies to appear at the output that were not present at the input. There are several types of distortion. They are often expressed as a percentage of the total signal. The smaller the number the better.

dynamic range: the difference, in decibels, between the loudest and the softest portions of musical performance (or between the maximum signal and the noise floor of a piece of electronic equipment). (See Fig. E.)

equalizer: an electronic device that will amplify (boost) and/or attenuate (cut) certain portions of the audio spectrum.

frequency response: the range of frequencies which a device or audio system will pass. Frequency response has no meaning unless a tolerance is specified: i.e., 20 Hz to 20 kHz, +/-1 dB.

gain: the amount of amplification, expressed in decibels.

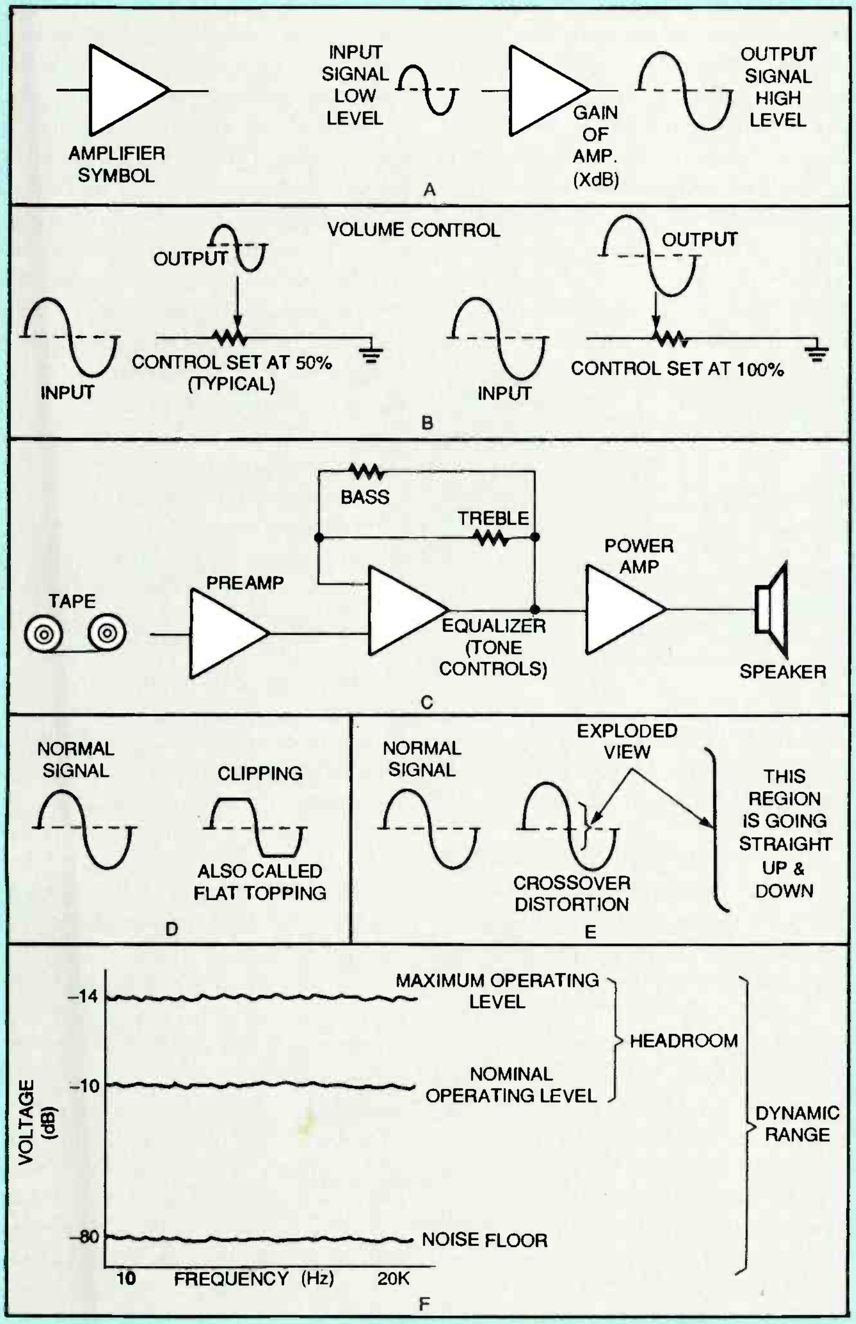
headroom: the difference between nominal operating level and the maximum level at any point in an audio system or device, usually expressed in dB. 10 to 14 dB is usually a good value. (See Fig. F.)

noise: any unwanted signal such as hum, buzz, rumble, crosstalk, etc.

noise floor: the basic noise that is developed by the thermal noise of the equipment. Another kind of noise is tape noise which is normally the hiss you might hear. This number is a negative number and is measured in -dB. The lower the number the less the noise. (See Fig. F.)

nominal operating level: the average signal level at which a circuit, an input or an output of a piece of electronic equipment is meant to operate at for best performance. (See Fig. F.)

signal-to-noise ratio: the difference between the nominal or maximum operating level and the floor, specified in dB.



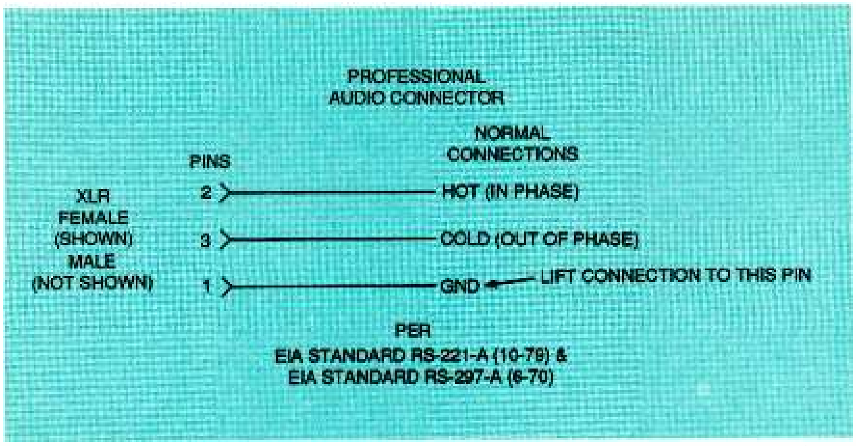


FIG. 3 — CONNECTIONS INSIDE AN XLR audio connector. To eliminate hum lift the ground connection to pin 1 of the male connector.

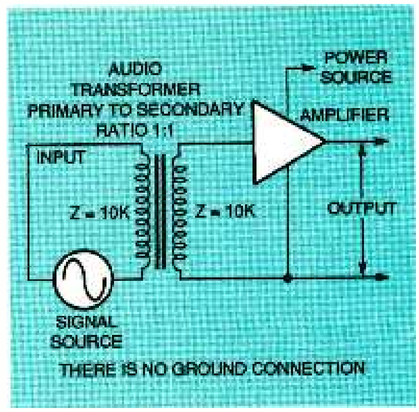


FIG. 5 — AUDIO TRANSFORMERS are another way to isolate audio equipment. Some are available as plug-in accessories.

connection in some other way (see Fig. 2). *Never do this*! Yes, you might get rid of the hum, but you will also create a potential shock hazard that could kill you.

There are two kinds of audio systems that you might have to deal with. The first is a professional system that has balanced inputs and outputs. Second is a semi-professional system that has unbalanced inputs and output. The easiest to deal with is the professional system and the most common fix is to eliminate the audio ground between the two pieces of equipment that are causing the hum. In a multiple device system your first step is to isolate the equipment causing the problem. The process is simple. Unplug one piece at a time, starting at the input end of the system. When the hum goes away you have identified its source. This doesn't work if the ground causing the problem is not AC ground (cable TV ground is an example).

As shown in Fig. 3, you can eliminate the audio ground between equipment by lifting pin 1 and possibly the connection to the shell of the connector. There are several ways to do this; you can open the connector (the male connector is the best choice since the shield should be connected at the female end) and cut pin 1 with diagonal cutters. Another solution is to use one of the many commercial products that lift the ground connection. Two manufacturers are Markertek Video Supply, 4 High Street, Saugerties, NY 12477. Ask for their model GLX for $16.99. 800-522-2025. Or try Sescom Inc., 2100 Ward Dr., Henderson NV 89105. Ask about Model IL-17 for $20.00. 800-551-2749.

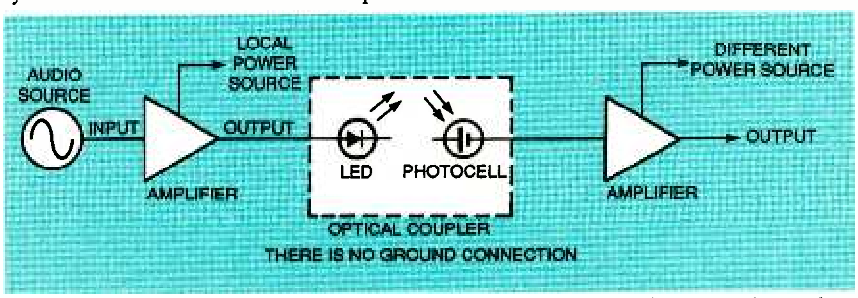


FIG. 4 — OPTICAL COUPLERS are effective in isolating audio equipment and can often help resolve hum problems.

If the input circuit is electronically balanced, lifting the ground may not eliminate the hum. Electronically balanced input circuits require precision resistors (0.01% tolerance) if they are to deliver −80 to −90 dB common-mode rejection. If the resistors are off even just a little, the circuit is not balanced and hum is the result. In these cases a good audio transformer can be inserted to eliminate the problem.

The more difficult circuit to fix is the unbalanced type used in many semi-professional systems. Most of these systems use RCA connectors. Sometimes 3.5-mm connectors are used as microphone input as well as headphone outputs. All of these input and output connectors share one common point, the shield or ground. Here you obviously can not cut the ground connection as it is needed to complete the return path for the signal. As a result there are only two practical solutions. First you could try an optical coupler like the arrangement in Fig. 4. This kind of system is usually used to isolate data in long-distance systems. While it works it does tend to get costly and may introduce extra noise of its own.

The best solution would be to add a simple audio transformer between the two pieces of equipment. When you do this you do have to be sure that the grounds of the two systems are not connected and the audio is passed between the equipment by the audio transformer (see Fig. 5). Remember that this input/output combination is at high impedance, typically 1000 ohms or greater. Be sure to select a quality audio transformer.

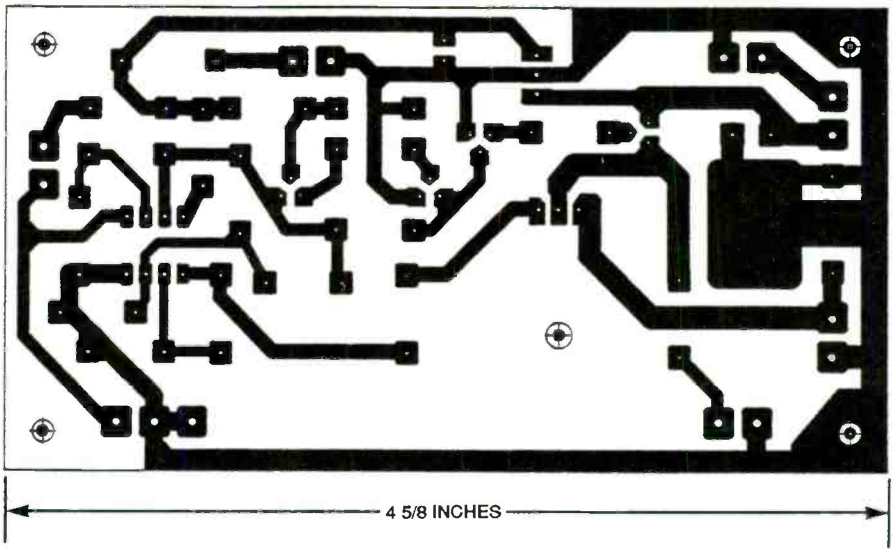
Since you will have to lift a ground on one of the transformer coupled equipment, good practice calls for lifting the ground at the output of the sending equipment. Leave the ground connected at the input of the receiving equipment.

There you have it — simple, practical solutions to a common audio system problem. Remember, there is no one solution to all problems. Your best tool is your knowledge of what can go wrong and the methods you can use to make the system work right. EN

LEVITATOR

continued from page 34

turn on, which turns Q2 and Q1 off, so the electromagnet coil receives no current. Likewise, if the beam is completely blocked, the output of IC2-b will drop below 0.7-volts. Again Q4 and Q3 will be on which forces Q2 and Q1 off. However, when the object is partially blocking the beam during levitation, the voltage out of IC2-b should be somewhere between the 0.7 and 2.7-volt thresholds. In that case, Q4 and Q3 will be off, with Q2 and Q1 on. Whenever Q1 is on, the red LED indicates that Q5 and the coil are receiving current.



Building the levitator

The easiest way to build your own anti-gravity levitator is to use an etched circuit board. The foil pattern for a suitable board is shown here. However, if you don't want to fabricate your own board, a pre-etched and drilled board can be purchased from the source given in the Parts List.

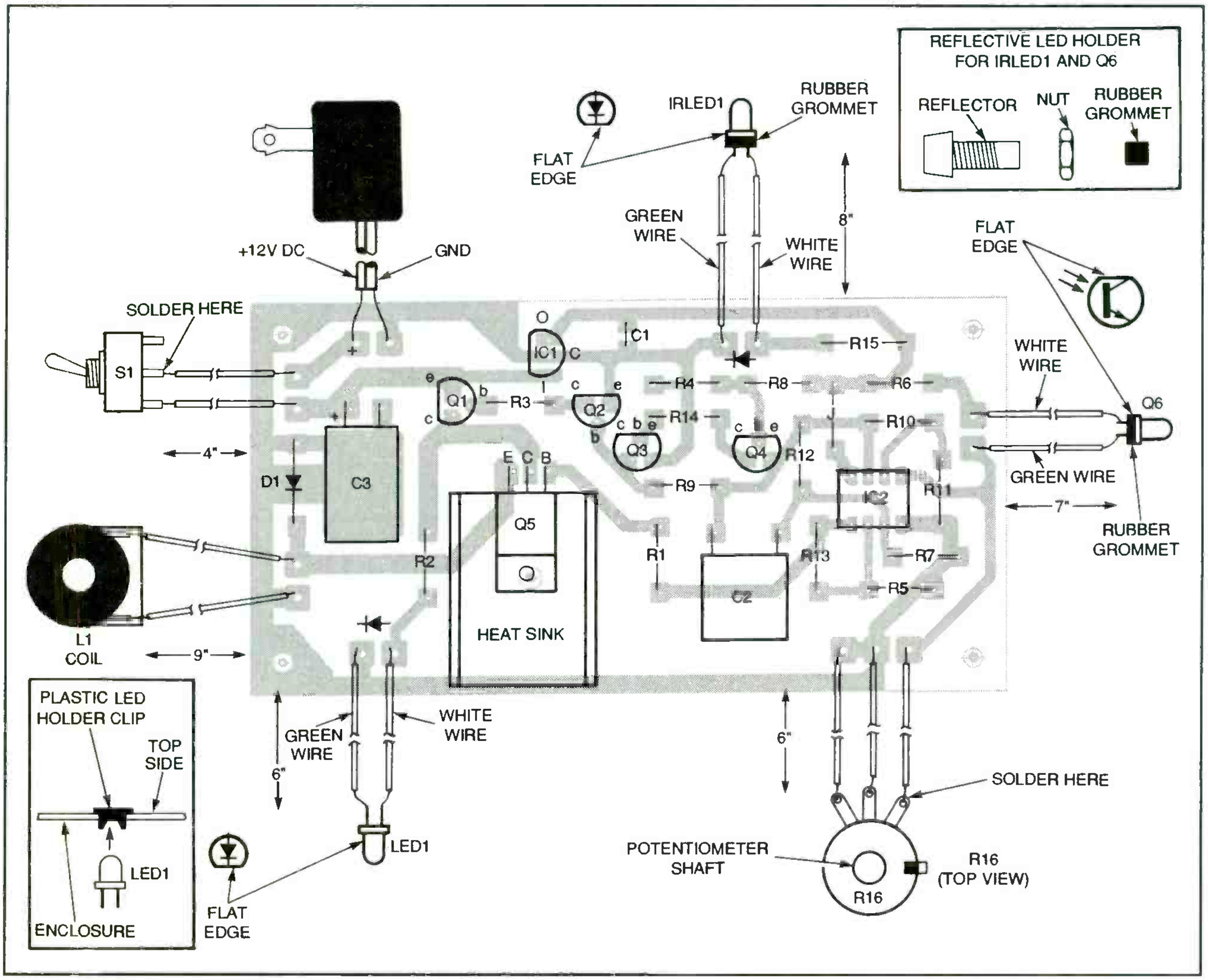


FIG. 2—PARTS-PLACEMENT DIAGRAM **and wiring details for off-board components.**

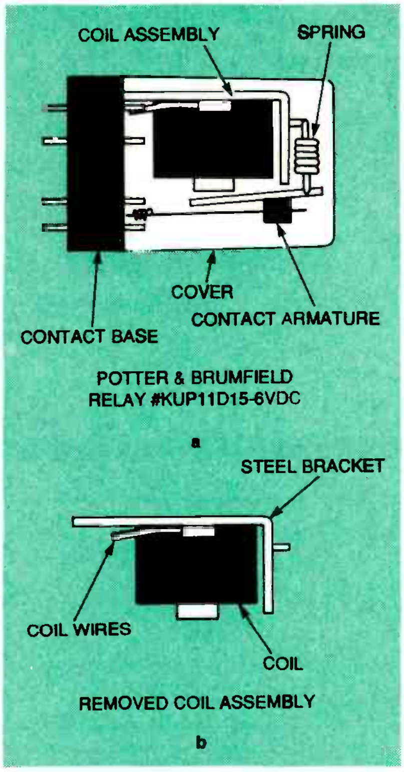


FIG. 3—THE ELECTROMAGNET that is used in the levitator is obtained by disassembling a relay as shown.

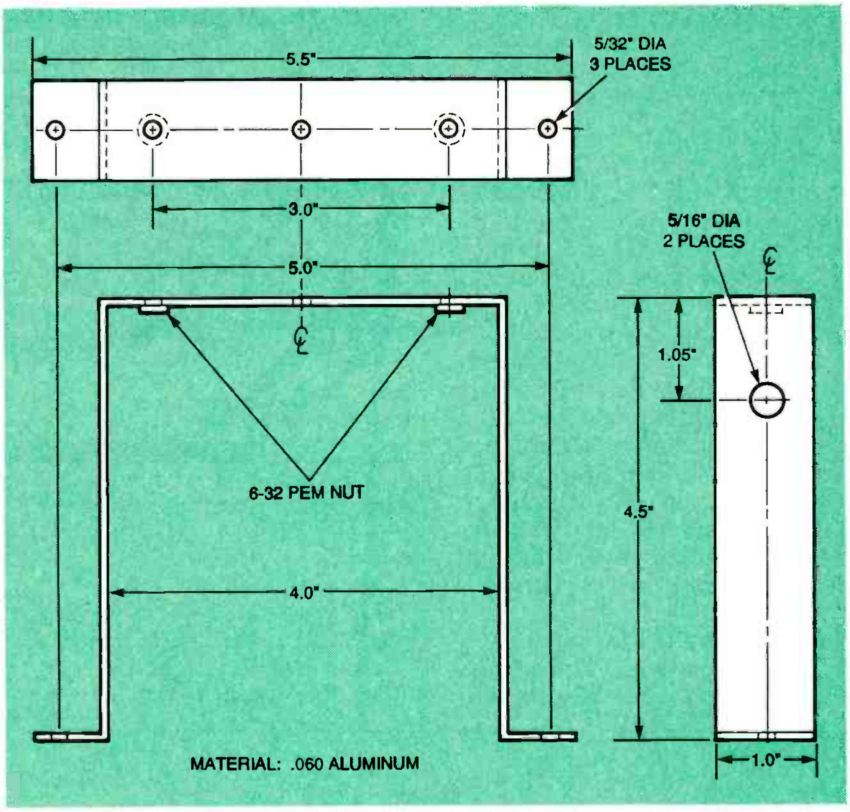


FIG. 4—AN ALUMINUM BRACKET should be fabricated as shown.

Locate all the components shown in the Parts List and use the parts-placement diagram of Fig. 2 to determine their proper location on the PC board. First solder a solid-wire jumper at the location marked J. Next install diode D1, paying close attention to its orientation. Then install and solder resistors R1 to R15. Trim the excess leads before proceeding to the next step.

Locate the 0.1 μF capacitor C1. Again using Fig. 2 as a guide, install it and solder in place. Next locate the 8-pin IC socket and install it at the location marked IC2. Don't install IC2 in the socket, however. Move on to transistors Q1, Q2, Q3, and Q4. Install each with the proper orientation indicated on the parts placement diagram. Then locate and solder the 9-volt regulator IC1 in place. Capacitors C2 and C3 are large and should be bent to lie against the PC board after installation. The TO-220 transistor Q5 and its heat sink also mount against the board and are held down with a No. 4-32 screw and nut.

Figure 2 also contains details

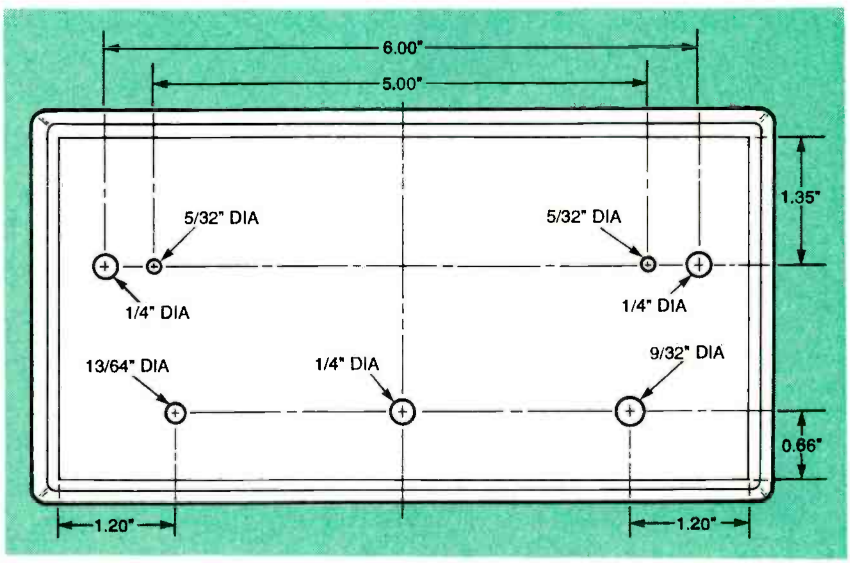


FIG. 5—DRILLING GUIDE for the levitator enclosure.

on wiring off-board components S1, R16, LED1, IRLED1, Q6 and the AC adapter. Use No. 24 AWG stranded hookup wire and solder wires from the PC board to S1 and R16 as shown. The infrared emitter and detector (IRLED1 and Q6) need special preparation before they are attached to the PC board. To form a directed beam that will not be affected by external infrared energy, the two components will need to be mounted in reflective LED holders, which are then mounted to the levitator's metal bracket. At this point, however, just remove the round rubber pieces from the reflective holders and slide one each onto IRLED1 and photodetector Q6. Then attach the wires as shown. Using colored wire will help you keep the polar-

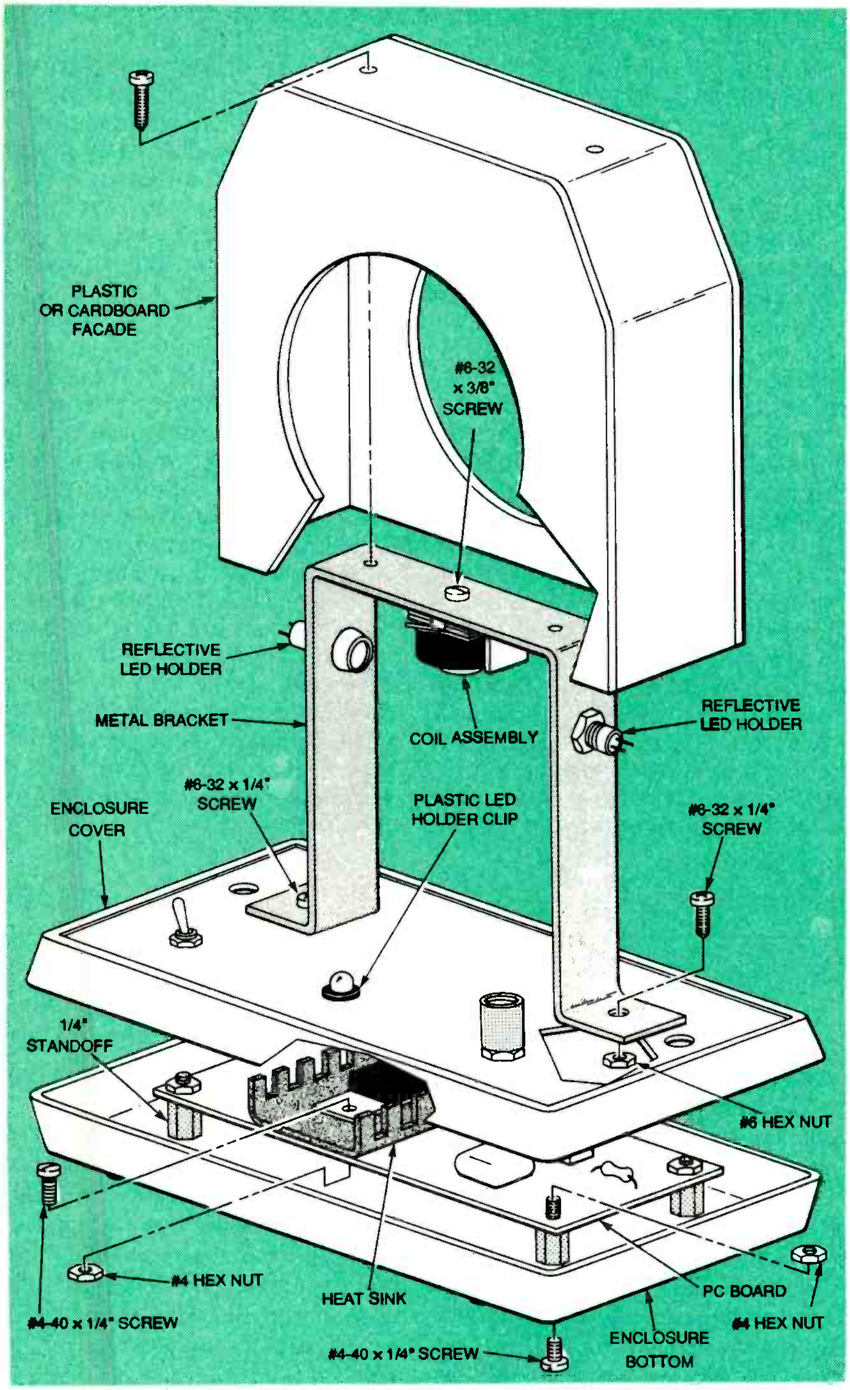


FIG. 6—A PLASTIC OR CARDBOARD COVER hides some of the levitator's components, enhancing the illusion that the globe is floating as if by magic.

ities correct.

Use two more pieces of wire to attach the red LED to the PC board. Again, use colored wire to make sure the connections match those shown in Fig. 2. Lastly, solder the two wires from the 12-volt adapter to the PC board, observing the proper polarity. Now locate the LM358 dual op-amp, IC2. Use the notch in the plastic package to orient pin-1 and install the IC firmly into the 8-pin socket.

The electromagnetic coil for this project should have a DC resistance between 25 and 35 ohms, and a steel or iron core. Winding such a coil can be tedious, so a readily available source for this part was located. A Potter & Brumfield relay (Model: KUP11D15- 6V) contains a coil that works fine. The relay should be disassembled and all parts discarded except the coil and metal "L" bracket as shown in Fig. 3. At this point solder the two wires for the coil to the PC board, but don't attach the coil to the other ends until after the board has been mounted in the plastic case.

Final assembly

Because the magnetic field from the coil loses strength rapidly with distance, it is important that the center of the infrared beam formed by IRLED and IRDET be no more than 0.2 inches below the coil. Otherwise, the coil will not be able to overcome the weight of the metal globe. This distance was determined by experimentation using the specific components shown in the Parts List. If you use a different coil or try to levitate objects of different weights, you will have to experiment on your own to find the best beam position.

The aluminum bracket shown in Fig. 4 is a convenient mounting support for the coil and the reflective LED holders. The dimensions shown will ensure that the infrared beam is the correct distance below the coil. This bracket is available from the source shown in the parts list or you can use Fig. 4 to fabricate your own.

Figure 5 shows how to drill the top cover of the plastic enclosure to accept the aluminum bracket and provide mounting holes for S1, LED1 and R15.

Figure 6 shows how everything fits together for the final assembly. Mount the PC board inside the enclosure bottom using 1/4 inch standoffs and the appropriate hardware. Next attach the metal bracket to the top of the enclosure with two No. 6-32 × ¼ inch screws and nuts. Remove the nuts from the reflective LED holders and mount both of them as shown in the diagram. Then attach the coil assembly to the top of the bracket with another No. 6-32 screw. Lastly, push the plastic LED holder clip into the center hole of the cover as shown.

Feed the IRLED and its wires through the ¼-inch hole in the top cover and insert the infrared LED into the reflective holder. Push the IRLED in until the rubber piece fits snugly. Repeat the process with Q6 on the other end. Next feed the coil wires from the PC board through the cover and solder them to the coil. Then mount S1, LED and R16 to the enclosure cover. Before putting the enclosure halves together, file a small notch in the back edge to allow the adapter's cord to exit. Attach the plastic knob to the potentiometer R16.

Operation

Place the anti-gravity levitator in a location that has normal room lighting. Try to keep it away from strong sources of infrared energy such as full sunlight or a bright desk lamp. Plug the adapter into a 120-volt AC outlet and turn R16 fully counter-clockwise before switching S1 on. Make sure nothing is under the coil that would block the infrared beam. The red LED should be off at first. Slowly turn R16 clockwise and observe the LED. As you turn the potentiometer the LED should come on and then turn back off as you continue to increase the Q6 threshold with R16. Stop turning R16 as soon as the LED turns off again. (The potentiometer should be between one-quarter to one-half of its range at this point).

Now take a small hollow steel globe, place it on your outstretched hand and lift it *slowly* towards the coil until it starts to break the infrared beam. It is important NOT to hold the globe between your fingers because your fingers will accidentally break the beam and prevent levitation. When done properly, the coil's field will gently grab the globe from your hand and suspend it in mid-air! Do not lift the globe so high that it touches the coil. The proper point of levitation will be about 0.2 inches below the coil.

If the globe constantly jumps up and sticks to the coil, then R16 is set too high. Start R16 once more from the counter-clockwise position and stop as soon as the LED comes on and goes back off again. Once you have the globe successfully levitating, try gently blowing on it. With a little practice you can make it spin just like the earth does.

Some non-metallic objects can also be levitated by attaching a small magnet to the object. This will take some experimentation. The magnet must be facing in the direction that will be attracted, not repelled, by the coil. Also the total weight of the object and magnet must not exceed the coil's ability to lift.

You may want to make a cardboard or plastic cover to hide the metal bracket and wires. This will make your levitator more attractive when you invite your friends to observe your power over gravity! Everyone is sure to be both amazed and impressed. Ω

HARDWARE HACKER

continued from page 55

This is greatly improved over the older Solar I. The primarily new material now includes color pictures, better navigation, and total Acrobat .PDF support, 350 megabytes of text and GIF files. It runs on either the Macintosh or PC.

More information on alternate energy resources is available in HACK28.PDF. More on Acrobat in ACROBLAT.PDF and hundreds of other files in *GEnie* PSRT.

New tech lit

A well done tutorial on quantum computing appears in *Science* for October 13, 1995. On pages 255-260. With a good bibliography. Quantum computing offers the potential of a *billion* to one speedup over today's PC's. Also in the same issue, some new magnetoresistive materials and a speech recognition breakthrough are covered.

A 64 page catalog listing hundreds of energy books is now offered by the *Association of Energy Engineers*.

Books on hydraulics are stocked by the *Fluid Power Bookstore*.

Freebie samples of keyboard snap disks are offered by *Snaptron*. *Luke Systems International* is yet another obsolete-semiconductor source.

PCMCIA card and frame kits are sold by *PC Card Products*.

A new MX-COM product guide on unusual communications, caller-ID, and security chips is available.

More details on electroluminescent panels: *BKL* has lots of data and kits available. Despite EL being a "cold light", the efficiency of today's best panels is only around *one-third* that of a plain old light bulb—around six lumens per watt or so. While the brightness increases with frequency and voltage, the efficiency does *not*. Best overall efficiency takes place at low voltage and frequency. Both the brightness and efficiency drop substantially over time.

One fresh approach to on-demand *hardback* book binding has been released by *Flesher*. Around $3 and 3 minutes per book. For custom hardbound covers, a peel-and-stick technique is used along with a taped spline and no provision for trimming the actual pages. It's way overpriced, but it's still a partial book-on-demand solution.

Much more on tested and proven small-scale desktop home publishing opportunities in my *Book-on-demand Publishing Kit* from *Synergetics*. Full details in our nearby ad.

I've just bought an *entire* college electronics department at an auction. There are some outstanding buys in everything from logic analyzers to printed-circuit etchers to mint Tektronix manuals to fine test and breadboard bargains. Write or call for a list. EN

PARTY LINE
continued from page 36

power transistors Q1 and Q2, which in turn drive step-up transformer T1. Note that T1 is used "backward:" its low-voltage secondary is driven, and its output is derived from the high-voltage primary. The output of T1 is about 90 volts AC. Ideally, that output would be a clean sine wave. Although most equipment will not be bothered by the harmonics present in the T1 output, there is a possibility that some might be.

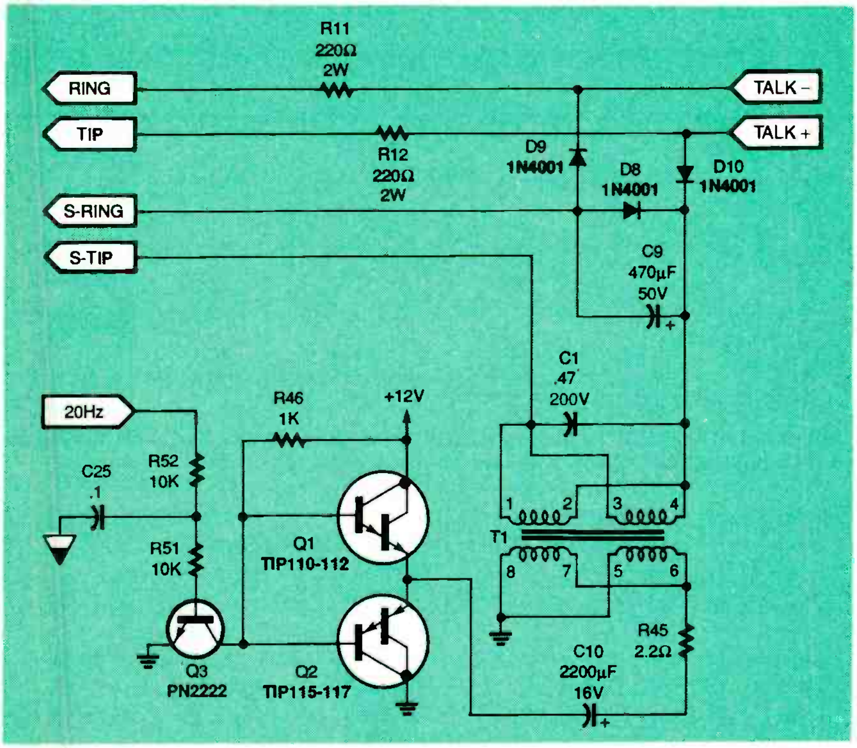


FIG. 4—THE STEP-UP CIRCUIT creates a 90-volt AC ring signal by driving transformer T1 via push-pull amplifier Q1 and Q2. The 20-Hz signal is generated under software control by the microcontroller.

Caller ID modulator

Caller-ID delivers its information in a 1200 bit-per-second (bps) serial modem-tone format formally known as Bell 202. Under Bell 202, a high is a 1200-Hz tone, a low is a 2200-Hz tone, and the nominal signal level is −13.5 dBm.

Party Line uses a clever technique to reproduce these modulated tones. Instead of a traditional hardware-based solution, a software process called *bit-banging* creates the tones. Bit-banging can often both improve reliability and reduce cost in comparison with hardware methods. Under MCU control, the high bit of addressable latch IC7 (returning to Fig. 3) is used to create the Caller-ID (CID) tone.

In operation, Party Line waits for the first ring, temporarily removes the caller's phone from the talk path (via the line relays), then carefully manipulates IC7's Q7 output to con-

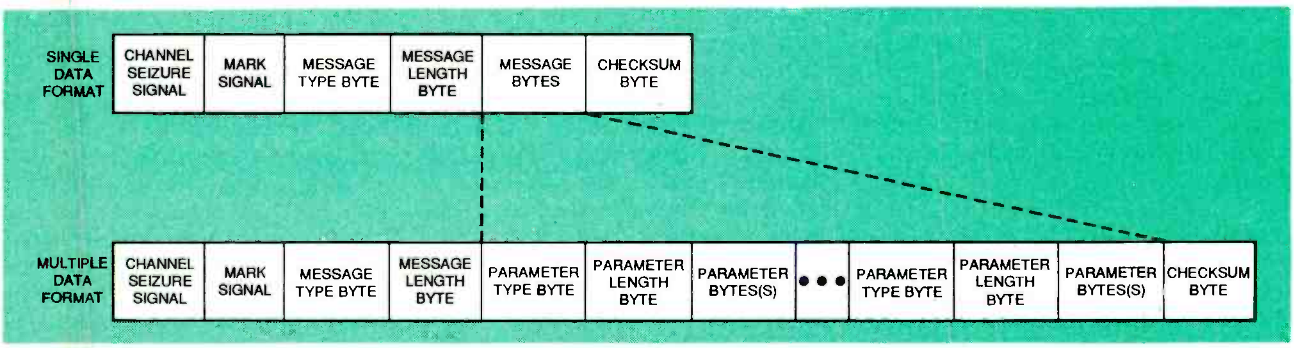


FIG. 5—CALLER-ID MESSAGE FORMATS ARE VERY SIMILAR. The Single Data Message Format includes a single message; the Multiple format inserts multiple messages in the parameter block used by the simple message.

TABLE 4—CALLER ID MESSAGE FORMAT

Message	Description
Power Ring	Not shown. The first ring is called the power ring. It is used to get the attention of the Caller-ID receiver. The ring is followed by 500 ms of silence.
Channel Seizure	Sync bytes, consisting of 30 ASCII U's (250 ms duration).
Mark Signal	1200-Hz marking tone, 150 ms duration.
Message	Message (or parameter) type, length, message bytes, and checksum.
Post-Msg Mark	After message data, an 80 ms mark tone is sent (optional).
Post-Msg Silence	All tones must end at least 475 ms before the next ring.

struct the modulated tones. Although the required frequencies are fairly low, the software keeps the MCU quite busy while generating the tones.

There are two CID data formats, as shown in Fig. 5. The two are very similar, except that the expanded format essentially embeds multiple data items in the position of the single data item of the simple format. Table 4 outlines the meaning of each field of the message.

CID data is transmitted unidirectionally. In addition, the receiver makes no attempt to acknowledge message receipt. Those limitations prevent the receiver from recovering from an erroneous transfer, so even minor transmission errors usually cause the loss of all CID information.

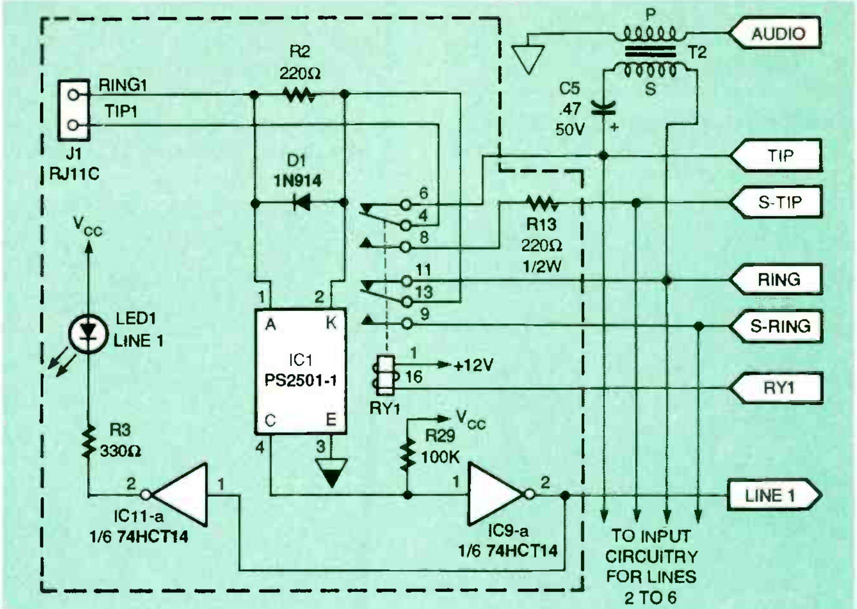


FIG. 6—INPUT CIRCUITRY: Note that everything inside the dashed lines repeats for each input line. Table 6 correlates the parts across all six circuits.

Relay drive

Returning again to Fig. 3, a ULN2003 drives the line-control relays. That IC has an array of seven independent high-gain Darlington NPN transistors, each of which includes an internal diode to prevent EMF damage.

Whenever one of IC8's inputs goes high, the corresponding output provides a return path for the coil of the corresponding relay. The seventh Darlington controls LED7, which provides status display. Status indications corresponding to different operating conditions appear in Table 5.

Input circuitry

Figure 6 brings together several strands of the circuit sections that have been discussed so far. Note that only one of six identical circuits is shown (the part within the dashed lines); Table 6 shows corresponding part numbers for all six stations. Note that there is only one set of audio-coupling devices (C5 and T2) for all six stations. Also, the four lines carrying tip and ring signals form a mini "bus" to which all stations attach in parallel. In contrast, each station has its own line-active indicator (e.g., LINE1) and relay driver (e.g., RY1). As discussed earlier, the LINEx signals drive the MCU directly, and the RYx signals come from the ULN2003 shown in Fig. 3.

Each station contains a loop detector circuit based on an optoisolator. The optoisolator (IC1) acts as a normally open switch that closes when a telephone goes off-hook. When that happens, current will flow through the optoisolator's input, which in turn forces its output low. That signal is then buffered and inverted by one section of a hex Schmitt trigger (IC9-a), and it is that signal that informs the MCU that a station is active. That same optoisolated and buffered signal also drives an LED (LED1) that provides visual indication when a station is active. If a telephone is plugged in, the indicator also flashes during the ring cycle. If a telephone is not plugged in, the indicator does not flash.

The loop detector circuit can detect a phone that goes off-hook during an active ring cycle, a desirable function called *ring trip*. Without ring trip, a very loud 20-Hz buzz would be heard when you answered a ringing phone. Ring trip is commonly available only on expensive phone-line simulators.

When a phone line is idle, the corresponding relay is energized. That removes each idle station from the talk path (Tip and Ring) and places it across the ring circuit (S-Tip and S-Ring) in preparation for a future ring cycle. During the active portion of a ring cycle, the MCU removes all idle stations—except for the station that is ringing—from the T1 circuit, and places them on the talk path. If you listen carefully, you can hear the relays deenergize during the ring cycle.

TABLE 6—LINE INPUT COMPONENTS

Line 1	J1	R2	D1	IC1	LED1	R3	IC11-a	R29	IC9-a	RY1	R13
Line 2	J2	R4	D2	IC2	LED2	R5	IC11-b	R30	IC9-b	RY2	R14
Line 3	J3	R16	D3	IC3	LED3	R17	IC11-c	R31	IC9-c	RY3	R15
Line 4	J4	R6	D4	IC4	LED4	R7	IC11-d	R32	IC9-d	RY4	R18
Line 5	J5	R8	D5	IC5	LED5	R9	IC11-e	R33	IC9-e	RY5	R19
Line 6	J6	R10	D6	IC6	LED6	R21	IC11-f	R34	IC9-f	RY6	R20

TABLE 5—LED STATUS

State	Description
Steady On	Power is on and unit is ready
Flashing	Station is ringing
LED Off	DTMF digit is being dialed

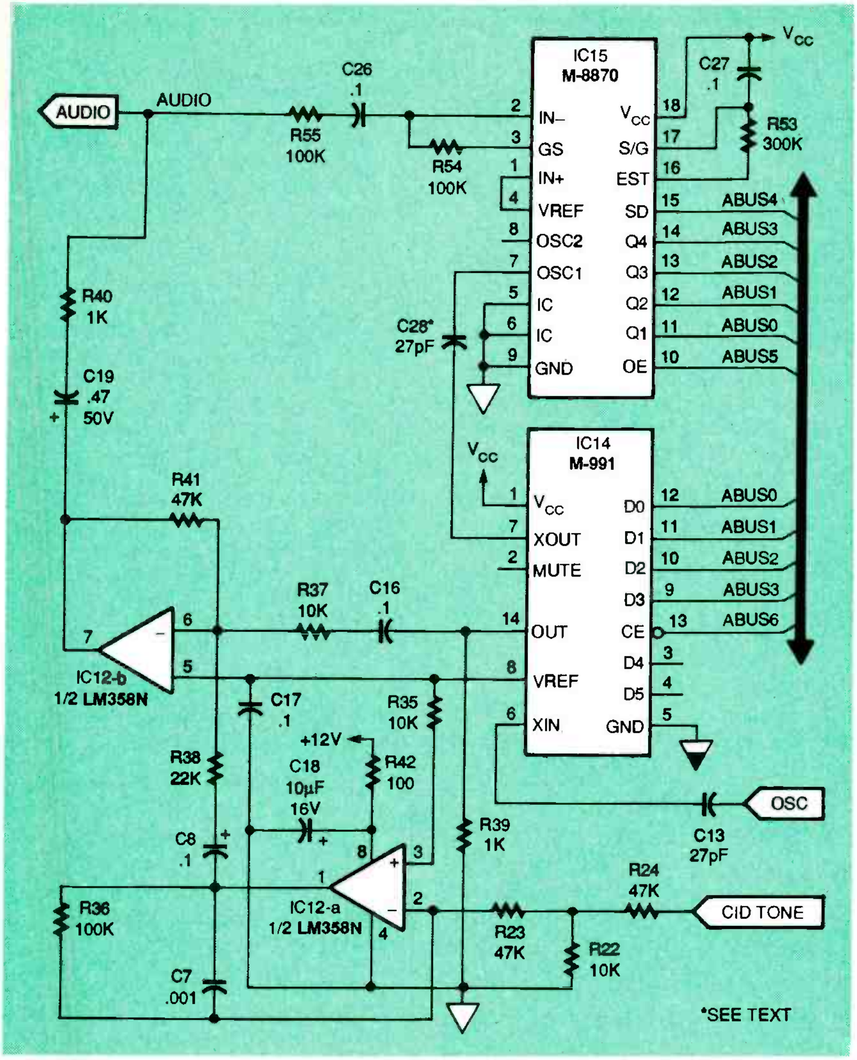


FIG. 7—TONE DETECTION AND GENERATION: IC14 generates one of several call-progress tones as determined by the binary input on its D0–D5 inputs. IC15 decodes DTMF tones and delivers them to the MCU via the 6-bit bus.

TABLE 7—DTMF CODES

Digit	D3	D2	D1	D0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0

When a station goes off-hook, the MCU deenergizes the associated line relay, which places that station on the talk path. Unless you like talking to yourself, at least two stations must be off-hook for you to carry on a conversation.

Tone decoding

Figure 7 shows how Party Line decodes incoming DTMF signals, encodes outgoing call-progress tones, and filters the MCU-generated 20-Hz ring signal.

Through use of a highly integrated DTMF tone receiver, decoding the dialed phone number is simple. Party Line uses the popular M-8870 (IC15), which is made by Teltone Corporation, Mitel Semiconductor, and others. The M-8870 decodes only DTMF telephone codes; it ignores rotary and pulse dialed digits. Because the M-8870 is crystal controlled, there are no adjustments to make. The IC incorporates switched-capacitor filtering to separate groups of tones.

Table 7 shows the binary code delivered by each telephone key. The DTMF encoding standard defines up to sixteen dual-tone combinations, but standard phones generate only twelve of them. The twelve keys appear in a matrix measuring four rows by three columns; those in a given row or column have one tone in common. Table 8 shows the row-column arrangement along with corresponding tones. Note: In 16-digit DTMF, there is an eighth tone (1633 Hz), which is not shown.

For example, if you press the "3" key, the phone generates 697- and 1477-Hz tones. Seven frequencies are involved in standard DTMF generation, and they are separated into two groups. The row information is called the low group; it has frequencies 697–941 Hz. The column information is called the high group; it has frequencies 1209–1477 Hz.

The codes get to the Microcontroller via bus lines ABUS0–ABUS3. The MCU periodically monitors bus line ABUS4; when it goes high, the MCU then reads the binary code from IC15. The software must decide if the tone code is new, because holding down a key will cause the tone code to be read about two hundred times per second. The software records the dialed digits as they are entered; when enough digits have been entered, the MCU starts ringing the station corresponding to the dialed number.

TABLE 8—DTMF TONES

	High Group		
Low Group	Column 0 1209 Hz	Column 1 1336 Hz	Column 2 1477 Hz
Row 0, 697 Hz	1	2	3
Row 1, 770 Hz	4	5	6
Row 2, 852 Hz	7	8	9
Row 3, 941 Hz	*	0	#

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.
R1,R39,R40,R43,R46—1000 ohms
R2,R4,R6,R8,R10,R16—220 ohms
R3,R5,R7,R9,R17,R21,R48—330 ohms
R11,R12—220 ohms, 2W, 5%, metal oxide
R13–R15,R18–R20—220 ohms, ½W
R22,R35,R37,R50–R52—10,000 ohms
R23,R24,R41—47,000 ohms
R25–R34,R36,R47,R54,R55—100,000 ohms
R38—22,000 ohms
R42,R44—100 ohms
R45—2.2 ohms
R49—470 ohms
R53—300,000 ohms

Capacitors
C1—0.47uF, 200V, metalized polyester
C2–C4,C6,C8,C15–C17,C25–C27—0.1uF, 50V, monolithic, radial
C5,C19,C20—0.47uF, 50V, electrolytic, radial
C7—0.001uF, 50V, polyester, radial
C9,C24—470uF, 50V, electrolytic, radial
C10—2200uF, 16V, electrolytic, radial
C11,C18,C22,C23—10uF, 16V, electrolytic, radial
C12–C14,C28—27pF, 100V, COG ceramic
C21—1000uF, 25V, electrolytic, radial

Semiconductors
D1–D7—1N914 signal diode
D8–D13—1N4002 rectifier, 1A, 100V
BR1—50V, 1A, W005 or equiv.
LED1–LED7—Green LED, 3mm
Q1—TIP110 NPN Darlington transistor
Q2—TIP115 PNP Darlington transistor
Q3—PN2222A NPN transistor
IC1–IC6,IC13—Optoisolator, NEC PS2501-1 or equiv.
IC7—74HC259 or 74HCT259 addressable latch
IC8—ULN2003 Darlington array
IC9,IC11—74HC14 or 74HCT14 hex inverter
IC10—PIC16C57-XT/P 8-bit Microcontroller, Microchip Tech.
IC12—LM358N dual low-power op-amp
IC14—M-991 Call progress tone generator, Teltone Corp.
IC15—M-8870 DTMF decoder, Teltone Corp.
IC16—LM317T adjustable regulator
IC17—LM7812 or LM78M12, 12V regulator
IC18—LM7805 or LM78M05, 5V regulator

Other components
F1—0.5A, 5 × 20mm fuse
J1–J6—Modular RJ11, 6/2 or 6/4 receptacle, PCB Mount
J7—1 × 3, 0.1-inch female header
JU1-JU4—4 × 2, 0.1-inch pin header with shorting blocks
JU5—See text
P1—1 × 3 0.1-inch pin header
XTAL1—3.5795 MHz, HC18
RY1–RY6—DPDT, 12V, DC, 16–20mA coil, DIP package (OMRON G6A-234P-ST15-US-DC12 or equiv.)
T1—Transformer, split bobbin, dual 115-VAC to dual 6.3-VAC, 2.5VA (Prem SPW401D, Magnetek/Triad FS12-200, or equiv.)
T2—Telephone coupling transformer, 600:600 (PREM SPT130, Mouser TL016, or equiv.)
T3—Power transformer, 28VAC center tapped, 300mA

Miscellaneous
IC sockets, 4/40 hardware, TO-220 heatsinks (2 each for IC17 & IC18), AC power cord, 2.5-inch H × 8-inch W × 6-inch L plastic enclosure, PC board, IC sockets, solder, wire, etc.

TABLE 9—CALL PROGRESS CODES

Tone	Frequency	D3	D2	D1	D0
Dial	350/440	0	0	0	0
Special	400/off	0	0	0	1
Alert	440/off	0	0	1	0
Ring	440/480	0	0	1	1
Busy	480/620	0	1	1	0

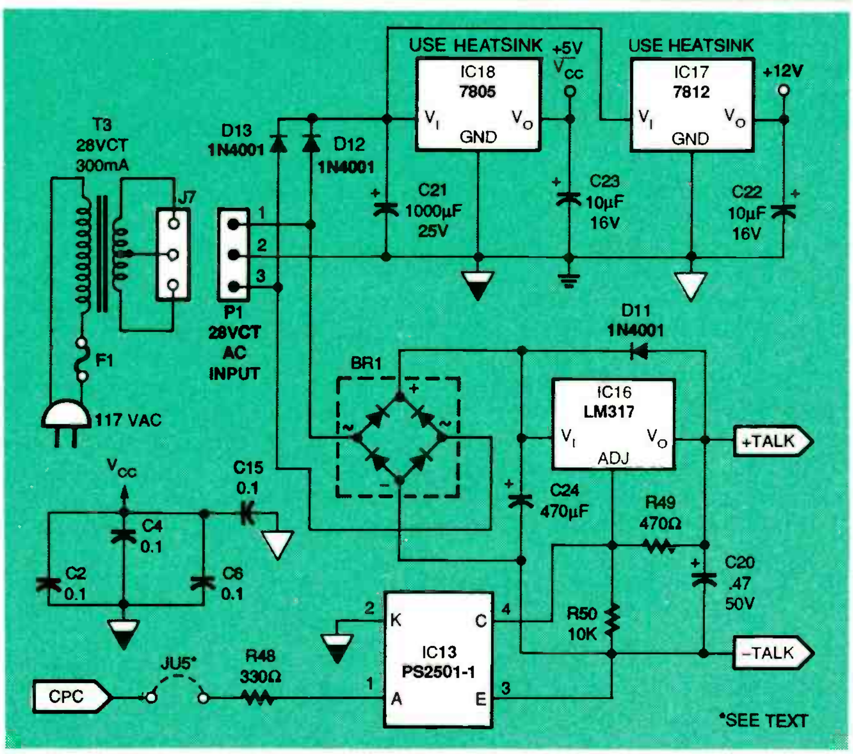


FIG. 8—A CONVENTIONAL POWER SUPPLY provides +5 and +12 volts DC. Note that IC16 can be turned off, thus disabling the talk circuit, if the input labeled CPC goes high. That happens under MCU control.

ORDERING INFORMATION

The following items are available from Digital Products Company, 134 Windstar Circle, Folsom, CA 95630, Voice: (916) 985-7219 Fax: (916) 985-8460. E-mail: DigProd@aol.com
KITS: Parts kit including printed-circuit board, programmed microcontroller, relays, transformers, IC's, resistors, capacitors, documentation, etc., less enclosure: ($199.95). Enclosure kit includes plastic case, drilled front panel, mounting screws, etc. ($32.95). Hard-to-obtain IC's, including M-8870, M-991, ULN2003, 74HC14 (2), 74HC259, PS2501-1 (7): ($31.25). Line transformers (T1, T2) and relays (RY1–RY6): ($48.50), power transformer kit with T3 (120VAC only), fuse, AC cord: ($14.75).
PARTS: Printed Circuit Board #PL6-001: ($34.95). Programmed PIC16C57 ($22.00). Complete documentation with schematic: ($7.25).
U.S. orders add $8 S/H for Kits, or $5 for Parts. Canadian orders add $14 for Kits, $9.50 for Parts. Write or fax for shipping information to other countries.
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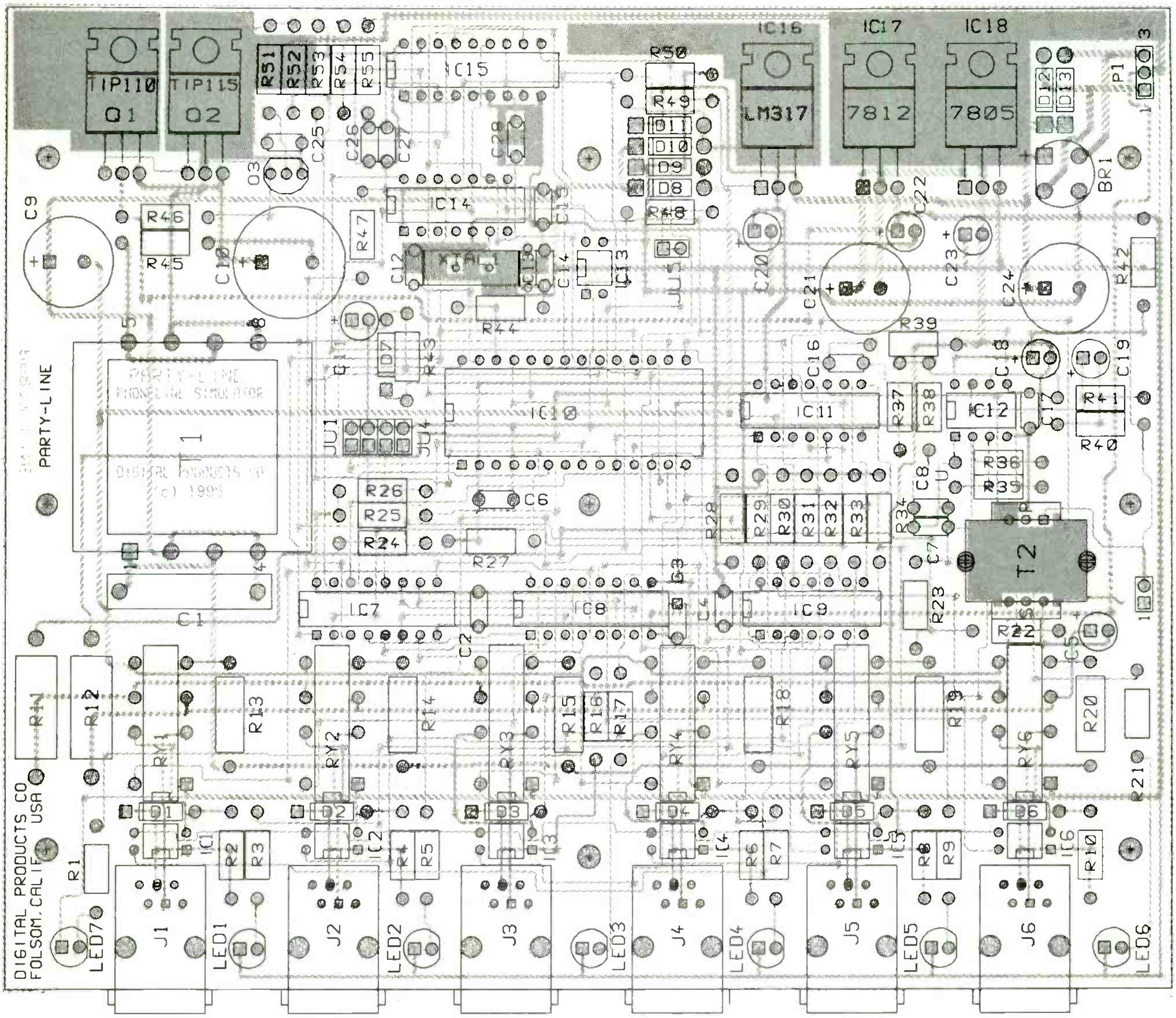


FIG. 9—PARTS PLACEMENT DIAGRAM: Mount all parts as shown here.

Call progress tones

The phone company considers sounds such as dial tone, busy, and ringing to be comfort tones that are present only to confirm the progress of the telephone call. Although foreign countries use similar tones, they often vary slightly from those heard in the U.S. Teltone's M-991 Call Progress Tone Generator (IC14) generates Party Line's call-progress tones. Table 9 lists several of the four-bit codes that the M-991 responds to. Some tones consist of a single, simple tone; others consists of several frequencies mixed together.

The M-991 makes generating the tones easy, but knowing when to generate them requires some intelligence. For example, busy tone signals must be gated on and off on a periodic basis. The MCU disables the IC when necessary by setting the chip-enable line (pin 13) of IC14 high. Because the four-bit codes are latched at the falling edge of $\overline{CE}$, the MCU's RC0–RC3 lines can be freed immediately for use by the DTMF receiver or relay control. Party Line's task-based software handles all those time-sensitive operations.

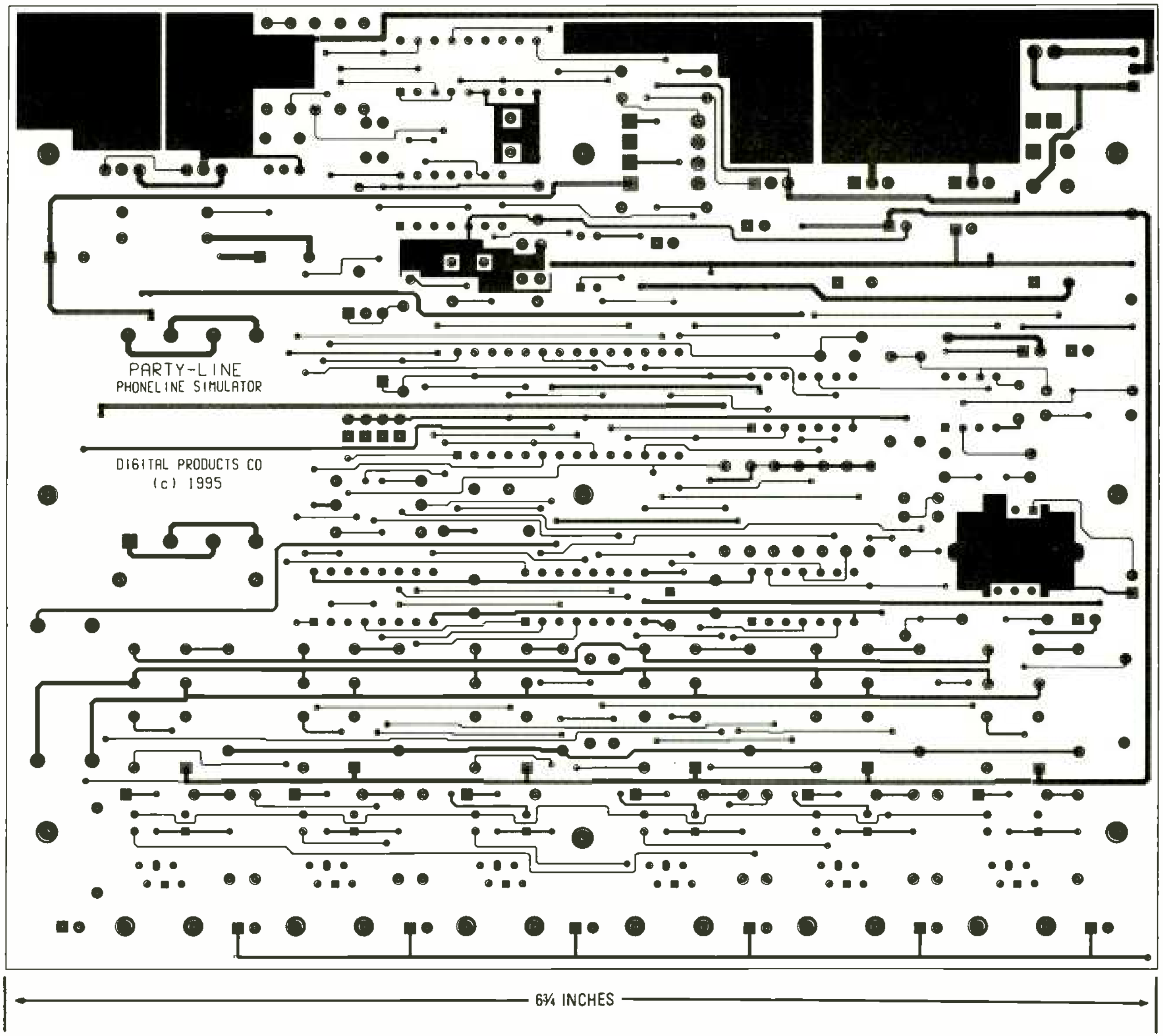
CID filtering

The MCU-generated CID information initially appears in squarewave format, which is unacceptable as a Caller-ID signal. Hence it must be converted to a sine wave; doing so is the job of active filter IC12-a. The op-amp is configured as a simple low-pass filter, with a roll-off frequency slightly higher than the highest frequency we need to send.

Although the filtered tones are not true sine waves—they look more like shark fins—they are quite acceptable to most Caller-ID products, which by design must be tolerant of signal anomalies, since in actual operation all phone lines introduce some noise and distortion.

Power supply

The power-supply schematic appears in Fig. 8. It contains three sections: two fixed-voltage 78xx regulators for powering the digital and analog circuits,



PARTY LINE ARTWORK CIRCUIT-BOARD COMPONENT-SIDE.

and a variable regulator that creates the DC talk-circuit voltage.

The power supply centers around a 28-volt center-tapped transformer driving a full-wave bridge rectifier. Capacitor C21 provides bulk filtering of the raw DC, which is then applied to the 5- and 12-volt regulators, (IC18 and IC17, respectively).

The circuit requires only a few hundred milliamperes of current, so either ½-A or 1-A (78xx) regulators can be used. Because they are series-pass regulators, they run warm. You must use a heatsink on IC17 and IC18.

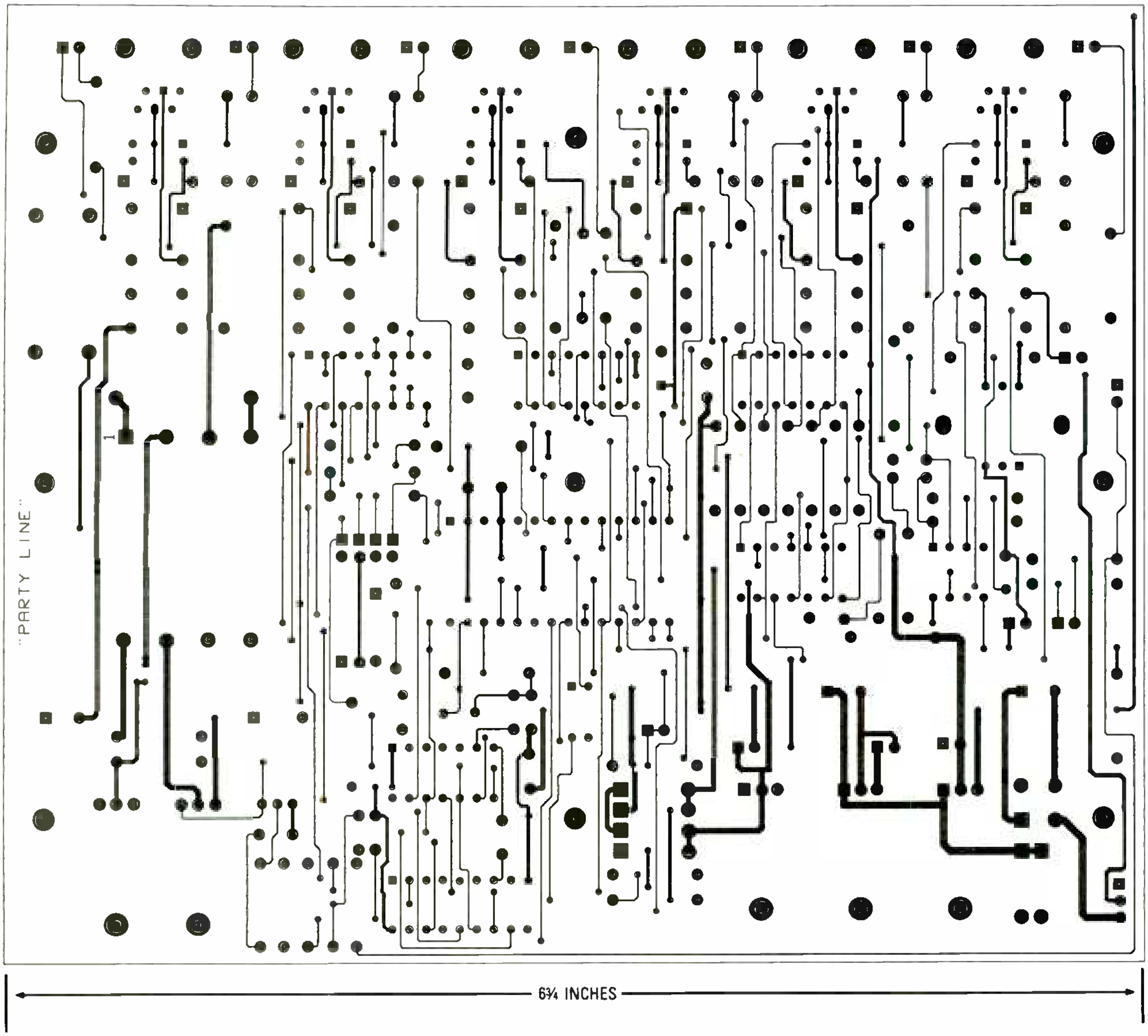
The phone line's DC power (+Talk and −Talk) is provided by an LM317 (IC16). Unlike 78xx regulators, the output of the LM317 varies depending on the values of resistors R49 and R50. The chosen resistor values set the output to about 28 volts DC. The following formula determines the output voltage:

$$V_{OUT} = 1.25 \times (1 + R50/R49) + (0.000055 \times R50)$$

In our case, V_{OUT} works out to about 28.4 volts. Although most phone lines use a 48-volt talk voltage, our 28-volt supply is more than adequate. It should work correctly with all standard telephone equipment.

Notice that the regulator's ADJ terminal connects to optoisolator IC13. The latter may be used to shut off the voltage regulator during a CPC (calling party control) pulse. The purpose of a CPC pulse is to help disconnect some telephone equipment. When a CPC pulse occurs, the phone voltage is interrupted for a few hundred milliseconds after the phone call ends. That interruption causes devices such as answering machines to disconnect immediately.

MCU port RC7 controls the CPC pulse. That port is normally low. To generate CPC, RC7 goes high for 500 milliseconds. That turns on optoisolator IC13, which shuts down voltage regulator IC16, leaving the talk circuit with a 1.2-volt bias condition, and that's low enough to simulate the CPC condition.



SOLDER SIDE PC-BOARD ARTWORK.

The CPC feature can be disabled by removing JU5, but it is unlikely that you would ever need to do so. (Actually, JU5 exists as a trace between two pads on the PC board.)

Construction notes

Due to circuit complexity, circuit sensitivity, and number of components, we recommend use of a PC board. Figure 9 shows the parts layout diagram. Party Line is a fun project to assemble, but it's not for beginners. If you don't have experience with CMOS ICs and circuit-board assembly, please practice on some simpler and easier circuits before attempting the project.

TABLE 10—CONFIGURATION SETTINGS

Jumper	Function	On	Off
JU1	Call block (*67)	Disabled	Enabled
JU2	Distinctive ring	Disabled	Enabled
JU3	CID name delivery	Disabled	Enabled
JU4	Caller ID	Disabled	Enabled
JU5	CPC	Enabled	Disabled

Use a 25–47-watt soldering iron; a temperature-controlled iron (set at 700–800°) works best. Do not use a soldering gun. Use only 60/40 rosin core solder. If you purchase a circuit board from the listed source, don't clean it, as it has a special tin-plate coating that prevents oxidation.

We recommend that you do not substitute parts. Use the components shown in the Parts List, and only substitute those that you know are exact replacements. Capacitor voltage ratings are minimum recommended values; you can safely use units with higher voltage ratings. Use care in handling the ICs. They are CMOS devices that are sensitive to elec-

TABLE 11—SETTING TIME

Step	Description	Legal Values
1.	Enter time set command (#*)	#*
2.	Enter month (MM)	01–12
3.	Enter day (DD)	01–31
4.	Enter hour (hh)	00–23
5.	Enter minutes (mm)	00–59
6.	Enter exit command (*)	*

trostatic discharge, and can be damaged through mishandling.

Transformer T1 is a split-bobbin type with dual primaries and secondaries. This transformer is available from sources such as Microtran, Magnetek, Signal Transformer, and PREM Magnetics. Use of a standard power transformer is not recommended.

Transformer T3 can be either a wall- or chassis-mount type. Note that a 24-volt, center-tapped transformer will not operate Party Line correctly. If you use a chassis-mount device for T3, be sure to install a ½A fuse in the AC primary for protection. Although a power switch is not necessary, you can add an SPST toggle switch in series with T3's primary if desired. Be sure to thoroughly insulate any exposed high voltage wires! Also, do not apply power until all wiring has been inspected carefully.

Install the MCU (IC10) in a socket. Sockets for the other ICs are optional.

Transistors Q1 and Q2, as well as the three voltage regulators (IC16–IC18), should be anchored to the PC board with 4-40 machine screws and nuts. Install heatsinks on regulators IC18 (7812) and IC18 (7805). For best results, use a small amount of thermal grease (heatsink compound) with the regulators. Both IC17 and IC18 run warm.

Relays RY1–RY6 must be sensitive-coil types, and must not draw more than 20 milliamperes at 12-volts DC. Do not use a standard-coil relay.

Install a 4 × 2 pin, 0.1-inch male header block in the JU1–JU4 position. The PC board has a trace for JU5, the CPC control line. You can install a jumper block there if desired as well.

After assembly, be sure to trim any long component leads, and clean the solder flux off the board.

Mount the circuit board on short standoffs in an enclosure of your choice. If you are using a chassis-mounted transformer for T3, be sure to insulate it from the conductive surfaces of your cabinet! To avoid hum on the talk line, position T3 a minimum of two inches from T1 and T2.

Last steps

Table 10 outlines the settings for the four configuration jumpers (five counting JU5). To disable a function, simply remove the jumper. The only other step is to set time and date; Table 11 details the procedure. In brief, use a telephone at any station to enter the following: # * MM DD hh mm *. If you have successfully entered the time, you will receive a standard dial tone after pressing the final key. Incorrect time settings will result in a busy signal.

To test your Party Line, make a final check of the circuit board. Ensure that all parts are mounted with the correct orientation, and look for shorts, opens, and solder bridges on the PC board. Also, check the primary wiring to the power transformer.

You'll need two telephones to test the Party Line. Plug one phone into Station 1, and take the receiver off the hook. You should hear a dial tone, and the corresponding LED should light. Repeat the test for the remaining stations. Then plug in the other phone, and use one phone to call the other. Check that each station can dial out, and that each station can receive calls. Last, test the Distinctive Ring and Caller ID functions. Ω

VIDEO NEWS

continued from page 6

video-game hardware—are also working hard to produce games for personal computers.

Surf the Internet by TV

Long before HDTV—even this year—TV sets will take on more and more of the attributes of computers, just as many manufacturers are offering computers with TV boards. Sega and Philips have both developed add-ons to their video-game players that will provide Internet access for game-playing.

Thomson Consumer Electronics, the manufacturer of RCA TV sets, recently showed a prototype of a TV set that could be offered in the next two years. Using a standard 35-inch TV tube, the set has a built-in six-disc CD-ROM changer, a wireless QWERTY-type keyboard, 16 megabytes of memory, and a modem for Internet access. It's definitely not a computer—who needs a spreadsheet on the 35-inch TV in the living room? However, the manufacturer notes that CD-ROMs and Internet sites are increasingly offering entertainment that might be more appropriate for a family gathered around the TV than for an individual peering into a 14-inch computer screen. The company says that its TV sets are designed to offer all kinds of electronic entertainment, including those considered to be the province of computers. The company's picture-tube division is expected to start making tubes with finer pitch specifically for TV access to such computer functions. The higher-resolution tubes eventually will be necessary for HDTV images, as well.

An added note: In Japan, JVC is now offering a 16:9 widescreen-ratio TV set that can display TV and computer images simultaneously, presumably side-by-side. The 30-inch set uses signal-processing ICs to display interlaced and non-interlaced images at the same time. JVC predicts that in two years half of the widescreen TVs it sells will be directly computer compatible. EN

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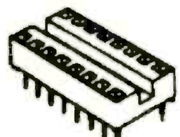

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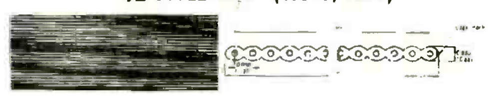

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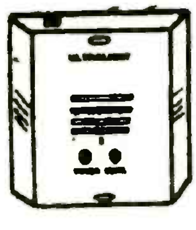

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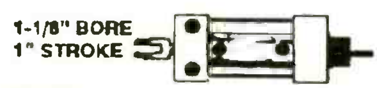

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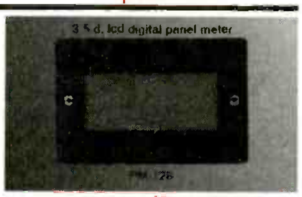

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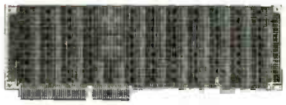

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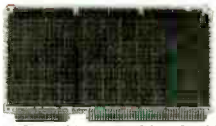
PC218903 (XT-BUS)



- Board Length: 13-1/8" (333mm)
- Board Width: 4-5/16" (110mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 D-Type Connector, 25-Pin

Vector Cross Ref. #4613-3

CAT NO	1	5
PC218903	$23.51	$18.63

(PRICE EACH)

PC232904 (Multi-BUS)

- Board Length: 12" (305mm)
- Board Width: 6-3/4" (171mm)
- Double Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 Header, 100x2, 0.1" Spacing

Vector Cross Ref. #4608

CAT NO	1	5
PC232904	$38.40	$29.80

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PC207905 (STD-BUS)

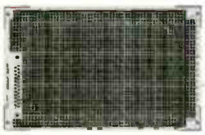
- Board Length: 6-1/2" (165mm)
- Board Width: 4-7/16" (113mm)
- Double Sided, 3-hole Solder Pads, Ground Plane and Power Bus
- Space Reserved for 1 Header, 34x3, 0.1" Spacing

Vector Cross Ref. #4610

CAT NO	1	5
PC207905	$13.66	$11.25

(PRICE EACH)

PC412902 (VME-BUS)



- Board Length: 6-5/16" (160mm)
- Board Width: 3-15/16" (100mm)
- Single Sided, Pad-Per-Hole and Power Buses
- Space Reserved for 1 D-Type Connector, 25-Pin

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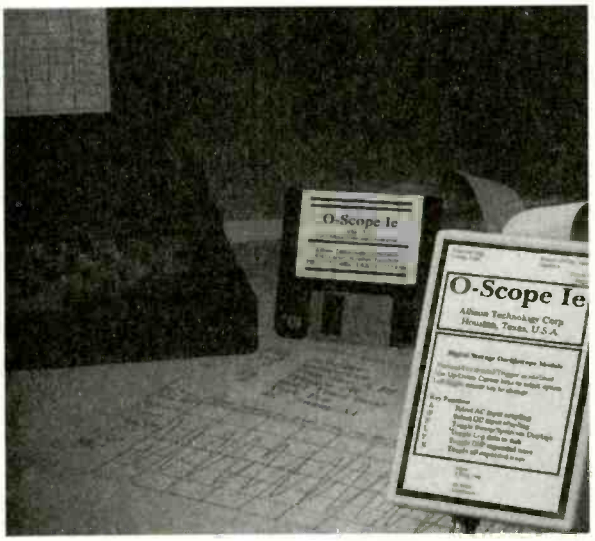

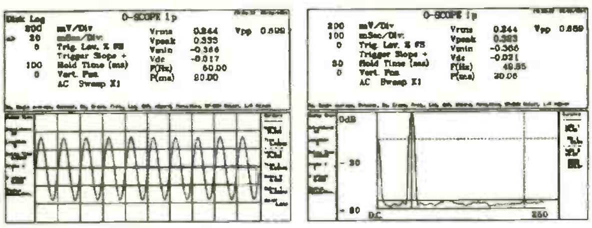

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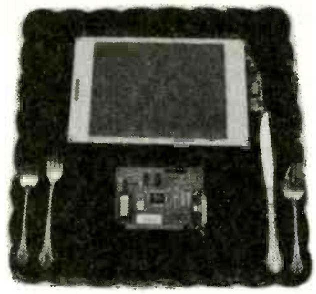

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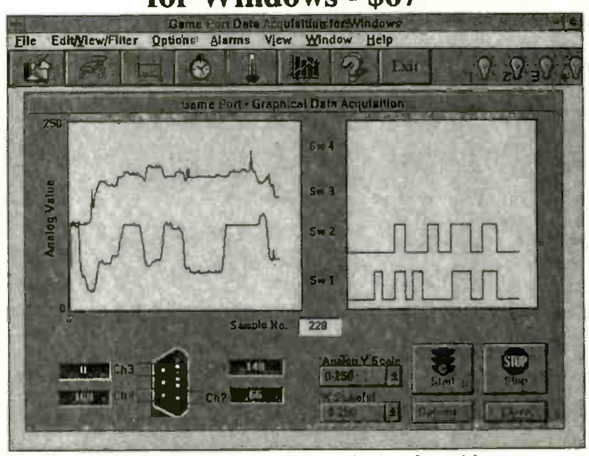

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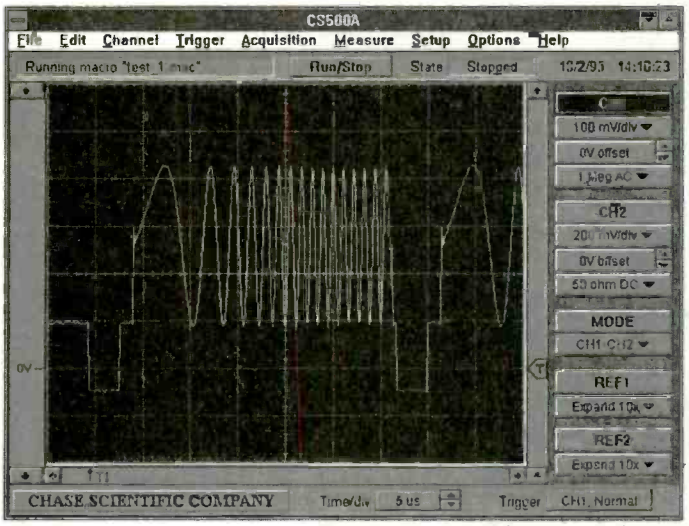

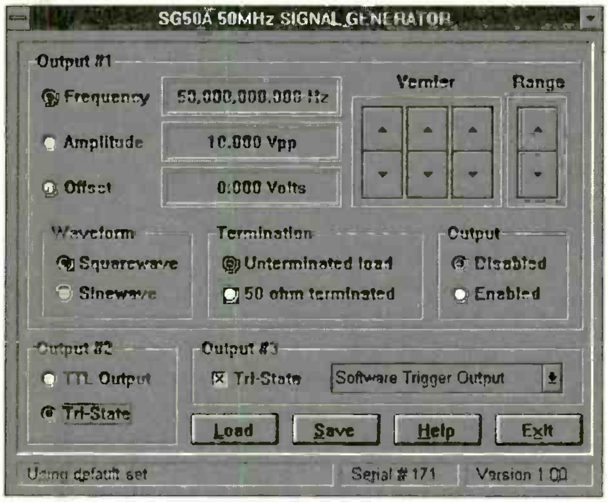

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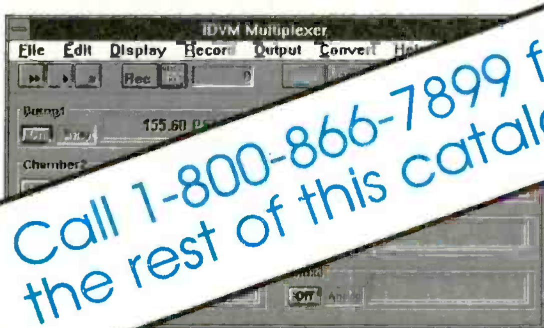

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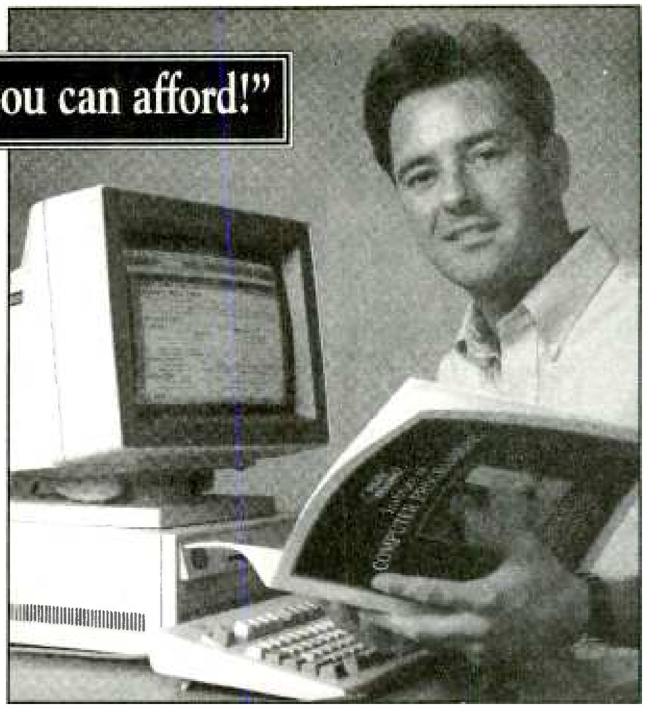

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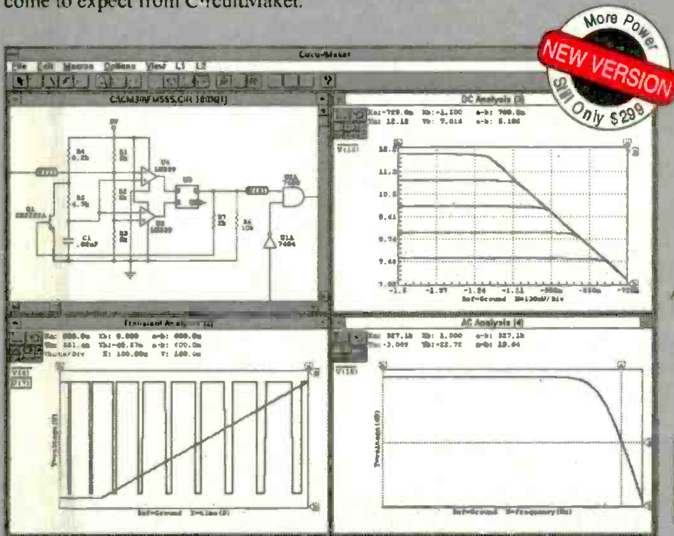

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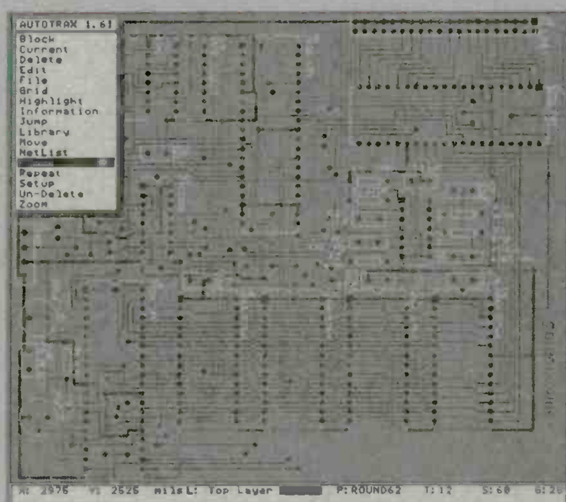

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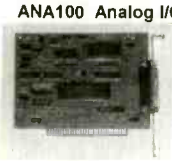

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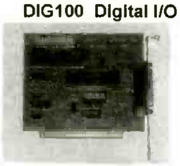

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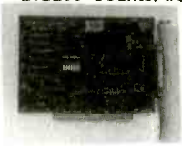

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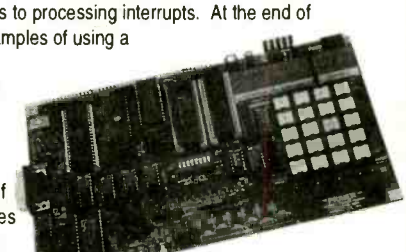

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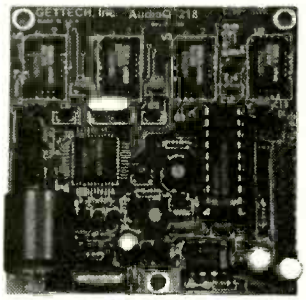

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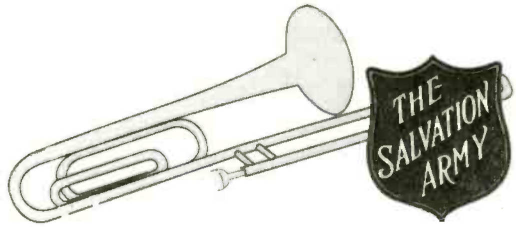

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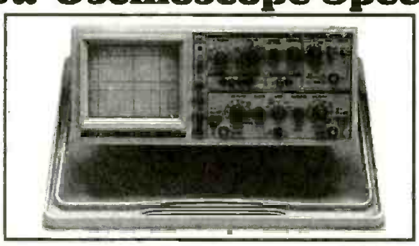

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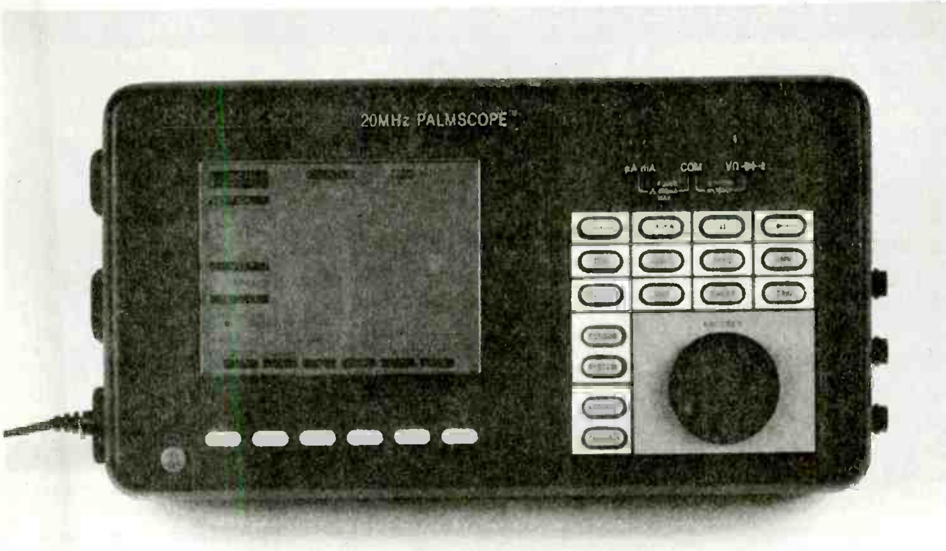
PALMSCOPE™ 320

ALL IN ONE DSO+DMM+LOGIC+COUNTER



Palmscope-320 features a 20Mhz DSO, 7 digit frequency counter, multimeter and logic scope. It can be operated with built-in battery for 3-4 hours typically. Built in RS-232 port and printer port extend your application. Optional software package is available.

PalmScope 320
$1695

DSO • *Dual channel digital storage oscilloscope (20 MS/sec)* • *Sensitivity range: 5mV / DIV - 20V / DIV* • *Sweep time: 50ns / DVI - 20s / DIV*

DMM • *Auto-range digital multimeter (4000 counts)* • *True RMS* • *DCV, ACV, DCA, ACA, Ohm Diode & continuity measurements*

LOGIC • *Logic Scope (8 channels, 50ns sample clock)* • *Selectable level: TTL/CMOS* • *Timing/State observation of logic signals*

COUNTER • *7 digit frequency counter (1 Hz to 20 MHz)* • *Selectable trigger level and FREQ/PER mode* • *Basic Accuracy ±10ppM*

General:
- Dual Channel Digital Storage Oscilloscope (20MS/s)
- Auto Range Digital Multimeter (3 3/4 digits, 4000 count)
- Frequency Counter (7 digits, 20 MHz)
- Logic Scope (8 channels, 50ns sample clock)

Display
- Number of Dots: 320(W)x240(H)
- Dot Pitch: 0.30 x 0.30 m/m
- Backlight: LED
- Data Out (RS-232C)
- Print Out: Portable Centronix and Epson Printer
- DC jack for AC adapter input
- LOW BATT Indicator

- Operating Temperature: 0°C to 40°C
- Operating Humidity: 0% to 70% R.H.
- Storage Temperature: -20°C to 70°C (0% to 80% R.H.)
- Dimension (LxWxH): 287x152x82 mm
- Weight: 2.0Kg
- Safety Compliance: it is designed to meet Class II per UL-1244, IEC 348 and VDE-0411

Introducing the Model #EDM-89S 5000 Count AUTO Range Digital Multimeter

Twelve Good Reasons To Buy The EDM-89S:
- 3-3/4 Digit, 5000 Count Digital Readout 50 Segment Analog Bargraph
- Auto/Manual, Dynamic Recording
- 0.1% DCV Accuracy, 20 kHz ACV Bandwidth, True-RMS AC Coupled
- 9999 Counts, 10 MHz Frequency Counter, Turbo Speed, and 50mF Capacitance Measurement
- dBm with Selectable Reference Impedance
- Dual Tone/Dual Display Logic Detection
- Relative Mode or Deviation Measurements
- Input Warning, Audible and Visible
- @ OFF Auto Power Off, Sleep Mode
- Overload Protection
- Audible Continuity/Diode Test
- Rugged Fire Retardant Case, Multipurpose Holster

MODEL #EDM-89S
$179.00

PRINT Products International

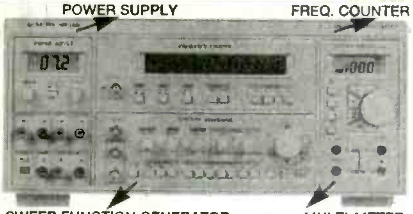
*8931 Brookville Road * Silver Spring, Maryland 20910 * 800-638-2020 * Fax 800-545-0058*

CIRCLE 264 ON FREE INFORMATION CARD

CIRCLE 336 ON FREE INFORMATION CARD

Unbeatable Discount Prices

1 YEAR WARRANTY
15 DAY MONEY BACK GUARANTEE



MT-100

Reg. $599.
$419.00

Four Instruments in One Instrument

1 **Function Generator**
- Sine, Square, Triangle, Pulse, Skewed Sine, Ramp, TTL
- 0.2 Hz ~ 2MHz

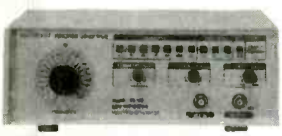
2 **Frequency Counter**
- 8 Digit LED
- 1 Hz ~ 100MHz
- ± (1 Hz + 1 dgt. + Time Base Error)

3 **Power Supply**
- 3-1/2 Digit LCD
- Triple output: #1. 0~50V, 0.5A MAX #2, 15V, 1A #3. 5V, 2A

4 **Digital Multimeter**
- 3-1/2 Digit LCD
- DCV, ACV, Ω, DCA, ACA
- ± (0.5% + 2 dgts)

FG-140 2MHz Function Generator

Reg. $249. **$149.00**



- 0.2 Hz ~ 2.0 MHz, 7 Decades
- Sine, Square, Triangle, Pulse, Ramp, Skewed Sine
- VCF, Symmetry
- Variable DC Offset Control

2MHz Sweep Function Gen. w/Freq. Counter

FG-150
Reg. $399. **$229.00**

- 4 Digit LED Display
- Sine, Square, Triangle, TTL, Pulse, Ramp, Skewed Sine
- Linear/Logarithmic Sweep
- 10 MHz Freq. Counter

1.0GHz Frequency Counter, High Resolution

FC-200
Reg. $399. **$219.00**

- 1.0 Hz ~ 1.0 GHz
- 8 Digit LED Display
- Auto & Manual Range
- 4 Selectable Gate Times
- 1MΩ & 50Ω Input Impedance

Oscilloscope Probe Set

Switch Selectable X1/X10

HP-9060, 60MHz *Reg. $29.* **$17.00**
HP-9150, 150MHz *Reg. $49.* **$27.00**
HP-9250, 250MHz *Reg. $59.* **$37.00**

PS-500 DC Power Supply

Reg. $249. **$159.00**
- 0 - 30 VDC
- 0.1 ~ 3A
- Short & Overload Protection

PS-540 DC Power Supply

Reg. $399. **$249.00**
- 0 - 16 VDC
- 0.1 ~ 10A
- Short & Overload Protection

Deluxe O'scopes w/Phillips CRT. "BEST BUY!"

OS-3304 *Reg. $499.* **$349.00**

OS-3324 *Reg. $599.* **$429.00**

OS-3344 *Reg. $899.* **$649.00**

OS-3304 25MHz, Dual Trace

1
- DC to 25 MHz. Dual Channel
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 2mV/div X-Y modes, Z Axis (intensity modulation)
- Rise time 14n Sec. or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 2kV
- 60MHz (X1.X10) Probe Kit: 2 sets
- Power: 115/230V AC

OS-3324, 3 Function

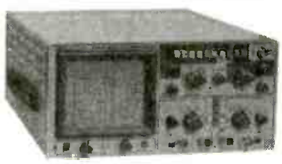
1 • OS-3304
2 • Dual Component Tester/Comparator
3 • Triple DC Power Supply 5VDC, +12 VDC, -12VDC

OS-3344, 5 Function

1 + 2 + 3 • OS-3324
4 • Frequency Counter 100MHz, 7 Digit LED Display
5 • Function Generator 0.02 Hz to 2.0 MHz

OS-3315 40MHz, Dual Trace Sweep Delayed

Reg. $799. **$549.00**



- DC to 40 MHz. Dual Channel
- Delayed Sweep 100nS to 1.0S 7 decade
- 6" Rectangular CRT with Internal Graticule 10x8cm (Phillips P31)
- Uncalibration LED.
- High Sensitivity 1 mV/div to 2mV/div X-Y modes, Z Axis (intensity modulation)
- Rise time 8.5nS or less.
- Full TV Trigger for TV-V & TV-H
- Acceleration Potential 12kV
- Variable Hold Off
- 16ns ~ 1.0s Time Base
- 60MHz (X1.X10) Probe Kit: 2 sets
- Power: 115/230V AC

Bel MERIT

DM5050C
DM5100

Reg. $149.
$89.00

Including Deluxe Holster

Features (DM5050C/DM5100)
- Basic DCV Accuracy: ± 0.25%
- AC/DC Volt & Amp, Ohm
- Diode, Continuity Beeper
- Alligator Clip Test-Leads
- Lead Holders/Velcro Strap Holster

DM5050C, DMM + Capacitance
- 9 Function / 42 Range
- Multimeter
  Ohm: Up to 2000MΩ
  Amp: AC/DC 2 Amp
- Extended Capacitance Meter (9 Range)
  0.1pF - 20,000µF
  Zero Adjust Knob
- Trig Lamp

DM5100, Wide Range w/Logic
- 11 Function / 45 Range
- Auto Power Off
- Data Hold & Peak Hold
- Freq: Up to 20MHz
- Amp: Up to 20A AC/DC
- Ohm: Up to 200MΩ
- Capacitance: 1p - 200µF
- Logic: TTL, TR hFE

Digital Engine Analyzer

Reg. $119. **$69.00**

DM230
- 3 1/2 Digit LCD
- Engine Analyzer Taco, Dwell, Duty Cycle
- DMM DCV, DCA, Ω
- Temperature 0 ~ 1.999°F
- Diode
- Continuity
- Holster, Temp. Probe, Clip Leads

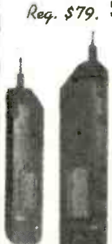
Capacitance Meter

Reg. $79. **$49.00**

CM210
- 3 1/2 Digit LCD
- 0.1p-20,000µF 9 Ranges
- 0.5% basic Accu.
- Zero Adjust Knob
- Test Leads & Built In Socket

Pen-Type DMM w/Logic

Reg. $79. **$59.00**



DM150
- 3 1/2 Digit
- Dual Display
- Auto & Manual
- DCV, ACV, ACA, DCA, Ω
- Logic CMOS/TTL
- Data Hold
- Diode
- Continuity

Multifunction DMM

Reg. $99. **$64.00**

DM4050
- 3 1/2 Digit
- Basic Accuracy: 0.25%
- Heavy Duty, 20A AC/DC Resistance 20MΩ
- Capacitance
- Freq. up to 20MHz
- TR-hFE
- Diode
- Continuity
- Deluxe Holster

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CIRCLE 333 ON FREE INFORMATION CARD

NOVEMBER 1995

NEW SENSOR CORPORATION

20 COOPER SQUARE • NEW YORK, NY 10003
(212) 529-0466 • (800) 633-5477 • FAX (212) 529-0486

USA MILITARY JAN TUBES

NEW, ORIGINALLY BOXED, AVAILABLE IMMEDIATELY

TUBE NUMBER	1 PC.	10 PCS.	25 PCS.	50 PCS.	100 PCS.	500 PCS.	1000 PCS.
0A3 JAN	1.15	.90	.75	.65	.55	.45	.40
0C3W JAN RAYTHEON	3.65	2.90	2.30	1.90	1.60	1.30	1.20
5Y3WGTA JAN PHILIPS	4.90	3.90	3.40	2.90	2.60		
6AN8a JAN PHILIPS	5.90	4.70	4.20	3.80	3.15	2.60	2.30
6AS7GA JAN GE	6.15	4.90	3.50	2.90	2.55	2.20	1.90
6BJ7 JAN GE	2.00	1.60	1.40	1.20	1.00	.90	.80
6BL8 JAN SYLVANIA	1.65	1.30	1.10	.80	.65	.50	.45
6BQ7a JAN GE	2.00	1.60	1.35	1.15	.95	.80	.70
6C4WA JAN PHILIPS	4.70	3.75	2.90	2.30	1.80	1.65	1.55
6DJ8 JAN PHILIPS	3.65	2.90	2.30	1.60	1.40	1.15	.95
6EA8 JAN PHILIPS	2.00	1.60	1.35	1.15	.95	.80	.70
6J5WGT JAN PHILIPS	4.40	3.50	2.60	2.10	1.80	1.65	1.55
6L6GC JAN PHILIPS	21.50	16.90	16.20	15.40	14.90	14.40	13.90
6L6WGB JAN PHILIPS	19.90	15.90	14.90	13.90	12.90	12.20	11.80
6SJ7 JAN GE METAL	1.15	.90	.80	.70	.60	.55	.50
6SL7WGT JAN PHILIPS	7.40	5.90	4.90	4.40	3.90	3.60	3.30
6SN7WGTA JAN PHILIPS	7.40	5.90	4.90	4.40	3.90	3.60	3.30
6SQ7 JAN GE	3.15	2.50	2.00	1.50	1.20	1.15	1.10
6U8a JAN PHILIPS	2.00	1.60	1.35	1.15	.95	.80	.70
6V6GT JAN GE (GLASS)	12.40	9.90	9.50	8.80	8.40	7.60	6.90
6X5WGT JAN PHILIPS	1.90	1.50	1.35	1.20	1.05	1.00	.95
12AT7WC JAN GE	6.15	4.90	4.40	3.90	3.25	2.90	2.70
12AU6 JAN PHILIPS	1.90	1.50	1.25	1.00	.90	.80	.70
12AX7WA JAN GE	9.65	7.70	6.50	5.90	5.40	4.90	4.50
12AX7WA JAN PHILIPS	9.65	7.70	6.50	5.90	5.40	4.90	4.50
12SG7 JAN RCA	1.00	.80	.70	.60	.50	.40	.35
12SH7 JAN GE	1.00	.80	.70	.60	.50	.40	.35
12SL7JAN GE	1.25	1.00	.90	.80	.70	.60	.55
83 JAN GTE	875	7.00	6.40	5.80	5.50	4.90	4.65
829B JAN CETRON	8.55	6.85	6.25	5.65	5.35	4.75	4.50
5656 JAN RAYTHEON	7.50	6.00	5.00	4.20	3.30	2.50	2.20
5750 JAN GE	1.00	.80	.70	.60	.50	.40	.35
5751 JAN GE	6.15	4.90	4.30	3.90	3.20	2.70	2.30
5814a JAN PHILIPS	3.75	3.00	2.75	2.50	2.20	2.00	1.90
6072a JanGE - MIL 12AY7	9.65	7.70	6.50	5.90	5.40	4.90	4.50
6080WC JAN GE	6.15	4.90	4.40	3.90	3.40	2.90	2.60
6188 JAN PHIL - MIL 6SL7	11.15	8.90	7.90	6.40	5.90	5.60	5.30
6189W JAN PHILIPS	3.75	3.00	2.75	2.50	2.20	2.00	1.90
6922 JAN PHILIPS	4.25	3.40	2.80	2.10	1.90	1.65	1.45
7581a JAN PHILIPS	19.50	18.00	17.25	16.50	15.75		

MASTER CARD/ VISA ACCEPTED • MINIMUM ORDER $100.00 • ALL ORDERS SHIPPED F.O.B. N.Y.C.

CIRCLE 258 ON FREE INFORMATION CARD

DO-IT-YOURSELF AUDIO AMPLIFIER KITS

Mark V Electronics, Inc.
8019 E. Slauson Ave.,
Montebello, CA 90640
In business since 1985

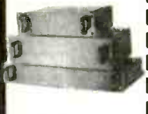
Enclosures at Unbeatable prices !

Free Catalog 213/888-8988 Fax 213/888-6868
Order 1-800-521-MARK / 1-800-423-FIVE

Kit skill levels are specified as ▲ beginner ▲▲ intermediate or ▲▲▲ advanced!

Metal Cabinets with Aluminum Front Panel

Best Buy



LG-1273	3x12x7"	$ 26.50
LG-1684	4x16x8"	32.50
LG-1924	4x19x11½"	38.25
LG-1925	5x19x11½"	42.00
LG-1983	2¼x19x8"	35.25
LG-1923	3x19x11½"	36.50
LG-1927	7x19x11½"	50.50

LG- Black anodized rack cabinet

New

*LL-1923B	2¾x19x12"	69.50
*LL-1925A	5x19x12"	79.50

*LL- High quality full Aluminum Cabinet
*LL- Front panel .157" & other panels .078"

- Dimensions in inches ±.05
- Custom-made for other dimensions if over 100 pcs for single model !

Modular Desktop Consoles

	L x W x H	
LE-453	4x4¾x3"	$ 7.50
LE-653	6x4¾x3"	9.75
LE-853	8x4¾x3"	11.75

LE- Black finished aluminum panel 1mm thick.

Alarm Box with Lock

Mejor Compra !

LB-1085	8¼x10¼x5"	$18.75
LB-1395	9¼x13¼x5"	25.50
LB-1525	12¼x15¼x5"	35.25
*LB-1494	9¼x14¼x4¼"	21.50
LB-1383A	8½x13¼x4"	23.25

*No lock & LB- Sheet Metal 0.8mm

Camera Housing

*LD-1244	2¾x10¾x4"	$55.00
**LD-1516	3¾x13¾x4"	29.50
**LD-1565	4x13¾x5¼"	31.75

*LD- Stainless Steel 0.7mm
**LD- Sheet Metal 1mm

Power Transformers &**Toroidal Transformer

001	28/30V x 2	6A	$ 30.00
002	36V x 2	3A	25.00
003	40V x 2	6A	32.00
**008	28/30V x 2	6A	40.00
**009	48/53V x 2	8A	66.00
**012	33/40/42Vx2	6A	48.00

TA-800MK2 ▲▲ 120+120W Pre & Main Stereo Amp. (4 lbs.)

Kit:$ 67.92
Asmb.$ 86.95

Power Output:120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response:10-20KHZ. THD: <0.01%. Tone Control: Bass ±12dB, Mid & Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40VDC @ 6A. Suggested Mark V model 001 or 008 transformer. Recommended Metal Cabinet LG-1924.

TY-13 ▲ 20 Color LED Level Meter

Clearance Sale

Kit:$ ~~20.15~~ $ 9.90

Use this dual LED display indicating meter with your stereo power amplifier to indicate instantaneous speaker power. Operating range is -30dB to +5dB and can be calibrated to operate with 1 to 200 watt amplifiers. Not consume any amplifier power. A peak LED illuminates on overload!

TA-1000A ▲▲ 100W Dynamic Class A Mono Amp (4 lbs.)

Kit:$ 54.00 Asmb.$ 74.00

Power Output: 100W into 8 ohms RMS, 125W into 4 ohms RMS. Frequency Response: 10HZ-100KHZ. THD: <0.008%. Signal to Noise Ratio:80dB. Sensitivity: 1V. Power Requirements: 35 to 45VDC @ 3A. Suggested Mark V model 001 or 008 transformer. Capacitor 10,000uf 80V model 016. Recommended Metal Cabinet LG-1924.

TR-503▲ Regulated DC Power Supply

Kit:$ 18.75 Asmb.$ 27.65

It is short circuit proof and has overload protection. Output voltage is variable over a range of 0-50V. Current limit trip is adjustable up to max of 3A. Suggested Mark V 002 transformer. (1 lb.)

TA-388 ▲▲▲ Class A FET Dynamic Buffer Stereo Pre-Amp (1 lb.)

New

Kit:$64.00 Asmb.$ 80.00

Frequency Response (at rated output): Overall 10HZ-100KHZ +0.5dB-1dB. THD: Overall <0.007% at or below rated output level. Channel Separation (at rated output 1KHZ): Overall better than 70dB. Hum & Noise: Overall better than 90dB. Input Sensitivity (1KHZ for rated output): 300-600mV. Maximum Output Level: Pre-Amp output 1.8V (0.1% THD). Power Requirement: 30V X 2 AC 500mA.

SM-302▲▲ 60+60W Stereo Power Amp

Kit:$ 75.00
Asmb.$ 94.00

It provides 3 input jack pairs. One pair accept a high impedance microphone. The two remaining pairs are for high & low level input sources. Power Output: 60W per channel into 4 ohms RMS. 20HZ-20KHZ. THD:<0.1%. Input Sensitivity: Mic/Guitar 10mV,Hi 380mV,Lo 640mV. Ready to plug in when assembled. (11 lbs.)

SM-100 ▲▲▲ 150 MHZ 8 Digit Frequency Counter (2 lbs.)

New Release

Kit:$ 79.00
Asmb.$ 99.00

Frequency Range: 10HZ-150MHZ. Gate Time: 0.01s, 0.1s, 1s, 10s. Input Sensitivity: KHZ range 10HZ-10MHZ 20mV(min.). MHZ range 1MHZ-120MHZ 20mV(min.), 120MHZ-150MHZ 35mV (min.), 150MHZ-200MHZ 40mV(typical). Time Base: 10MHZ crystal, ±10 ppm. Input Impedance: 1M ohm. Response Time: 0.2s. Resolution: 0.1 HZ: 10s gate time, 1HZ: 1s gate time, 10HZ: 0.1s gate time, 100 HZ: 0.01s gate time. Hold the last input signal. Reset counter to 0. DC 9V power adapter or 1.5VX4"D"size batteries.(Adapter not included)

School Project Kits Source ....

SM-36	Dynamic Noise Reduction ▲	$ 26.00
TA-006	6W Mini-Amplifier ▲	9.50
TA-28	Digital Voice Memo ▲▲	25.00
TA-120	36W Class A Power Amp. ▲▲	32.50
TA-201	Mircophone Mixer Mono Amp.▲	20.79
TY-45	20 Bar/Dot Level Display ▲▲	41.45
TY-2	Flourescent Light Driver ▲	14.75

See our catalog for more kits!

Minimum order $ 20. We accept Visa, MasterCard & Money Orders. Checks allow 2 weeks for clearance. We ship by UPS ground inside US (min $ 4.00) and ship by US mail outside US. Please call for orders shipping & handling or fax foreign orders. PO Orders are welcome from schools. We are not responsible for typographical errors.

CIRCLE 329 ON FREE INFORMATION CARD

Use ELECTRONICS NOW Classifieds

READ BY ELECTRONIC BUYERS AND SELLERS AND TRADERS

INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

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 each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). 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 ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name 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 $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

If you use a Box number you must include your permanent address and phone number for our files. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues.**Boldface (not available as all caps)**, add .40 per word additional. **Entire ad in boldface**, add 20%. **Tint screen behind entire ad**, add 25%. **Tint screen plus all boldface ad**, add 45%. **Expanded type ad**, add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. 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.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word, Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 -- Antique Electronics	270 -- Computer Equipment Wanted	450 -- Ham Gear Wanted	630 -- Repairs-Services
130 -- Audio-Video Lasers	300 -- Computer Hardware	480 -- Miscellaneous Electronics For Sale	660 -- Satellite Equipment
160 -- Business Opportunities	330 -- Computer Software	510 -- Miscellaneous Electronics Wanted	690 -- Security
190 -- Cable TV	360 -- Education	540 -- Music & Accessories	710 -- Telephone
210 -- CB-Scanners	390 -- FAX	570 -- Plans-Kits-Schematics	720 -- Test Equipment
240 -- Components	420 -- Ham Gear For Sale	600 -- Publications	730 -- Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #________ **Special Category $30.00 Additional** ________________

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50	29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50	33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50	37 - $92.50	38 - $95.00	39 - $97.50	40- $100.00
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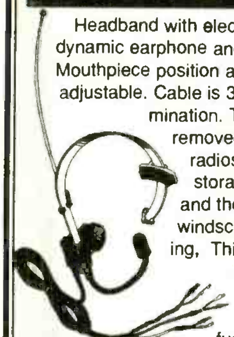

Headband with electret microphone, dynamic earphone and antenna. Mouthpiece position and headband are adjustable. Cable is 3' long with 6 wire termination. These are new units removed from walkie-talkie radios. They have been in storage for a long time, and the foam microphone windscreens are deteriorating. This may detract from the appearance of the units, but they are unused and functional

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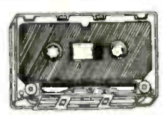

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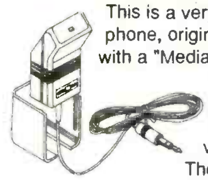

This is a very cool looking microphone, originally designed for use with a "Media-Vision" multi-media package. It has an electret element, so it requires a little voltage to operate. The overall size of the mike is 1.5" high and 0.64" thick including the pocket clip on the back. Also included is a little plastic holder with an adhesive backing which allows the mike to be stored or used while attached to a computer or automobile dashboard. 7' cable with stereo 3.5mm plug. Beige mike, holder and cord.

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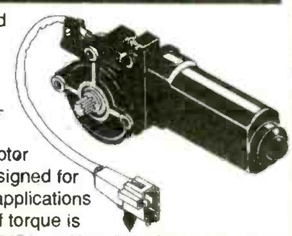

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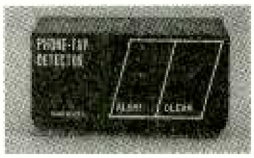

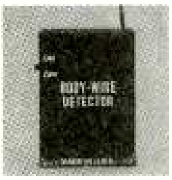

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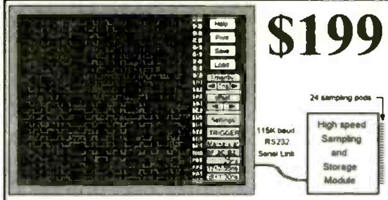

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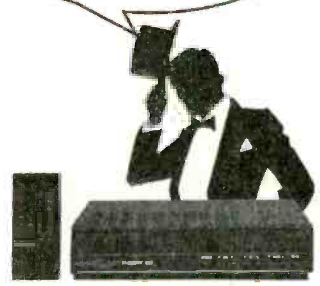

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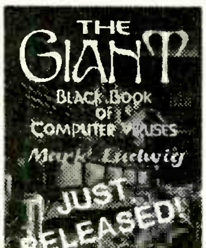

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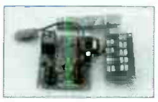
- Circuit designed around a single TDA7052 IC
- Ideal part for larger projects
- Drives 8 Ohm speaker (not supplied)
- Ideal for battery powered circuits, operates on 3-15 VDC solder pads for all connections • Batteries not included
- Size: 1.3"L x 1.1"W x 0.9"H
- Weight: 0.1 lbs.

Part No.	Description	1-4	5-9
125111	1 watt amp module	$7.95	$6.95

Combination Lock Kit



- Easy introduction to electronic locks
- 2 boards: one with 1-9 touch pads and connected to 2nd board by 3 ft. cable; 2nd board has decoding IC's, matrix to set 4 number code, and relay to control external loads
- Auto reset if wrong number entered
- Requires 9V battery (not included)
- Size: 3.0"L x 2.5"W x 1.0"H
- Weight: 0.2 lbs. for both boards

Part No.	Description	1-4	5-9
125129	Combination lock	$17.95	$15.95

Switching Power Supply Kit

- Basic step-up switching supply circuit designed around single IC
- Selectable 1.5 or 3 VDC input
- Provides a fixed output of 9V @ 18mA from a 1.5V "AA" cell
- Solder pads for input and output
- 1 cell and 2 cell "AA" holders supplied
- Batteries not included
- Size: 1.6"L x 0.8"W x 0.5"H • Weight: 0.1 lbs.

Part No.	Description	1-4	5-9
125153	1.5/3V to 9V conver.	$8.95	$7.95

Ultrasonic Motion Detector Kit

- 2 boards: one with matched pair of Ultrasonic transducers to detect motion from 4-7m away; 2nd board contains crystal controlled oscillator and all circuits
- Switchable latch, red LED indicator
- Solder pad output to drive external relay or circuits
- Requires 9V battery (not included)
- Size: Main board: 2.8"L x 2.0"W x 0.8"H Transducer board: 2.8"L x 0.6"W x 0.9"H
- Weight: 0.1 lbs. for both boards

Part No.	Description	1-4	5-9
125090	Ultrasonic alarm kit	$29.95	$26.95

Siren Kit

- Circuit designed around a dual Op-Amp connected as an oscillator and driver
- Oscillator is off until you press the switch then a rising tone is produced until a steady value is reached
- If switch is released the tone starts dropping until it cuts off
- Requires 9V battery (not included)
- Speaker and switch supplied
- Size: 2.0"L x 0.8"W x 0.5"H
- Weight: 0.2 lbs.

Part No.	Description	1-4	5-9
125137	9V siren module	$6.95	$5.95

PRECISION NAVIGATION, INC.

Vector 2X Compass Module NEW

- Applications: vehicle mapping and tracking, robotics, HAM radios, camera positioning
- 2° accuracy, 1° resolution
- 3-wire serial output format (compatible with Motorola SPI and National Microwire)
- Pin selectable BCD or binary output format
- Power supply: single 5 volt
- Size: 1.5" x 1.3" x 0.4" • Weight: 0.1 lbs.

Part No.	Description	1-4	5-9
126703	Vector 2X module	$49.95	$44.95

PRECISION NAVIGATION, INC.

Vector 2X Developers Kit NEW

- Development board which allows your Vector 2X to directly communicate via the parallel port of your PC
- Weight: 0.8 lbs.

Part No.	Description	1-4	5-9
126691	Vector 2X kit	$99.95	$89.95

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127159

127141

- Kits in electricity and magnetism
- Includes book with all materials to complete projects (one D-cell battery required for electricity kit – not included)
- Puzzles to reinforce terms and concepts
- Size: 10.2"L x 8.1"W • Weight: 1.0 lb.

Part No.	Description	1-9	10-24
127159	Magnetism kit	SALE	$19.95
127141	Electricity kit	SALE	19.95

Protect Your Home with X-10 POWERHOUSE™ Lamp Module NEW

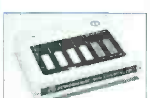
One-year warranty!

For controlling incandescent lamps or an air conditioner, stereo, TV, etc. – anywhere in the home.

- For lamps up to 300W

Part No.	Description	1-9	10-24
126447	Lamp module	$14.95	$13.49

Mini-Controller



Lets you control up to 8 X-10 modules at the touch of a button from anywhere in the house. Has an "All Lights On" button and dims lights too.

Part No.	Description	1-9	10-24
126471	Mini-controller	$12.95	$11.49

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- Size: 9.2"L x 7.2"W x 3.6"H
- Weight: 10.9 lbs.

Special!

Part No.	Description	Price
125508	Desolderer...... SPECIAL	$259.95

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48979	7400	$.35	$.29	$.25
49015	7402	.39	.35	.29
49040	7404	.39	.35	.29
49091	7406	.45	.39	.35
49120	7407	.45	.39	.35
49146	7408	.45	.39	.35
49437	7414	.39	.35	.29
50235	7432	.49	.45	.39
50420	7447	1.19	1.09	.99
50551	7474	.35	.29	.25
50577	7475	.45	.39	.35
50593	7476	.89	.79	.69
50665	7486	.55	.49	.45
50681	7489	SALE	2.49	1.95
50690	7490	.79	.69	.59
49293	74116	SALE	.99	.89
49322	74121	.99	.89	.79

EPROMs

Part No.	Product No.	Description	Price
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40133	2732A-45	4K x 8	3.95
40205	2764-25	8K x 8	3.95
40248	2764A-25	8K x 8	3.95
39829	27C64-15	8K x 8	3.69
39933	27128-25	16K x 8	4.95
39677	27C128-15	16K x 8	4.95
40045	27256-20	32K x 8	4.59
39731	27C256-25	32K x 8	3.49
39773	27C512-12	16K x 8	4.59
39781	27C512-15	64K x 8	4.49
39669	27C010-20	128K x 8	4.95
65699	27C020-15	256K x 8	7.25
85462	27C040-15	512K x 8	11.95

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Includes mother-board, computer case and power supply

- Supports optional 80387SX-33 math-coprocessor
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- Weight: 18 lbs. • One-year warranty

Special!

Part No.	Description	Price
121208	486SLC2 66MHz SPECIAL	$259.95

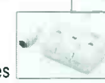
2-Button Joystick

- PC/XT/AT and compatible systems
- Precise self centering analog joystick
- 4 suction cups for desktop mount
- Single/rapid fire selector switch & triggers
- Size: 5.5"L x 4.3"W x 7.5"H • Weight: 0.9 lbs.

Part No.	Description	1-4	5-9
120088	2-button joystick	$11.95	$10.49

Gamestar Programmable Game Controller

Game Control



Configuration Control

- IBM compatibles
- MS DOS or PC DOS required
- Program and save created game templates
- Includes configuration and game control
- Size: 6.5"L x 3.3"W
- Weight: 1.1 lbs. • One-year warranty

Part No.	Description	1-4	5-9
124505	Game controller	$19.95	$17.95

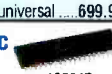
EPROM Programmers

- Programs EPROM's, EEPROM's, and flash memories
- Programs 16KB to 8MB EPROM's
- Full screen buffer editor
- File formats supported: Intel Hex, Motorola S Hex, Tektronix Hex, and Binary
- 2 & 4-way Binary file splitting programs
- 2 & 4-way Binary file shuffler programs
- Includes adapter card, software & manual
- Size: 7"L x 5.5"W x 1.75"H
- One-year warranty

Special!

Part No.	Description	Price
101400	1 socket 16K-512KB	$119.95
78457	1 socket 16K-2MB	199.95
78465	4 socket 16K-2MB	259.95
104651	1 socket 16K-8MB universal	699.95

80C52-Basic Microcontroller



125647

The 80C52-Basic chip is a custom-masked 80C52 microcontroller with a full-featured 8K-byte ROM-resident Basic-52 interpreter.

Part No.	Description	1-9	10-49
125647	CPU 8-Bit CMOS	$19.95	$17.95

The 8052 Microcontroller Idea Book (1994)

- Circuits, programs and applications featuring the 8052-Basic single chip computer

126375	Microcontr. Idea Book	SALE	$31.95

Basic-52 Reference Book (1989)

- Complete reference to programming 80C52-Basic and 8052AH-Basic microcontrollers

126252	Basic-52 Progr. Ref.	$19.95	$17.95

Software Disk for Basic-52 Book

- 3.5" Disk of circuit examples for P/N 126252

126295	Basic-52 3.5" Disk	$9.95	$8.95

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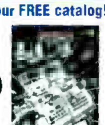

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