Radio-Electronics®

CONTROL YOUR HOME BY TELEPHONE

FEBRUARY 1989

TECHNOLOGY - VIDEO - STEREO - COMPUTERS - SERVICE

A GERNSBACK PUBLICATION

HIGH-DEFINITION TV

The battle for acceptance heats up

BUILD AN ACTIVE ANTENNA

To improve the performance of your shortwave receiver

CIRCUIT COOKBOOK

Practical circuits put downcounters to work

BUILD A 10-MHZ FREQUENCY COUNTER

It's really traceable to the National Bureau of Standards!

COMPUTERDIGEST

A look at the Atari ST

$2.25 U.S.
$2.75 CAN

PLUS:

- ★Hardware Hacker
- ★Video News
- ★Shortwave Radio
- ★Audio Update

93 xxxxxxxxxxx 5-DIGIT 60505
390736 DHM 0997G093 02
JAN 90
MR ROBERT DAHM
997 GRAND AV
AURORA, IL 60505

FLUKE AND PHILIPS – THE GLOBAL ALLIANCE IN TEST & MEASUREMENT

FLUKE ®

PHILIPS

Introducing a whole new way to look at oscilloscopes.

Operation that's instinctively, unbelievably clear. Information that's detailed, yet free of errors. And intelligence that will speed your work. Philips' micro-computer controlled medium-frequency Smart Series. They could change forever the way you look at oscilloscopes.

HIGH PERFORMANCE WITH A VIEW

- *LCD window.* Large digital indications note all selected functions, instrument settings and parameter values. Instantly. Precisely. With no mistakes. And right where you need them—next to the CRT. Not hidden in crowded frontpanels. Not wasting critical waveform display area. It's a revolutionary idea that facilitates the use of an oscilloscope like nothing else. And it's only from Philips. Once again.
- *16kV CRT.* Higher acceleration voltage and advanced electron optics assure brilliance and spot quality that outshines anything else in this class.
- *Pushbutton simplicity.* Quick, one-function buttons have replaced knobs for faster, surer, more reliable operation.
- *Instant-action AUTOSET.* Philips' intelligent beamfinder automatically selects channel, amplitude, timebase and triggering for error-free display of any input signal. Great for troubleshooting!
- *"Clever" cursors and delayed sweep.* Standard on the PM 3070, "clever" cursors supply immediate amplitude and timing measurements with direct CRT readout. And an exclusive cursor-operated ZOOM function offers the most efficient use of delayed sweep available in analog scopes.
- *Auto-Triggering intelligence.* Provides fast, stable triggering up to 150 MHz.
- *Probefactor compensation in LCD.* It automatically adjusts all readouts for the probe you're using.
- *IEEE compatibility.* For fast computer hook-up and automated production test and calibration.
- *Choice of four models:* Single and dual timebase; 60 or 100 MHz bandwidths.

SUPPORTING VIEW

Philips' medium-frequency instruments come with a 3-year warranty, a 30-day money-back guarantee and all the technical and service assistance you need. From Fluke—the people who believe that extraordinary technology deserves extraordinary support.

POINT OF VIEW

Call Fluke today at **800-44-FLUKE ext. 77**. And find out how easy it is to change the way you look at oscilloscopes.

Ask for your free copy of our new guidebook, Basic Principles of Oscilloscopes.

John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C,
Everett, WA 98206
U.S.: 206-356-5400 CANADA: 416-890-7600
OTHER COUNTRIES: 206-356-5500

SMART SERIES OSCILLOSCOPES • 60 & 100 MHz

FLUKE ®

CIRCLE 121 ON FREE INFORMATION CARD

February 1989 Radio-Electronics

Vol. 60 No. 2

BUILD THIS

44 PHONLINK II
Control your home appliances from any touch-tone phone.
Janet McNabb and Gene Roseth

51 ACTIVE ANTENNA
Get good short-wave reception, even where there's no room for a long-wire antenna.
Rodney A. Kreuter

55 CARRIER CURRENT RECEIVER
An AM or FM receiver completes the carrier-current audio system.
William Sheets and Rudolf F. Graf

63 10-MHz FREQUENCY STANDARD
Use WWV to calibrate test equipment economically.
Al Palmer

TECHNOLOGY

35 HIGH-DEFINITION TV
A look at the major contenders in HDTV.
Len Feldman

CIRCUITS

71 DOWN-COUNTER COOKBOOK
Recipes for pre-setable down-counter circuits.
Ray Marston

DEPARTMENTS

6 VIDEO NEWS
What's new in this fast-changing field.
David Lachenbruch

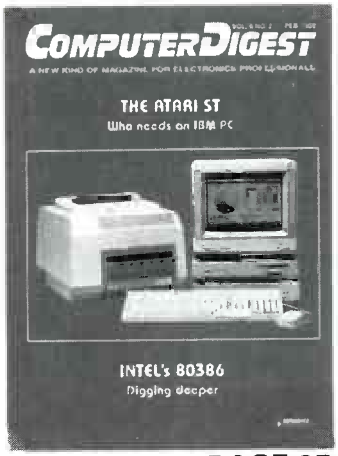
22 EQUIPMENT REPORTS
Canon's FAX-L920 Laser Facsimile and American Reliance's AR-6400P Cable Tester.

78 HARDWARE HACKER
HDTV: An alternate viewpoint.
Don Lancaster

87 SHORTWAVE RADIO
Sunrise and sunset affect propagation.
Stanley Leinwoll

89 AUDIO UPDATE
The question of reliability.
Larry Klein

91 ANTIQUE RADIO
Loudspeakers and things.
Richard D. Fitch



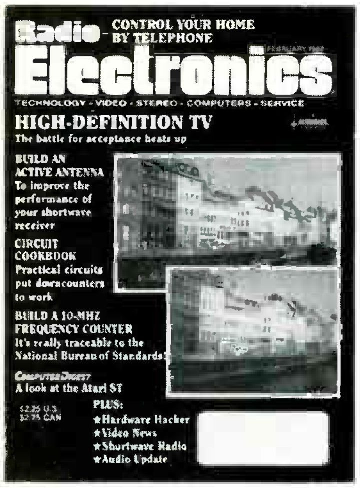
PAGE 95

PAGE 51

AND MORE

132 Advertising and Sales Offices
132 Advertising Index
12 Ask R-E
133 Free Information Card
14 Letters
112 Market Center
26 New Products
108 PC Service
4 What's News

ON THE COVER



The technology exists for high-definition TV; in fact, you could say that too much technology exists. Before HDTV can become a viewing reality, a consensus must be reached on one HDTV standard. There are currently close to 20 separate proposals vying for that position. Some are fully-compatible with NTSC standard and will display a picture on a conventional television. Other systems are "semi-compatible," requiring extra bandwidth for HDTV broadcasts; still others are completely incompatible with NTSC television. We take a look at all three categories, explain their pros and cons, and introduce you to the major contenders in the HDTV ring, beginning on page 35.

COMING NEXT MONTH

THE MARCH ISSUE IS ON SALE FEBRUARY

LASER POWER SUPPLIES
Buid a universal power supply for Helium-Neon Tubes.

SERVICING VCR's
Advanced oscilloscope features, including auto setup, cursors, and on-screen readout, simplify the repair of VCR's and camcorders—and some basic maintenance and common-sense solutions will help you keep your VCR out of the repair shop.

COMPUTERDIGEST
How to use an Amiga computer for video production.

RADIO-ELECTRONICS, (ISSN 0033-7862) February 1989. Published monthly by Gernsback Publications, Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735 Second-Class Postage paid at Farmingdale, NY and additional mailing offices. Second-Class mail registration No. 9242 authorized at Toronto, Canada. One-year subscription rate U.S.A. and possessions $17.97, Canada $23.97, all other countries $26.97. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies $2.25. © 1988 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

POSTMASTER: Please send address changes to RADIO-ELECTRONICS, Subscription Dept., Box 55115, Boulder, CO 80321-5115.

Radio-Electronics

Radio-Electronics is indexed in *Applied Science & Technology Index* and *Readers Guide to Periodical Literature*.

Microfilm & Microfiche editions are available. Contact circulation department for details.

Advertising Sales Offices listed on page 132.

Surplus HP Gear—up to 90% off!!!

Now you can afford a

- 9114B HP-IL 3 1/2" Disc Drive
- 2225B HP-IL ThinkJet Printer
- HP-75D Portable Computer/RAM/Pod Package

Here's the story—

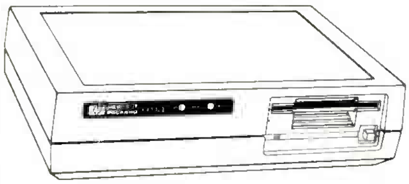
These units were recently installed in a chain of stores for point-of-sale inventory control until a corporate decision to change accounting methods prematurely retired them.

It's a shame. But we lucked out to get them at a truly low price. This corporate mistake is your opportunity—however, you must act fast.

Used, yes—but believe me, this industrial-grade equipment is in excellent, near-new condition—perfect operating shape—and every unit comes with our 30-day guarantee. If your unit fails to operate properly in any way whatsoever, we'll replace it FREE.

This liquidation means you can have that IL Disc Drive or ThinkJet that you've wanted, and that full-memory HP-75 to experiment with—these units are really affordable! But **do not delay**—we must limit these fantastic savings to stock on hand. Let us know right away that you want one.

3½" Disc Drive—

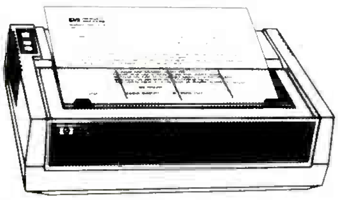


this is the current model (HP-9114B), and it comes with everything: rechargeable batteries, recharger, disc, HP-IL cable, manual.

It is HP-IL driven, so you can use it with the the HP-75D and also with the HP-41, HP-71 or HP-110. **Easily portable**, it weighs only 6 lb, is battery powered, 3" high and its footprint is the size of typewriter paper. 2-sided flexible discs hold 630K, and the drive automatically monitors wear and checks for defects at each use. Data access time is ½ sec and transfer rate is 6K/sec. List price new is $695, so you buy this used unit at a **whopping 57% discount!**

Stock # 9114BU [Used 3½" Disc Drive].. $295

IL ThinkJet Printer—



this is the current production model (HP-2225B) that is so popular.

It prints 80 columns and is **HP-IL driven**, so you can use it with the HP-75D and also with the HP-41, HP-71 or HP-110. **Completely portable**, it weighs only 5½ lb and it's battery operated. Yet it's so **quiet** and so **robust** that you see it as a public-access printer in many libraries, and it has a life of 100,000 pages! It's **fast**, 150 characters per second, and has **high quality print** with an 11 × 12 dot matrix (bidirectional, logic-seeking, 1K buffer, and it does underlining or boldface in 1 pass). There's no ribbon—you simply replace the printhead for $11.

List price new is $495, so you can have fast, quiet IL printing now at this **giant 60% discount!**

Stock #2225BU [Used ThinkJet Printer]....................................$195

Portable Computer/ RAM/Pod Package—

loaded with extras! You get the HP-75D computer, plus the 8K RAM Expansion Module that plugs into its battery compartment, plus the Expansion Pod that adds a modem, barcode decoders, and a huge 64K RAM disc full of super-fast memory, plus the Barcode Wand! That's a lot, so I'll display the list here for you (remember, you are getting the whole package)—

1. (HP-75D) Portable Computer
2. (HP-82700) 8K RAM Memory Module
3. (HP-82718B) Expansion Pod
4. (HP-92267B) Barcode Wand

HP-75D is 5 × 10 × 1¼ inches, 26 oz, with 16K RAM built in. It has a card reader, wand interface and port, touch-type keyboard (the keyboards on these units have never been used). Comes with manual, battery pack and adapter/recharger, IL cables.

Expansion Pod fits as a cradle on your 75, has 300 baud, direct-connect modem and decoders for 3 of 9 Code and Code 11.

Barcode Wand is medium resolution (0.19 mm min width of narrow element) for code produced on dot-matrix printers.

The total list price for this gear new is $2715—so your cost is discounted **an unbelievable 90% !!!**

Stock #HP-75DU [Used Computer Package]............................$275

Who is EduCALC? In 12 years we have become one of the largest HP dealers in the world. You see, we guarantee you'll be completely satisfied with your purchase, or your money back!

Order by mail: Californians add 6% tax. Add $4 for UPS delivery (no extra charge for multiple items). Allow 12 days for personal checks to clear, or send your MC/Visa number and card address.

For fastest service, call during west-coast business hours at **(714)582-2637**. Or, for all days/all hours call toll-free **(800)633-2252**, ext. 357, with your MC or VISA card. Of course, if you live in Southern California, drop by in person and pick up your new HP gear.

I guarantee you'll be delighted—or your money back within 15 days, no questions asked.

Jim Carter

EduCALC Mail Store-Dept. 57
27953 Cabot Road
Laguna Niguel, CA 92677

WHAT'S NEWS

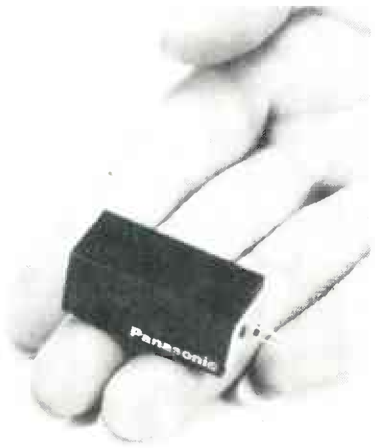
Longer CD recordings with new blue laser

Matsushita scientists report the development of industry's first ultra-compact blue laser, using a unique technology that combines a second harmonic generation element and a semiconductor-diode laser. The device will permit higher recording density for information-memory devices, as well as potential size reductions for data-processing equipment—such as laser-color printers and projection TV's—that are currently equipped with large gas lasers.

Low recording density has been a critical problem in compact-disc and optical-memory equipment. Increased recording density requires a shorter wavelength for the beam that writes to or reads from optical-memory discs. Present equipment uses a semiconductor laser with a wavelength of about 780–840 nanometers. By using the ultra-compact blue laser, with a wavelength of 390–420 nm, an optical disc's memory can be quadrupled. (That shorter wavelength—one-half as long—cuts the size of an optical disc's pits by 50 percent.)

To achieve the lightest and most compact equipment, Matsushita has combined an infrared semiconductor laser and the new second harmonic generator in a single module, thus obtaining a blue-laser output of 420 nm from an infrared laser operating at 840 nm. Beam power is 1 milliwatt.

Samples of the new laser—to be marketed under the Panasonic name—should be available by the time you read this.



THE PANASONIC ULTRA-COMPACT blue laser device will quadruple the memory of optical discs.

Microbial batteries seem a possibility

Fuel cells—those in which the electrolyte is continuously being used up and replaced—are well known. Unfortunately, fuel cells have their own difficulties; one is that most of them have to operate at high temperatures.

It has been known almost from the turn of the century that microorganisms such as bacteria can generate a voltage or produce a current. As the organisms break down (or catabolize) the large molecules in their food, they produce intermediate substances that are rich in electrons. The problem is that the organisms have a "skin" of liquid membranes and cell walls that block passage of the electrons. Currents from experimental cells have been low.

Now scientists from Kings College in London report a class of chemicals that "connect" the electron-rich interior of the cell to the negative terminal. Those "mediators" are chemicals—such as resorutin, thionin, and others—that are well known to biochemists. In effect, they penetrate the outer layer of the microorganism and make it possible for the electrons to get through.

Experimental bacterial cells fed with various sugars have been made with outputs as high as 2 amperes, and researchers are already talking of running cars with sugar in their tanks. At the other end of the scale, there is much interest in cells that would deliver milliwatts or even microwatts of power. (Less than one tenth of a gram of carbohydrate would power a watch for a year.) Another possible application is power from an abundant, inexpensive agricultural or industrial waste, such as sugar cane.

New editing technology harmonizes tape and film

Video-program producers have long wished to be able to shoot on film, edit on video tape, and release prints in both media, including a matching sound track for each. But film and videotape are incompatible—film operates at 24 frames per second, and videotape operates at 30—so that dream has always been thought of as being impossible.

Now engineers from CMX Corp., a leading designer of computerized film- and television-editing systems, have solved that problem with a revolutionary new patented software technique that is called MC^2 (Matched Computer Cut). MC^2 works within the CMX 6000 editing system that transfers film or videotape to laser videodiscs for editing purposes. With MC^2, editors are now able to prepare a film cut and a videotape master—including the audio portion for each of them—and they have them both "frame accurate" at 24 frames and 30 frames per second.

MC^2 also solves an international problem. Many foreign standards for video, such as PAL and SECAM, differ from the American NTSC. MC^2 can be used as an easy alternative to create high-quality PAL or SECAM masters from standard NTSC tapes. **R-E**

CIRCLE 109 ON FREE INFORMATION CARD

VIDEO NEWS

DAVID LACHENBRUCH,
CONTRIBUTING EDITOR

• **An HDTV tube.** Just as semiconductor manufacturers are pushing for government grants or consortiums to lay the foundations for a "new consumer-electronics industry" in the United States, the last surviving major American-owned television manufacturer is pushing for government aid to keep it afloat. Zenith Electronics has asked for a grant (believed to be in the neighborhood of $60,000,000) to develop its unique *F*lat *T*ension *M*ask (FTM) tube as a high-definition, giant-screen picture tube. Zenith says that FTM is ideally suited for HDTV and can be made cheaply after further development. (FTM tubes currently are being made in the 14-inch size for data display only.) The FTM differs from conventional tubes in that its faceplate is completely flat—it can be made of conventional window glass—and the shadow mask is stretched just behind the faceplate and bonded into the glass, preventing any significant change in its contours as the tube heats up.

The display on the FTM tube is unique. Because there need be virtually no reflection, the picture looks more like a 35mm slide than a TV image. However, Zenith has had difficulty manufacturing the tube, and some members of the industry doubt that it can ever be produced economically.

While Zenith pleads for government aid in developing its tube into a consumer device, it is also seeking either to sell its consumer-electronics operation or enter into some kind of joint venture—developments that may have occurred by the time you read this. Zenith's problems and those of the semiconductor manufacturers, however, still underline the problems of the low-profit consumer-electronics industry.

• **Creating an industry.** Some of the semiconductor and related Silicon Valley manufacturers now pushing for a bailout to "revive the American consumer-electronics industry" were formerly engaged in the manufacture of TV sets and other consumer-electronic products, and left the industry voluntarily or sold out to Japanese manufacturers. They are now seeking government money to get back into a field they once quit because the profits were too low. However, those same manufacturers point out that the lack of a consumer-electronics industry as a major consumer of chips could imperil American defense.

A major campaign is on. Although there is a score of TV-assembly plants in the United States, the vast majority are foreign-owned, and many depend on imported parts and subassembly. The question is whether the supply of consumer-electronics products will continue to be the province of overseas manufacturers as the world enters the age of high-definition TV.

• **HDTV in spotlight.** High-definition television is getting increasing attention in Washington and elsewhere, as the public imagination is captured by the concept of a TV picture that looks like a movie, both in width of screen and in detail. Semiconductor manufacturers are urging the U.S. government to finance a major program to develop "a new consumer-electronics industry" as a stimulus to the development and sale of IC's. They claim that only 6% of the semiconductors used in consumer-electronics products sold in this country are made in the United States, and they insist that HDTV provides a good opportunity for the development of a new American consumer-electronics industry.

In the background is an FCC directive to American broadcasters that any new HDTV system be compatible with existing NTSC transmissions and channels. That virtually rules out the Japanese 1,125-line HDTV system that actually is designed for direct broadcasting from satellites and not for terrestrial-TV transmission. (In fact, the first Japanese HDTV transmissions will be to receivers in public places rather than in consumers' homes.) The FCC's compatibility ruling has cleared the air and helps to quell the rumors that the Japanese will export an incompatible system here with no opposition. **R-E**

Intermittents. We Hear You.

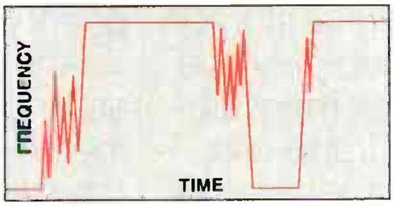
Introducing The Heavy-Duty DMM With An Audible Readout That Lets You Keep Both Eyes On The Job.

Intelligent design and solid construction make the new HD 150 Series the best DMMs in their class.

They're the latest in a distinguished line that began when Beckman Industrial pioneered heavy-duty DMMs with their distinctive yellow color. Many competitors have since imitated that color. As for imitating their performance, no one comes close.

The HD 150 Series attains new levels of excellence with a range of advanced features. They're waterproof. Drop proof. Auto-ranging. Slim-styled for one-hand comfort and convenience. With auto-off to prolong battery life. Plus 2 fuses, PTC resistor *and* MOV for unsurpassed overload protection.

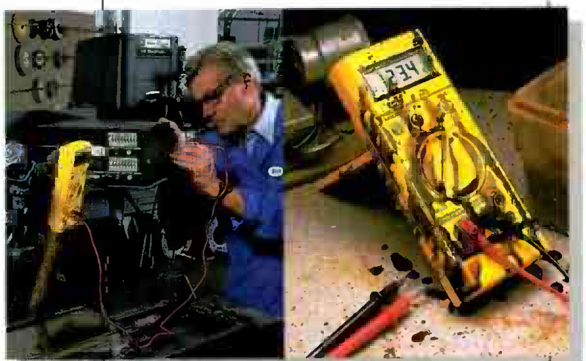
Audible readout. A "sound" reason to go with the HD 150 Series. With this unique feature on the HD 153, you measure parameters by listening to a continuous variable tone. As the parameter you measure rises or falls, the tone's frequency increases or decreases, accordingly. Use it for volts, amps, or ohms. It's ideal for peaking and nulling, too.



Intermittent alert. A key application of audible readout. The HD 153 pinpoints intermittents by emitting a "crackling" sound when they're detected. The response sounds in about 1 msec—far faster than the information appears on any DMM display.

Logic function. The HD 153 detects TTL or CMOS logic pulses using standard test leads.

Easy to use. The HD 150 Series lets you read the LCD even at wide angles. With the large rotary dial you select functions with one-handed (right or left) convenience. Auto-ranging speeds you to the right range. A tilt-stand and Skyhook let you set or hang the DMM almost anywhere.



Built tough to work hard. The HD 150 Series DMMs are so tightly sealed against water and grime that they're *guaranteed for five years* against contamination. And, because they're built so tough, they're guaranteed for two years against *any* damage (except abuse). Crashes, overloads, moisture, dust…you name it. The HD 150 Series can handle it all!

Listening is believing. For a hands-on demo, see your distributor now. Learn why the HD 150 Series is the soundest DMM value you'll see. Or hear.

Key Specifications

	HD 151	HD 152	HD 153
Auto-ranging	✓	✓	✓
Range Lock		✓	✓
Audible readout			✓
Tilt Stand and Skyhook™	Optional	Optional	Included
Logic pulse detector			✓
DC voltage accuracy	0.7%	0.5%	0.25%
10A range		✓	✓
Suggested list price	$149.00	$169.00	$199.00

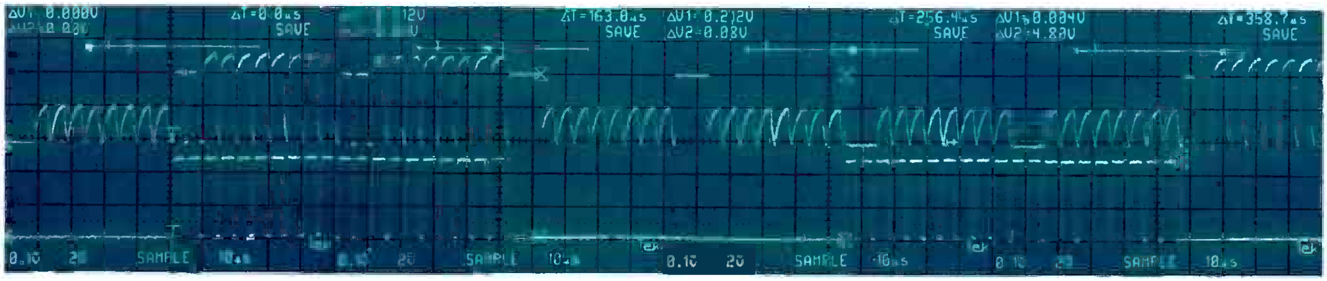
Beckman Industrial™

In Service Instruments, We're The One.

Beckman Industrial Corporation
Instrumentation Products Division
A Subsidiary of Emerson Electric Company
3883 Ruffin Road, San Diego, California 92123-1898
(619) 495-3200 • FAX: (619) 268-0172 • TLX: 249031

CIRCLE 98 ON FREE INFORMATION CARD

Digital scopes with a



Give up real-time capability for storage? Not with Tek!
That's because analog capability is integral to low-cost Tek digital storage oscilloscopes. So you need only one instrument to make all your measurements efficiently. With no trade-offs.

It's another Tek advantage: analog and digital in one familiar, affordable package.

Select either mode at the push of a button.
With digital storage you can capture events which are difficult if not impossible to see on conventional scopes. Pre and post trigger events. Fast transients.

Single-shot events. Elusive glitches. Low-speed phenomena.

Four screen photos spliced end to end illustrate the benefit of full four-screen capture using the 2230's 4K record length.

Any waveform can be viewed for as long as you like. Or stored in 4K of memory for later analysis or comparison to other waveforms. And if there's a question about a digital measurement, just push a button for real-time display analysis.

real-time advantage.

The affordable portables.

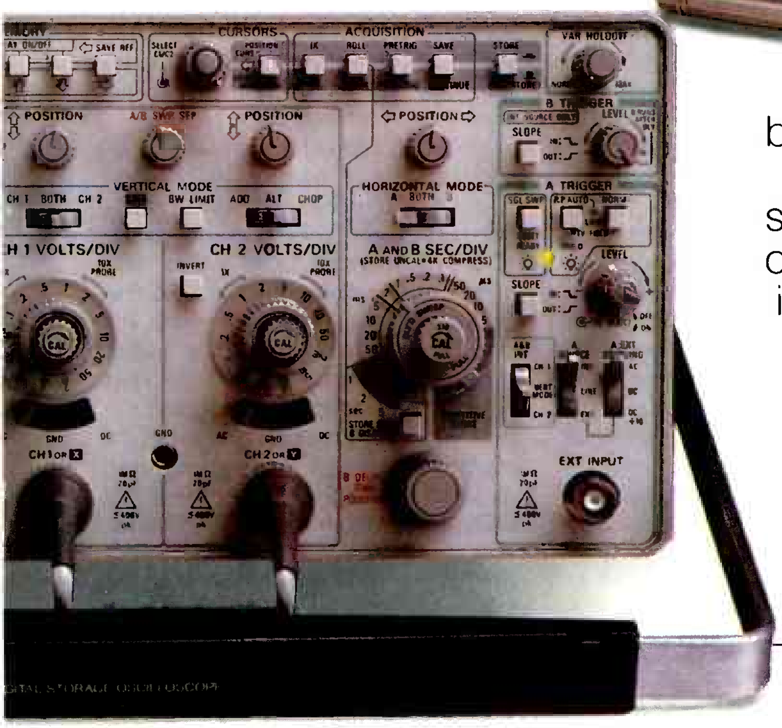
These are the world's best-selling digital storage oscilloscopes. And with the new 20 MHz Tek 2201 joining the family, there's now an even better selection—in bandwidth, performance and price.

Select for advanced features such as 100 ns glitch capture at any sweep speed, CRT readout, measurement cursors, multiple acquisition modes and hardcopy output, plus optional GPIB or RS-232-C interfaces and software.

These scopes are perfect for first-time digital users. And seasoned operators will appreciate even more their versatility, convenience and value. All backed by Tek quality and a 3-year warranty.

Features	2230	2221	2220	2210	2201 NEW
Bandwidth	100 MHz	60 MHz	60 MHz	50 MHz	20 MHz
Max. Sampling Speed	20 MS/s	20 MS/s	20 MS/s	20 MS/s	10 MS/s
Vertical Resolution	8-12 bits	8-10 bits	8 bits	8 bits	8 bits
Record Length	1K/4K Selectable	4K	4K	4K	2K
Glitch Capture	100 ns	100 ns	100 ns	No	No
CRT Readout/ Cursors	Yes	Yes	No	No	No
GPIB/RS-232-C Options	Yes	Yes	Yes	No	RS-232-C Hardcopy
Warranty	3-years on labor and parts including CRT				
Price	$4995	$3995	$2995	$2395	$1495

Each scope offers a range of capabilities you'd expect to find only in much more expensive instruments.



Discover the potential. Let Tek show you what you're missing . . . without making you give up analog to see it. That's the real-time advantage of Tek digital storage.

For easy ordering or more information call Tek Direct:

1-800-426-2200

VISA MasterCard

Tektronix®
COMMITTED TO EXCELLENCE

CIRCLE 92 ON FREE INFORMATION CARD

ASK R-E

WRITE TO:

ASK R-E
Radio-Electronics
500-B Bi-County Blvd.
Farmingdale, NY 11735

TIME-BASE CORRECTOR

Can you explain exactly what a "time-base corrector" does? I want to be able to mix two video sources together, and I'd like to know if I need one of those to do it. Also, what other equipment do I need to do video mixing?—S. V., Okinawa, Japan

In order to understand what the time-base corrector does, you first have to understand what the time-base corrector corrects. The drawing in Fig. 1 is a typical line of video. The horizontal sync on the line is what makes the beam zip back to the left edge of the picture and start a new line of video. Although you only see what occurs on the line during the picture portion of the line, Fig. 1 should make it clear that there's a lot of other stuff going on during the blanking interval as well—behind the scene, so to speak.

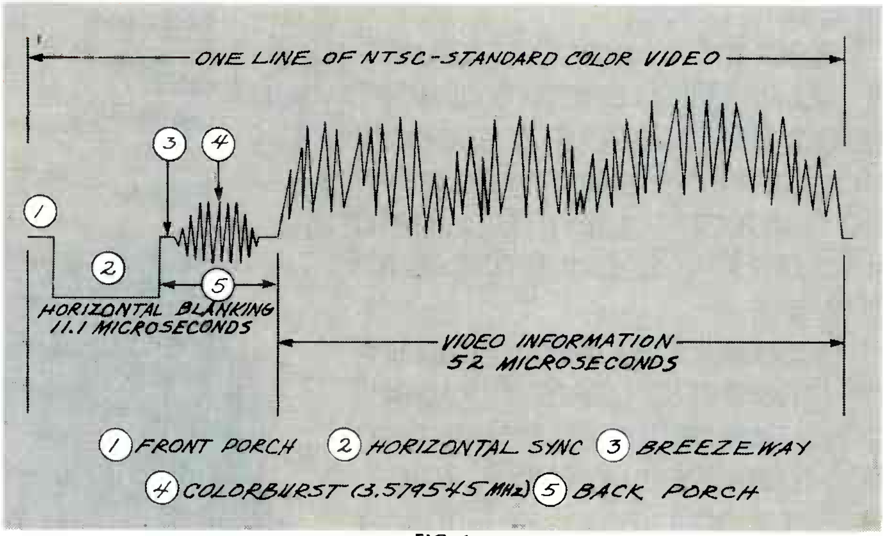


FIG. 1

When you record on a VCR, all the control signals (including sync) have to be recorded as well—that's obvious; but what's not obvious is that they're not recorded as part of the picture. The circuitry in the VCR separates the sync from the picture and records it all on a separate track called, appropriately enough, the control track.

When you play back a tape, things like bobble, misalignment, and jitter, often cause the control track to be read either a bit early or a bit late. All VCR's suffer from that to some degree, even high-quality professional ones. There's just no way to avoid it, since the VCR is only a mechanical device and mechanical devices are built with mechanical tolerances.

Even if you managed to get a VCR in super-duper alignment, so that there was no jitter on the drum to misalign the control and video tracks, it wouldn't be long before normal mechanical wear caused it to fall out of alignment.

Now that we've seen what causes the problem, we can start talking about a time-base corrector. Since the picture's horizontal jitter is caused by timing errors in synchronizing the control and video tracks, they can be eliminated by synchronizing the video to a sync source that's independent of the recorded sync.

A time-base corrector takes the incoming video signal, strips sync from it, and remixes it with a new set of sync signals. The video is processed line by line, and the original sync is just used as a trigger to mark the correct position on the line for injecting the new sync. The actual circuitry that does the job can be designed several ways. You can have something similar to the auto-triggering circuitry found on an oscilloscope, or it can use a phase-locked loop to lock the old and new sync together.

You don't need a separate time-base corrector to mix several video sources together because most consumer video mixers will separate sync signals from video and inject new control signals on the output of the mixer anyway. It's possible to build your own video mixer, but even a basic mixer needs fairly complex circuitry.

If your interest is primarily in electronic design, designing one of those would be an interesting thing to do. If, on the other hand, you're more interested in having one to use, you'll probably find it a more efficient use of your time to go out and buy one.

DIGITAL METERS

I've built the digital oil-temperature gauge, temperature gauge,

and voltmeter that appeared in the July, August, and September 1983 Radio-Electronics, and I'm looking for some other ones. Do you know of any other digital meters I could build?—S. Salisbury, Omaha, NB

If you've already built the three gauges you've mentioned, you've also already built all the gauges that you need. That isn't meant as any sort of editorial judgment on the place of digital electronics in cars; it just means that you've already got all the circuitry you need to build as many digital gauges as you can fit between the driver's door and the cigarette lighter. If you look at the block diagram in Fig. 2, you'll see what I mean.

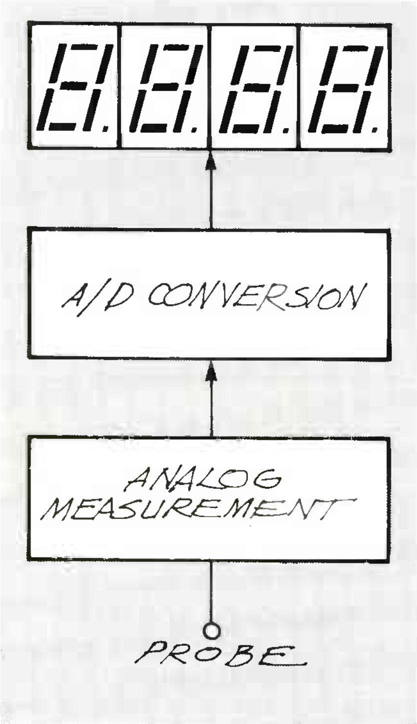


FIG. 2

Most digital gauges either count pulses per time unit or measure a standard electrical unit (usually volts). An electronic tachometer is an example of the former, and your digital voltmeter is an example of the latter. If you think of the meter as a sealed unit, there's a big difference between a digital temperature gauge and a digital oil-pressure gauge, but if you look at the illustration, you'll realize that the two meters are more alike than they are different.

The difference between the two gauges is only in the sensor and the conditioning circuitry. Both meters are actually measuring the same electrical parameter. To make the point clearer, let's suppose that you wanted to make a digital fuel-flow meter. That could come in handy because it would be calibrated and gated to show fuel economy. In any event, the design of a meter like that would revolve mostly around the device that you were using to measure fuel flow, and not on the meter that was measuring it.

The first place you would begin looking as you built up the design is in a catalog of rotary transducers, as they are good for measuring fuel flow. The deal here is that the most important part of the meter is the device that gives you something to measure. In this example, the rotary transducer would produce a voltage proportional to the fuel flow. Once you've got that signal available, you can measure it with the digital voltmeter that you built. **R-E**

LETTERS

NOT QUITE TRUE RMS

It has come to our attention that there are a couple of errors in the schematic diagram (Fig. 2) for the article "True RMS Converter for your DMM," that appeared in the December 1988 issue of **Radio-Electronics**. Neither pin 4 of IC1 nor the anode of D2 should be connected to ground, as the schematic indicates. Instead, as shown here in Fig. 1, pin 4 of IC1 should be connected directly to the anode of D2, and the connection from J4 to pin 4 should be removed.—*Editor*

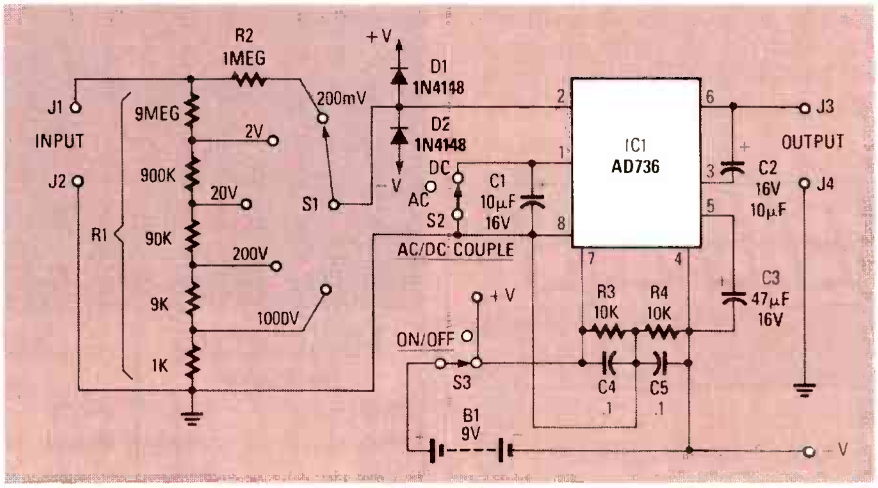


FIG. 1

DIGITALKER AVAILABILITY

Your readers will be interested to know that the National Semiconductor Digitalker system you described in "Build This Speech Synthesizer (**ComputerDigest**, December 1988) is no longer being produced by National Semiconductor, nor is there any plan to begin production again. While many distributors (including some of your advertisers) stock the part, anyone contemplating using the Digitalker in a new design should be aware that once current stocks are depleted, no more will be available.

FRED WICKERSHAM
Product Mkting Manager
Telecommunication IC's
National Semiconductor
Santa Clara, CA

COPING WITH BASIC

I read with interest the article, "Coping with Coils," in the November 1988 issue of **Radio-Electronics**. As a beginner in computers, and knowing very little about coils, I felt that it would be a good way to learn something about BASIC on a Hewlett-Packard 125.

I'm writing to inform you that the program, as it is presented in the article, will not work on the HP 125. Every time I tried to run the program, it displayed "Syntax Error on line 110." After some experimentation I found that it would work when line 110 was changed to read:

110 pi = 3.1415926545

Removing "cls:" from line 110 took care of the syntax error. I ran the program and it worked as described—until the end. After briefly displaying the calculations, it exited the BASIC mode. So I modified lines 540 and 1000 as follows:

540 if n 9999 then print "ERROR - turns count larger than 1000":END

1000 END

Changing "system" to "END" lets the calculations remain on the screen, so that I can read them and print them out if I want to. I can calculate other coils, one after the other, without having to take the time to reinstall BASIC after each calculation.

Thanks for the chance to learn more about the HP 125.

RON RAMIREZ
Providence, KY

CHANGE OF ADDRESS

Del-Phone Industries is relocating to Florida on February 1, 1989. We are still supplying parts for the "Digital Telephone Lock (**Radio-Electronics**, October and November 1988). The new address is: Del-Phone Industries, 4487 Plumosa Street, Spring Hill, FL 34606.

There have been no price changes; however, Florida residents must add the appropriate sales tax.

STEVE SOKOLOWSKI

COIL CORRECTION

I enjoyed David Powell's article, "Coping with Coils"—especially converting the IBM BASIC program to run on a modern computer. The program certainly makes RF-coil calculations easy.

There is one error in the program listing as printed. Line 855 should read:

PRINT INT (W.LENGTH-INT(W.LENGTH/12)*12

With the values given in the article's Fig. 2, the length of wire is 99.868 inches, or 8 feet 3.868 inches, not 8 feet 10 inches as shown.

RUSSELL K. PRATER
Parker, FL

DATA-CARRYING CAPABILITY AND BANDWIDTH

Referring to "Communications Corner" in the October 1988 issue of **Radio-Electronics**, the frequency ratio of 5.5:1 does not necessarily indicate a high data-carrying capability. For example, the range from 1 Hz to 5.5 Hz would have a very low data-carrying capability.

What counts is the frequency bandwidth. The above example has a bandwidth of only 4.5 Hz. In the range Herb Friedman is discussing, the 200 nm UV has a frequency of 1500 TeraHz, and the 1100 nm IR has a frequency of 270 TeraHz. The bandwidth is then 1230 TeraHz.

That bandwidth would give the theoretical potential of far more signal-carrying capability in a single fiber than all radio frequencies combined. However, it is the frequency *bandwidth* that counts, and *not* the ratio between the high and low.

MARION E. WOLFE
Glendale, CA 91202

PATENT PROBLEMS

I'd pretty much agree with Don Lancaster's observations on patents ("Hardware Hacker," **Radio-Electronics**, October 1988), particularly that industry does not want inventions from outside, and that fewer than 1% of patents earn the cost of getting them.

In my younger (and hungrier) days I got patents for some people who hoped to sell them. They were enthusiastic; the inventions looked good. Then I went over the old files and listed (a) the patentees who were actually in the business of making and selling the stuff invented, and (b) those who just hoped to sell or license the patent to some forward-looking company. It turned out that there was not one single success in category (b). Not one.

Were I to advise someone with an invention—or what he thinks is an invention—it would go like this: First, if you aren't already in the business or preparing to go into it, forget it. Second, a preliminary search in the patent literature is a must.

LAWRENCE FLEMING
Registered Patent Agent
Pasadena, CA 91106

THE DANGERS OF RADIATION

Leslie P. McCarty's letter in the September 1988 issue accuses **Radio-Electronics** of "yellow journalism" concerning the health effects of radon and radiation. To support his contentions, he makes several or misleading statements.

Dr. McCarty's statement that there is a "negative correlation between the presence of radon and lung cancer" is at odds with multi-year epidemiologic studies of data from the U.S., Sweden, and Canada. In 1984 the National Council on Radiation Protection and Measurements estimated that among every one-million people exposed over a lifetime to a relatively low dose of radon, there would be an average of 130 lung-cancer deaths above those normally occurring. That risk estimate was recently raised by nearly a factor of three, to 350 additional lung-cancer deaths, following a 3-year study by the National Research Council of the National Academy of Sciences.

That new figure falls into the middle of the EPA-estimated range of 5,000 to 20,000 lung-cancer deaths per year linked to radon exposure—making radon the second leading cause of lung-cancer deaths after smoking. The study also found that the separate risks of lung cancer from radon and smoking are not additive, as some experts have believed. Radon exposure multiplies smokers' lung-cancer risk by at least a factor of ten.

Dr. McCarty also states that there is nothing to support the EPA-set action level for radon exposure of 4-picoCuries per liter (pCi/l), implying that the level has been set too low. Establishing environmental-exposure limits for even well-recognized public-health hazards can be very difficult. Estimates of the risk to the general population have been characterized through evaluations of lung-cancer mortality rates and radon-exposure data for uranium miners working in environments with typically high levels of radon gas.

In the above-mentioned study, risk estimates calculated by the National Research Council were referenced to a measurement called *Working Level Months* (WLM). A WLM exposure is based on a specific amount of alpha-particle energy per liter of air over a 170-hour work month. A person staying at home an average of 12 hours per day, and exposed to a radon level of 4 pCi/l, would receive about 0.5 WLM annual exposure. Rather than too low, that level may be too high. That study found that people exposed each year to radon levels at or slightly above the present EPA limit have a 50% greater risk of contracting lung cancer than people who are exposed only to the extremely low, normal levels of radon in outdoor air. Living with a 4-pCi/l level of radon is equivalent to smoking eight cigarettes a day, or undergoing 200 chest X-rays in a year.

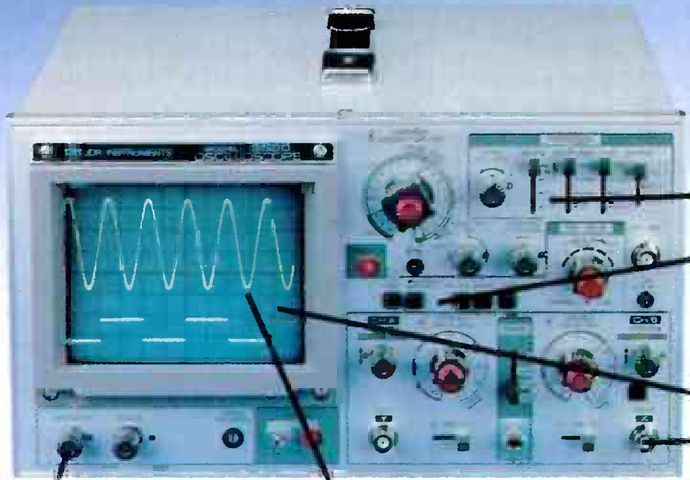
With respect to detecting radon with a Geiger counter, Dr. McCarty guesses "that alpha particles do not penetrate" the window of the Geiger-Mueller tube. Alpha particles are indeed characterized by shallow penetration depths. (The short penetration depth is associated with the higher linear-energy transfer of such particles as compared to X-rays and gamma rays, and reflects the generally more-damaging nature of particulate radiation.) However, a typical halogen-quenched Geiger-Mueller tube, having a thin mica end window (on the order of 1.4 milligrams per centimeter squared) is quite capable of detecting alpha particles down to 2.5 MeV directly. Detection sensitivity is generally greater than 80% at energies above 3.6 MeV. Radon decays predominantly through emission of particles at energies in excess of 5 MeV.

I also find it interesting that, after his comments concerning the detection of alpha particles, Dr. McCarty concedes that a "Geiger counter can measure some of the radon daughters." Of the six direct and indirect radioactive daughters of radon, four are predominantly alpha-particle emitters.

While I cannot personally judge the extent of Dr. John Gofman's objectivity, Dr. McCarty appears willing to accept a court statement that "Dr. Gofman's...conflict with all the world's radiation experts...destroys his credibility as an objective witness." I would tend to suspect any statement containing the phrase "all the world's...experts." The "experts" in radiation health risks not only have had difficulty estimating the exact national magnitude of indoor-radon pollution, but continue to debate risk assessments. Dr. McCarty apparently has his own bias in that area—as we all probably do.

JDR INSTRUMENTS™

Complete customer satisfaction... superior service... friendly, knowledgeable personnel... quality merchandise... providing the best values in leading edge technology.



35 MHZ OSCILLOSCOPE

A remarkable value

$499.95

Wide bandwidth and exceptional 1mV/DIV sensitivity make the Model 3500 a powerful diagnostic tool for engineers or technicians at a remarkable price. Delayed triggering allows any portion of a waveform to be isolated and expanded for closer inspection. Variable Holdoff allows stable viewing of complex waveforms.

DMM-300 $79.95

3.5 DIGIT DMM/MULTITESTER

This full function 3.5 digit DMM offers highly accurate performance and a host of added features like audible continuity, capacitance, transistor, temperature, and conductance to help you do the job—fast. Temperature probe, test leads and battery included.

- Basic DC accuracy: plus/minus 0.25%
- DC voltage: 200mv–1000V, 5 ranges
- AC voltage: 200mv–750V, 5 ranges
- Resistance: 200 ohms–20M ohms, 6 ranges
- Capacitance: 2000pf–20 µf, 3 ranges
- Transistor Tester: 0°–2000°F
- Conductance: 200ns
- Fully overload protected
- Input impedance: 10M ohm.

MODEL 2000 $389.95

20 MHz DUAL TRACE OSCILLOSCOPE

Model 2000 makes frequency calculation and phase measurement quick and easy. The component tester aids in fast troubleshooting. Service technicians appreciate the TV Sync circuits for viewing TV-V and TV-H and accurate synchronization of the video signal, Blanking, VITS, and V/H sync pulses.

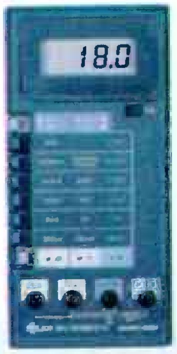
- Exceptionally bright 5" CRT
- Built-in component tester
- TV Sync filter
- X-Y operation *110/220 volts

DMM-100 $29.95

3.5 DIGIT POCKET SIZE DMM

Perfect for the field service technician. Shirt pocket size without compromising features or accuracy. Large, easy to read ½" LCD display. Fully overload protected for safety. 2000 hour battery life with standard 9v cell. Probes and battery included.

- Basic DC accuracy: plus/minus 0.5%
- DC voltage: 2v–1000v, 4 ranges
- AC voltage: 200v–750v, 2 ranges
- Resistance: 2k ohms–2M ohms, 4 ranges
- DC current: 2mA–2A, 4 ranges
- Input impedance: 10M ohm
- Fully overload protected
- Approx. 5" x 3" x 1". Under 7 ozs.



DMM-200 $49.95

3.5 DIGIT FULL FUNCTION DMM

Get highly accurate performance at a very affordable price. Rugged construction, 20 amp current capability and 22 ranges make it a perfect choice for serious field or bench work. Low battery indicator and tilt-stand. Probes and 2000 hour battery included.

- Basic DC accuracy: plus or minus 0.25%
- DC voltage: 200mv–1000V, 5 ranges
- AC voltage: 200mv–750V, 5 ranges
- Resistance: 200 ohms–20M ohms, 6 ranges
- AC/DC current: 200µA–20A, 6 ranges
- Input impedance: 10M ohm
- Fully overload protected
- Approx. 7" x 3½" x 1½". Wt. 11 ozs.

DPM-1000 $54.95

3.5 DIGIT PROBE TYPE DMM

Custom 80 pin LSI chip provides accuracy and reliability in such a compact size. Autoranging, audible continuity and data hold feature help you pinpoint the problem quickly. Case and batteries included.

- Basic DC accuracy: plus/minus 1%
- DC voltage: 2v–500v, autoranging
- AC voltage: 2v–500v, autoranging
- Resistance: 2k ohms–2M ohms, autoranging
- Fully overload protected
- Input impedance: 11M ohm
- Approx 6½" x 1" x ¾". Under 3 ozs.

★ **2 YEAR REPLACEMENT WARRANTY**
★ **30 DAY MONEY BACK GUARANTEE**
★ **TOLL FREE TECHNICAL SUPPORT**
★ **NEXT DAY AIR SHIP AVAILABLE**

MasterCard VISA

JDR INSTRUMENTS, 110 KNOWLES DRIVE, LOS GATOS, CA 95030
RETAIL STORE: 1256 SOUTH BASCOM AVE., SAN JOSE, CA (408) 947-8881

ORDER TOLL FREE 800-538-5000

CIRCLE 59 ON FREE INFORMATION CARD

I will agree that the *Journal of Health Physics* can probably consider the biological effects of ionizing radiation better than **Radio-Electronics** can. The public majority, however, does not subscribe to the former publication; that should not exclude them from the debate. Public exposures to radon far exceed those from the more widely reported Three Mile Island accident. I believe that the data supports the conclusion that radon is a significant health hazard, and long-term exposure should be viewed with some degree of alarm. Only an informed and educated public can rationally address health-risk problems of that nature. **Radio-Electronics** has not engaged in the cheaply sensational reporting of "yellow journalism"—nor has it strayed from what is "technically correct."
TIM M. SHARON, Ph.D.
El Toro, CA

CABLE-HUM CURE

In the August 1988 "Letters" column, Melvin Zion suggested a "cure"for cable-TV converter hum. I have used the same volume-adjustment solution, but I would consider it only a temporary "fix." I, and several of my friends, have experienced the problem of 60-Hz hum on various cable systems, and I have always been able to get rid of it.

My solution is to use two 75-to-300 ohm transformers connected back-to-back at the 300 ends. That seems to provide the isolation from the hum. Each of the transformers provides electrical isolation but allows the signal to be passed inductively, via the ferrite core. I use two transformers to ensure that the 75-ohm impedance is maintained.

I suppose that a single isolation transformer (with 1-to-1 windings) would be sufficient. I have not tried that, because one or two of the 75-to-300 variety are usually provided with devices to be used with cable.

For the electronics engineers in the crowd: I know that the use of transformers can cause other problems. However, I have only noticed the elimination of the 60-Hz hum when using that particular arrangement.
KIRK JOHNSON
Santa Clara, CA

ANTIQUE CAR-RADIO MEMORIES

In his "Antique Radios for Antique Autos" (**Radio-Electronics**, July 1988) Richard D. Fitch made no mention of Motorola.

I had a Radio-Operators First Class license, and I worked part-time for radio station WIBO in Chicago until they went off the air in June, 1933. I remember that in the early 1930's Motorola had a sales room and installation shop on Washington Blvd. in Chicago. They had a promotion deal whereby you could have a Motorola radio installed in your car for $125.00. If you sent them a customer, they gave you a $25.00 refund. If you referred five customers to have radios installed in their cars, your radio was free.
C.E. STEIL
Loveland, CO

Make good money in a challenging career as a security electronics technician—even start a profitable new business of your own

All-new from NRI!

Now NRI trains you to be today's expert security electronics technician as you install and troubleshoot state-of-the-art security systems in your own home and auto.

Violent crime, theft, fire. . .they're facts of life in the U.S. today. But now there's good news, too. All across the nation people are fighting back with high-tech electronic security systems. In fact, Americans will spend over 17 billion dollars on security services and equipment by the year 1991.

For you, this new consumer demand for electronic security systems means even more good news. It means a breakthrough opportunity to get in on the ground floor of a booming new industry. Now, no matter where you live, you can start a high-paying career—even a business of your own—installing, servicing, and maintaining residential and commercial security systems.

Best of all, NRI's ready now to give you the hands-on security electronics training you need to get started fast.

You train with and keep a closed-circuit television camera, mount, and 9" monitor; state-of-the-art fire/intrusion alarm control panel with digital dialer; remote entry keypad; passive infrared motion detector; smoke detector; remote control auto alarm with motion detector, ignition disable relay, and siren; NRI Discovery Lab® for circuit demonstrations; and hand-held multimeter with 3½ digit readout.

Right away, you get the skills you need to install and service all security systems

NRI's at-home Security Electronics training gives you solid electronics know-how, plus a complete working knowledge of popular security devices in use today.

You learn how to install and service magnetic contacts and pressure mats. . . microwave, ultrasonic, and passive infrared detectors. . . personal identification systems and electronic listening devices. . .even central station alarm systems and today's most sophisticated fire warning equipment. But that's not all.

Installing home security systems like this closed-circuit camera and monitor is just one way you can make money as a security electronics technician.

Your hands-on training includes state-of-the-art CCTV equipment plus home and auto electronic alarm systems you keep

NRI gives you hands-on experience with today's newest, most popular security systems as you train with the professional closed-circuit television surveillance equipment and high-quality electronic home and auto alarm systems included in your course.

Step by step, you learn by doing. . .evaluating your own security needs, installing complete electronic alarm systems in your own home and auto, testing and troubleshooting working alarm circuits. You actually safeguard your own property while gaining the expertise you need to move fast into an exciting career—even a business of your own—as today's expert security electronics technician.

Send for your FREE catalog today

For all the details about NRI's at-home Security Electronics training, send the coupon today. If the coupon is missing, write to NRI School of Electronics, McGraw-Hill Continuing Education Center, 4401 Connecticut Avenue, Washington, DC 20008.

NRI SCHOOL OF ELECTRONICS
McGraw-Hill Continuing Education Center
4401 Connecticut Avenue, Washington, DC 20008.

Check one catalog only

- ☐ **Security Electronics**
- ☐ Computers and Microprocessors
- ☐ Robotics
- ☐ TV/Video/Audio Servicing
- ☐ Basic Electronics
- ☐ Air Conditioning, Heating, and Refrigeration
- ☐ Electrician
- ☐ Small Engine Repair
- ☐ Automotive Servicing
- ☐ Locksmithing

Name__________ Age______

Address__________

City______ State______ Zip______

Accredited by the National Home Study Council   For career courses approved under GI Bill ☐ check for details.   3-029

EQUIPMENT REPORTS

American Reliance AR-6400P Cable Tester

Don't let cable problems slow you down.

CIRCLE 39 ON FREE INFORMATION CARD

HAVE YOU EVER SPENT HOURS TRYING to troubleshoot a computer interfacing problem only to find that a short between 2 pins in the 25-conductor cable was the cause? Are you involved with electronics manufacturing where cabling problems are a constant quality-control concern? We've recently examined a tool for technicians and manufacturers who routinely come up against cabling problems and who need a quick way to find and solve them: the *AR-6400P* cable tester from American Reliance, Inc. (9241 E. Valley Blvd., Rosemead, CA 91770).

The *AR-6400P* is a microprocessor-based instrument; it consists of a main unit with two 64-pin ports and an optional test fixture which is connected to the main unit by two 64-pin ribbon cables. The test fixture offers convenient access to the I/O ports of the tester. Various connectors can be attached to the test fixture to allow convenient testing of generic cable assemblies. The test jig comes equipped with various D-type and Centronics-type connectors, which you might expect to come across when servicing computers. It is possible to add other connectors to the test fixture, but we would assume that most users would want to make their own test jigs.

Cables can be tested for opens, shorts, and mis-wiring. Intermittent connections can be detected and latched as you squeeze and wiggle the cable. The integrity of the cable's insulation can also be verified.

Non-standard cables present no problems to the tester, as long as you have a good cable that the tester can learn from. To teach the

continued on page 24

Canon FAX-L920 Laser Facsimile

The future of facsimile is here today.

CIRCLE 40 ON FREE INFORMATION CARD

THE FACSIMILE REVOLUTION IS HERE, and it shows no signs of slowing down. Many radio stations across the country are now accepting music requests by fax, and local take-out restaurants accept lunch orders by fax. Fax is the fastest growing item in the fast-growing home office market. But don't expect the fax machines of tomorrow to be like the ones you're now familiar with. Expect them to be like the *FAX-L920* plain-paper laser facsimile from Canon U.S.A. (One Canon Plaza, Lake Success, NY 11042).

The *FAX-L920*, which consists of a main unit and a printer, doesn't look like a fax machine. In fact, we originally intended to show the machine on the cover of our November 1988 issue, which focused on fax technology. We thought the Canon machine would be a great choice because it was the most technically sophisticated fax we knew of. We eventually decided against using it on the cover because we didn't think that people would recognize it as a fax—the machine looks more like an office copier than a fax. (It is, incidentally, a full-featured laser copier, too.)

Advanced features

The *FAX-L920* features a 32-megabit memory that makes the machine's advanced features possible, including batch transmission, relay broadcast, confidential mailboxes, delayed transmission, and more.

Batch transmission is the ability to collect documents bound for any of up to 24 locations, and to send them at programmed times. In a real-life situation, a head office could collect, throughout the day, documents for its 24 salesmen stationed throughout the world. At pre-programmed times—which could correspond to the opening of each branch office—the documents would be sent to their destinations. In a high-volume operation, the savings in telephone costs could be dramatic.

Relay broadcast is a way of reaching hundreds of locations quickly and cheaply. An originating unit can be programmed to send a fax document to up to 151 relay units, each of which can be programmed to send them on to 150 additional locations. The main benefits are speed and, again, the ability to dramatically cut long-distance telephone costs. For example, a large corporation with several hundred stores nationwide could send a fax document to its regional offices. Each regional office could then relay the document to the stores in its area.

Confidential mailboxes can collect incoming documents and store them in memory. The contents of the mailboxes are printed only when the correct password is entered. Of course, only other Canon units can input data to the password-protected mailboxes. The confidentiality (or its lack) of faxed documents is an important issue that is only now beginning to be recognized.

A host of other convenient features are offered by the *FAX-L920*. For example, memory polling allows other Canon machines to request documents that have been stored in memory. Also, while the unit is receiving documents, you can still store documents in memory for transmission after reception is complete. Even running out of paper is less of a problem with the *FAX-L920*—up to 24 pages are automatically stored in memory until paper is supplied.

The fax features a flat-plate scanner, so sending images from books is not a problem. For paper documents, an automatic 50-sheet feeder is standard. The one thing missing from the *FAX-L920* is a computer interface. However, according to Canon, an RS-232 interface will be available in the future. When that becomes available, the fax will be able to work as a laser printer and a page scanner for the computer, as as well as a laser facsimile and copier.

Some of the unit's specifications are impressive. In a proprietary mode, a page can be sent to another Canon machine in about 12 seconds. In standard G3 mode, that increases to 18 seconds, and in a G2 mode things slow down considerably. Its scanning density is impressive as well. In its ultra-fine mode, the machine's horizontal resolution is 406 dots per inch, and its vertical resolution is 392 lines per inch. A halftone mode differentiates 16 shades of gray for reproducing photographs.

As you might expect, such advanced features and such impressive specifications do not come cheaply. The suggested retail price of the *FAX-L920* laser facsimile is $8395. **RE**

EQUIPMENTS REPORTS

continued from page 22

tester about a new cable, you must simply plug the good cable into the ports and press the READ key twice. The *AR-6400P* will then scan the cable's configuration, and store its characteristics in memory. When similar cables are tested, they are simply plugged into the ports. If the characteristics match, then PASS is displayed on the unit's LCD, and a two-tone beep is heard from the speaker. You can then wiggle and squeeze the cable to search for any intermittents. If one shows up, it will be latched, and the display will show BAD CONNECTION. The SHOW keys can be used to get an exact description of the pins presenting the problems on the LCD. Alternatively, the pin data can be output to a printer via the *AR-6400P*'s Centronics parallel printer port. To test another cable, the TEST key must be pressed. If any shorts or mis-wiring exist, the LCD will display ERROR. As before, the exact problem can be displayed on the LCD or output to a printer.

The cable tester features a STEP mode that allows it to memorize a sequence of up to 99 cable tests. That would be very useful to a manufacturer who wants to test all of the wiring harnesses of a piece of equipment before assembly. Each harness could be connected, in turn, to the tester; as long as they were tested in the proper order, the *AR-6400P* would know what configuration to expect. The STEP mode could also be used to test switching systems.

The *AR-6400P* features two additional modes, TOUCH and SEARCH, that can make a simple matter out of finding what's what in a rat's nest of wiring. Let's say, for example, that you have a cable with a connector on one end, but only wires on the other. You can plug the connector into the test fixture, and touch the bare wires with your hand. (You must be connected to the tester via a wrist strap.) The LCD will display the number of the pin you touched. The SEARCH mode is essentially the same. However, instead of relying on body conductance, a probe is used to touch the test points.

We liked the unit's two battery backups; one of which keeps the memory non-volatile for more than two weeks. A separate rechargeable battery acts as a uninterruptable power supply for the tester. We do have a couple of minor complaints. We'd like to see a backlight for the LCD, and we'd like to see a carrying handle on the unit even though it's really a little too heavy (almost 15 pounds) and big (about 14×12×5 inches) for field service. We'd also like to see a new, clearly written instruction manual.

All in all, we found the *AR-6400P* an easy-to-use special-purpose tool. In a manufacturing environment, the tester could be easily used by a non-skilled worker. A skilled technician could cut his troubleshooting time dramatically. In each case, the time saved and problems solved would quickly make up for the unit's $995 price.

The optional test fixture sells for $99.95. **R-E**

New Products

CIRCLE 10 ON FREE INFORMATION CARD

ELECTRONIC ORGANIZER. A recent survey conducted by *Sharp Electronics* revealed that 50 percent of business executives spend half their work time out of their offices, traveling or meeting with business associates or customers. To help them—and busy people in all walks of life—keep organized, Sharp has introduced the *Wizard*, a hand-held instrument that combines a personal computer, phone directory, calculator, appointment diary, calendar, and world clock in a 4 × 6-inch unit weighing only 8 ounces. Information can be transferred between two Wizard units, and bi-directionally between the Wizard and a PC. It also connects to a printer to produce hard-copy documents.

The unit (model *OZ-7000*) is menu-driven and user-friendly, requiring virtually no computer or programming knowledge. The Wizard has raised keypads, separate alpha and numeric keys, and a 16 × 8-line LCD display. A software card enhances the command keypad and allows the user to access the Wizard's seven built-in capabilities at a glance. Other integrated-circuit software cards—a time-management system, thesaurus/dictionary, and 8-language translator at present, with more planned for the future—are available as options. The addition of those cards will increase the Wizard's 32K RAM memory up to 96K.

The seven built-in functions include the calendar mode that features daily and weekly display, with 200-year capability; the schedule mode that allows the user to insert names, notes, and comments for each appointment; the telephone mode that permits customized storage and retrieval of entries by name, company, phone/fax number, and address; and world/local mode that tells the time in over 200 cities. Up to 16 pages of typed information can be stored in the Wizard's memo mode. As a calculator, the *OZ-7000* offers 10-digit ciphering with 3-key memory and can function as a paperless printer for up to 50 entries. For confidentiality, the secret mode prevents unauthorized access to password-protected information. All of those built-in OZ-7000 functions can be edited and updated continuously.

The Wizard has a suggested retail price of $299.—**Sharp Electronics Corporation**, Personal Home Office Electronics Division, Sharp Plaza, Mahwah, NJ 07430.

WIRE STRIPPERS. *Paladin's PA-1101 Maxi-Stripax* simplifies the stripping and cutting of 10- to 22-gauge wire. Its increased-leverage design and cam system reduce hand-pressure requirements by up to 30% and allow the tool to strip up to eight conductors simultaneously. The *PA-1101* also features a built-in wire stop, insulation to 600 volts, front feed for close-in work, and a built-in wire cutter to speed your work.

The tool is designed to cut flexible and solid PVC, and hard PVC insulation, as well as 10- to 12-gauge wire. When used for multi-core ribbon cables, several conductors can be stripped in one operation. Double-insulated or fiber-optic cable can be stripped in two operations with no adjustment.

The lightweight, but rugged, fiberglass-reinforced *PA-1101* has 66

CIRCLE 11 ON FREE INFORMATION CARD

stainless-steel stripping blades that are rated for a service life of 200,000 strips. Those blades will not cut or nick the internal wire while stripping.

The *PA-1101 Maxi-Stripax*, with cleaning brush, has a suggested list price of $52.95.—**Paladin Corporation**, 3543 Old Conejo Road, Suite 102, Newbury Park, CA 91320.

MENU-DRIVEN MULTIMETER.

Simpson's Model 560 menu-driven multimeter was designed for serious engineers and designers in audio, communications, and computer, as well as industrial-control fields. All of the unit's features and capabilities are accessible through front-panel, menu-driven programming.

The *Model 560* features very fast auto-ranging, a 500-kHz frequency counter, relative readings, and continuity and diode checks with audible beeper. Centronics-printer or RS-232 interfaces are available. The unit has data-logging capability on any selected range with 2,150-measurement memory and battery back-up. The dual-LCD format has a 5-digit, 52-segment measurement display and a 4-line menu/programming display.

The unit's functions include DC volts, true-RMS AC, or AC-plus-DC coupled volts, low and high power resistance; DC, and true-RMS AC or AC-plus-DC coupled amps; 5-Hz to 500-kHz frequency; dBm on any voltage range; diode and continuity tests; differential-peak hold; Rel; and Zero.

The available Centronics-compatible printer port is fully isolated for 8-bit data with strobe and busy. The isolated RS-232C serial port offers 300- to 9600-baud rates. Non-volatile RAM, with battery back-up, retains the last user selections and readings.

The *Model 560* menu-driven multimeter, including operator's manual, test-lead kit, and calibration certificate, costs $2,195.00 with RS-232C interface, and $2,395.00 with Centronics inter-

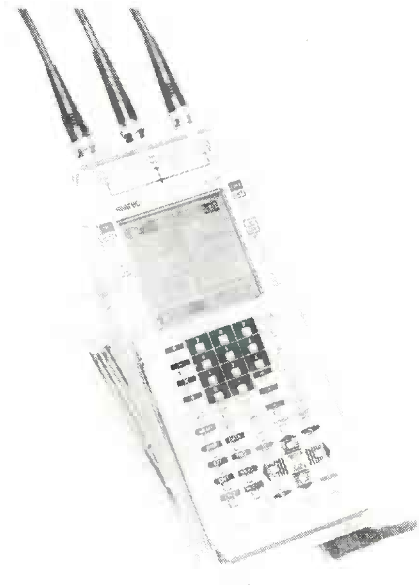
CIRCLE 12 ON FREE INFORMATION CARD

face.—**Simpson Electric Company**, 853 Dundee Avenue, Elgin, IL 60120.

PORTABLE OSCILLOSCOPE. *Createc's SCOUT SC-02* is a complete analog-to-digital, digital-to-analog measurement system. Surface-mount production technology allows benchtop features to be packed into a durable 25-ounce, handheld package that functions as an oscilloscope, a digital multimeter, a frequency counter, and a signal computer.

The oscilloscope's two independent 20-MHz digital-to-analog converters permit full-speed and parallel capture of periodic or single-shot waveforms. The *SCOUT SC-02* presents time, voltage ranges, cursor measurements, and trigger positions on the waveform display. It has 46 storage memories for storing and recalling waveforms and all related data. Other features include dual-timebase viewing, precise trigger placement, and an additional 10 complete setup memories. One saves the current set of setup parameters when the unit is shut off; the other nine are fully user-programmable.

As a multimeter, the *SCOUT SC-02* measures true-RMS voltages to 1 MHz with full-range accuracy of 1% or better. It also measures the DC-component, zero-to-peak, and peak-to-peak values. The unit can be fully DC-compensated for DC-voltage measurements of better than 0.5% accuracy. It displays accuracy figures, along with the associated measurement values that are calculated independent of the temperature of voltage-range setting, using a zener reference and the D-to-A feedback system. The voltage-range setting and a small, oscilloscope-type display of the waveform are also displayed; those features allow the user to view and measure a variety of waveforms without switching between the multimeter display and the oscilloscope.



CIRCLE 13 ON FREE INFORMATION CARD

When used as a frequency counter, the *SCOUT SC-02* performs time-period and fully autoranging frequency-setting measurements from DC to 7 MHz, with a typical accuracy of better than 0.5%. Frequency and time measurements, with associated accuracy figures, are displayed in the multimeter mode.

The signal computer tracks all incoming waveforms and automatically adjusts the timebase, trigger, trace, and cursor positions. It provides sophisticated past-processing and analysis functions on captured data. In addition, the signal computer constantly calibrates the system for changes caused by age and temperature drift of the components. For volume users with special requirements, the *SCOUT SC-02* can be custom programmed by the manufacturer.

The *SCOUT SC-02* costs $2,995.00.—**Createc Signal Computer**, 3337 Kifer Road, Santa Clara, CA 95051.

SYNTHESIZERS GENERATORS. *Philip's* series of synthesizers/function generators, combining full-GPIB programmability with high resolution and a wide choice of functions, consists of the Models *PM 5191 SM*, *PM 5192 SM*, and *PM 5193 SM*, and the *PM 5193 VM* that provides an additional video-modulation facility.

The series is designed for use in applications where two or more instruments, such as generators and counters, must be synchronized. The function generators can be synchronized at 10 MHz or any sub-harmonics of that frequency (i.e., 1 MHz, 2 MHz, 5 MHz), allowing a complete setup of different instruments to be synchronized

EXPAND YOUR CAREER HORIZONS...

The CIE Microprocessor Trainer helps you to learn how circuits with microprocessors function in computers.

START WITH CIE.

Microprocessor Technology. Satellite Communications. Robotics. Wherever you want to go in electronics... start first with CIE.

Why CIE? Because we're the leader in teaching electronics through independent study. Consider this. We teach over 25,000 students from all over the United States and in over 70 foreign countries. And we've been doing it for over 50 years, helping thousands of men and women get started in electronics careers.

We offer flexible training to meet your needs. You can start at the beginner level or, if you already know something about electronics, you may want to start at a higher level. But wherever you start, you can go as far as you like. You can even earn your Associate in Applied Science Degree in Electronics.

Let us get you started today. Just call toll-free **1-800-321-2155** (in Ohio, 1-800-362-2105) or mail in the handy reply coupon or card below to:
Cleveland Institute of Electronics,
1776 East 17th Street, Cleveland, Ohio 44114.

CIRCLE 60 ON FREE INFORMATION CARD

ARE-112

CIE World Headquarters

Cleveland Institute of Electronics, Inc.
1776 East 17th Street • Cleveland, Ohio 44114

☐ Please send your independent study catalog.
For your convenience, CIE will try to have a representative contact you — there is no obligation.

Print Name ______________________________

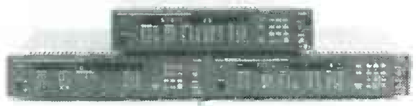
Address ______________________________ Apt. __________

City ____________________ State __________ Zip __________

Age __________ Area Code/Phone No. ______________________

Check box for G.I. Bill bulletin on Educational Benefits
☐ Veteran ☐ Active Duty **MAIL TODAY!**

Just call toll-free **1-800-321-2155** (in Ohio, 1-800-362-2105) with a single central clock. In addition to all standard-bus functions, all four models support bus-learn mode and can transmit status and setting information to the controller at any time; the units are thus suitable for flexible, bus-based automatic-test systems.



CIRCLE 14 ON FREE INFORMATION CARD

The *PM 5193 SM* is a 50-MHz unit with 20-volt peak-to-peak output. It offers crystal-controlled frequency, 8-digit resolution, and comprehensive modulation facilities. Eight waveforms are available: Sine wave, square wave, negative and positive sawtooth, haversine, triangle, and positive and negative pulse. The modulation modes—AM, FM, sweep, burst, and gating—can be controlled internally or by an external signal source. Voltage can be set in peak-to-peak, RMS, or dBm.

The *PM 5191 SM*—a 2-MHz instrument with 30-volt peak-to-peak output—and the *PM 5192 SM*—with a 0.1-mHz to 20-MHz range and 20-volt peak-to-peak output—both feature high-output accuracy and repeatability. Five waveforms are standard on both models: Sine wave, square wave, triangle, and positive and negative ramps. The output voltage on both can be set in RMS, peak-to-peak, or dBm. The *PM 5191 SM* provides AM modulation; the *PM 5192 SM* offers AM/FM/gating modulation and full sweep facilities.

The *PM 5193 VM* synthesizer/function generator adds video modulation to the wide range of standard facilities of the *PM 5193 SM*. The former's video-modulation mode replaces the AM-external mode of the latter. In the video mode, the carrier frequency can be adjusted up to 50 MHz, with high accuracy and an 8-digit maximum resolution.

Suggested list prices are $3,695.00 for the *PM 5191 SM*, $4,295.00 for the *PM 5192 SM*, $4,895.00 for the *PM 5193 SM*, and $5,895.00 for the *PM 5193 VM*.—**John Fluke Mfg. Co., Inc.**, P.O. Box C-9090, Everett, WA 98206; phone 800-443-5853, ext. 77.

DIGITAL AUDIO TAPE PLAYER. *Mitsubishi's DT 10*—one of the first car DAT players to hit the American market—delivers the remarkable sound reproduction of digital audio for car audio systems. Its chassis is designed for easy installation in American, Japanese, and European cars, and an auxiliary radio/tape input switch permits the use of an RCA-type preamp output radio with the DAT player.

The *DT 10's* advanced full-logic tape transport has extremely fast track-to-track scanning and rewind time (it is much faster than a regular cassette deck). Its dynamic range is rated at 85 dB, and signal-to-noise ratio is 90 dB with a frequency response of 20 to 20,000 Hz. The unit also features a moisture-protection circuit, with temperature sensor and automatic heater, that extends tape life and maximizes tape-player perfor-

CIRCLE 15 ON FREE INFORMATION CARD

mance by preventing condensation build-up on the internal components.

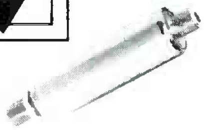
Other features include program skip, sequential program scan, four repeat modes (one-program, all-program, non-repeat, and selected program), tape-in indicator, automatic power off, and a large, multi-function LCD display. *DT 10* dealers also offer a fairly decent selection of European digital-audio tapes—including jazz, classical, and pop formats—supplied by Delta Music Inc./Capriccio (Los Angeles, CA).

The *DT 10* DAT player has a suggested retail price of $1650.00.—**Mitsubishi Electric Sales of America Inc.**, Mobile Electronics Division, 800 Biermann Court, Mt. Prospect, IL 60056-2173. **R-E**

Cable Checklist

ENJOY CABLE TV MORE THAN EVER

SNOOPER STOPPER/DATA BLOCKER $39.95



- Prevent cable companies from spying on you to see how many cable converters you have
- Removes beeping sound from your FM when radio is connected to cable TV
- Cable TV descramblers are being sold by the thousands, but few people know descramblers can be detected on most addressable systems

Maintain your privacy with a Snooper Stopper. For more detailed information, send $2.00 for our "Cable TV Snooper Stopper" article.

MACROVISION...NOW YOU SEE IT, NOW YOU DON'T

MS1-KIT $29.95

Includes all the parts, pc board, AC adaptor, and instructions from a published construction article in *Radio Electronics* magazine.

- Remove copy-protection from video cassettes
- Digital filter type; removes only Macrovision pulses

JMAK-4 BLACK BOX $14.95

Original box as shown in ad with two feet and four holes to mount pc board.

- No adjustments; crystal controlled
- Compatible with all VCRs
- Uses automatic vertical blanking level
- Assembles in less than three hours

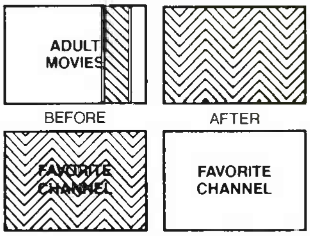
SIGNAL ELIMINATOR $29.95

- Works on cable or broadcast TV
- External adjustments allow precise tuning to any frequency

#23H-Tuneable to ch. 2 & 3 (50-66 Mhz) also 6 meter HAM TVI interference filter
#46FM-Tuneable to ch. 4-6 (66-108 Mhz & FM Band)
#713-Tuneable to ch. 7-13 (174-216 Mhz)
#1417-Tuneable to ch. 14-17 [A-D] (120-144 Mhz)
#1822-Tuneable to ch. 18-22 [E-J] (144-174 Mhz)

ELIMINATE a Channel that you find unsuitable for family viewing, but is poorly scrambled by your cable company. **OR**

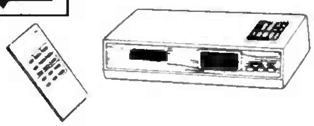
CLEAR UP a Channel that presently contains severe interference by ELIMINATING whatever signal is causing this.



Note: If picture and sound are equally affected, this IS interference and CAN be removed by our product.
If only picture is affected, this usually IS NOT interference and CANNOT be removed by our product.

72 Channel

CABLE CONVERTER with Infra-Red Remote .... MC-702 Converter $79.95



- Microprocessor controlled PLL operation
- Skip channel memory eliminates unused channels
- Parental control for all channels
- Compatible with all *external* descramblers
- Last channel recall
- Fine tune memory
- UL listed/FCC approved
- Simple installation with any TV
- Includes battery and 3 foot coax
- Channel output 2 or 3 switchable

Add $3.50 shipping & handling
$9.50 Canadian orders

ORDER TOLL FREE ANYTIME
1-800-227-8529

Inside MA: 508-695-8699 Fax: 508-695-9694
Ask for additional free information
Add $3.00 shipping & handling on all orders unless otherwise noted. $6.00 Canadian orders.
Visa, MasterCard, or C.O.D.

MEMBER DIRECT MARKETING ASSOCIATION

J & W ELECTRONICS, INC.
P.O. BOX 800 • MANSFIELD, MA 02048

CIRCLE 65 ON FREE INFORMATION CARD

HIGH DEFINITION TELE-VISION

The many ways of HDTV

LEN FELDMAN

AT LAST COUNT THERE WERE NEARLY 20 separate and distinct proposals for high-definition television systems. They generally fall into three major categories: fully compatible, semi- or backward-compatible, and those not compatible.

There are systems that are fully compatible with our presently used NTSC TV standards. Such systems display a conventional picture when tuned to on an older television receiver. Tuned to on receivers of the future, such systems would, generally speaking, offer increased resolution or picture detail as well as a new, preferred aspect ratio of either 5:3 or 16:9. Present NTSC picture displays have an aspect ratio of 4:3. That explains why many wide-screen motion pictures, when broadcast by TV stations, often have the edges of the picture cut off, forcing motion picture producers to concentrate the major action of their stories towards the center of the screen. Those systems that claim full compatibility with NTSC require no additional bandwidth or spectrum space, beyond the 6 MHz presently assigned to over-the-air-broadcast TV stations.

A second category of high-definition television systems might well be described as semi-compatible or "backwards compatible." Such systems will deliver a standard NTSC picture for those owners who tune in with older NTSC sets. Transmission of those types of HDTV signals, however, would require additional bandwidth beyond the standard 6 MHz—anywhere from 8 MHz to 12 MHz, which is two full channel widths. As was true of the first category, the benefits of such semi-compatible systems will only be realized by owners of new sets designed specifically for those systems.

The drastic difference in size and clarity between an NTSC TV's picture (inset) and the HDTV picture surrounding it, spells the demise of the aged NTSC format.

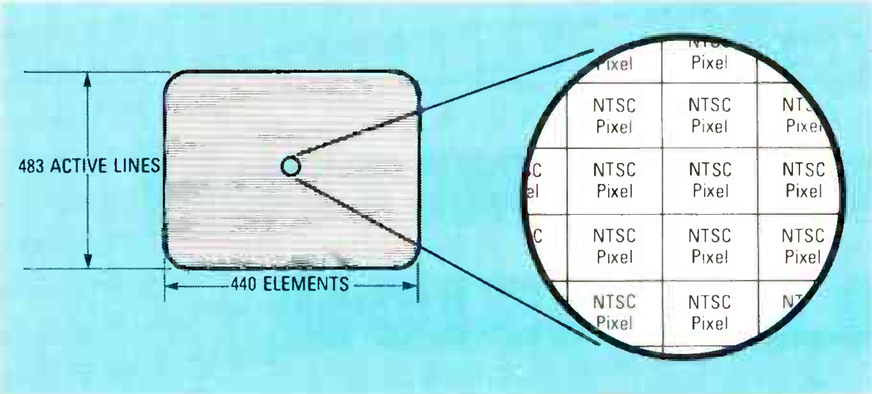


FIG. 1—THE NTSC PIXEL is represented as a rectangle of 1.46:1 ratio, corresponding to the present 4:3 NTSC aspect ratio.

The third category of the HDTV system is one that can be best categorized as the "no compromise" approach. That is, systems in this category are totally incompatible with the existing NTSC system used in this country. Generally speaking, these systems require extended bandwidth, but provide the greatest number of scan lines (1050 or 1125) and the greatest picture detail, both horizontally and vertically.

Any attempt to describe fully all of the proposed systems in all three categories would require more pages than are in this entire magazine. To give you some idea of the complexity and diversity of the ongoing HDTV debate, we will instead describe, briefly, one or two systems in each category.

HD-NTSC

An interesting and fully compatible system for a new high-definition NTSC broadcast system was proposed more than two years ago the The Del Rey Group, of Southern California. The system, dubbed HD-NTSC, can best be understood by regarding the smallest resolvable area of the NTSC picture as a "pixel," much as that term is used in referring to computer-screen resolution. In Fig. 1, the NTSC pixel is represented as a rectangle of 1.46:1 ratio, corresponding to the present 4:3 NTSC aspect ratio. A pixel, however, does not have to be rectangular or square in shape. It could be triangular, or even diamond shaped as shown in Fig. 2. One way to increase the number of addressable points of an image (and therefore the image detail) is to subdivide the pixels into smaller units, which might be called sub-pixels, as shown in Fig. 3.

Now, suppose a TV camera is able to scan only sub-pixel 1 during its first pass. After completing that frame 1/30 th of a second later, the camera scans again, this time hitting only sub-pixel-2 areas, and finally sub-pixel-3 areas. That approach is called a "Tri-Scan" technique. At the receiving end, a conventional NTSC receiver would not be aware of "sub-pixels" and would simply paint areas 1, 2 and 3 on top of each other as they come across in successive frames. A new, specially designed HD-NTSC TV set would reconstruct the same, higher detail image seen by the camera, placing the sub-pixels in their correct offset positions on the CRT. To change the aspect ratio, The Del Rey Group would simply "chop off" a few lines at the top and bottom of the existing NTSC line format, as illustrated in the comparison of Fig. 4. That arrangement would result in an aspect ratio of 14:9, as opposed to the present 4:3. As a side benefit, the HD-NTSC system creates 69 horizontal lines per frame that are no longer needed for the transmission of picture information. That new "data window" might well be made available for other information, such as encoded stereo digital audio!

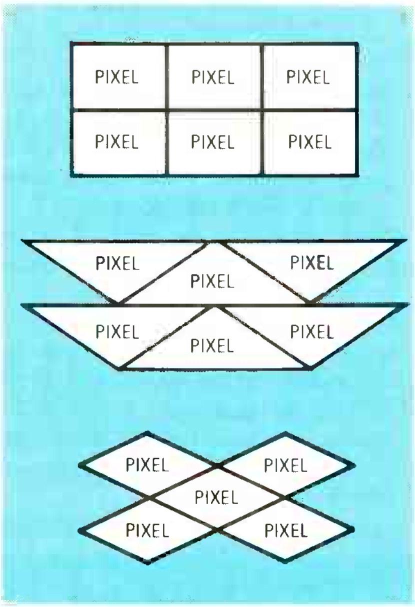


FIG. 2—A PIXEL does not have to be rectangular or square in shape. It could be triangular, or even diamond shaped.

ACTV

Originally introduced through the joint efforts by RCA, NBC, GE, and The David Sarnoff Research Center, ACTV was another system that was fully compatible with NTSC, in that it required only a single 6-MHz channel width for its implementation. Since then, the system has been divided into two systems, ACTV-1 (the original 6-MHz wide channel proposal) and ACTV-2, a system that remains compatible with NTSC but requires two full 6-MHz channels of bandwidth for its implementation. Here is how ACTV works: An original wide-

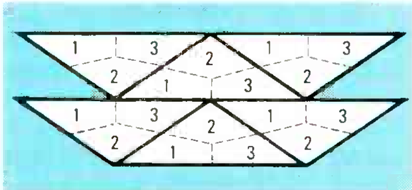


FIG. 3—ONE WAY TO INCREASE the number of addressable points of an image is to subdivide the pixels into smaller units, which might be called sub-pixels.

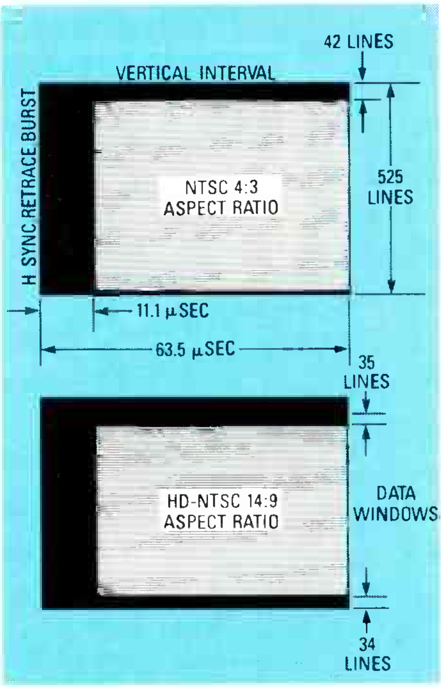


FIG. 4—TO CHANGE THE ASPECT RATIO, The Del Rey Group would chop off a few lines at the top and bottom of the existing NTSC line format.

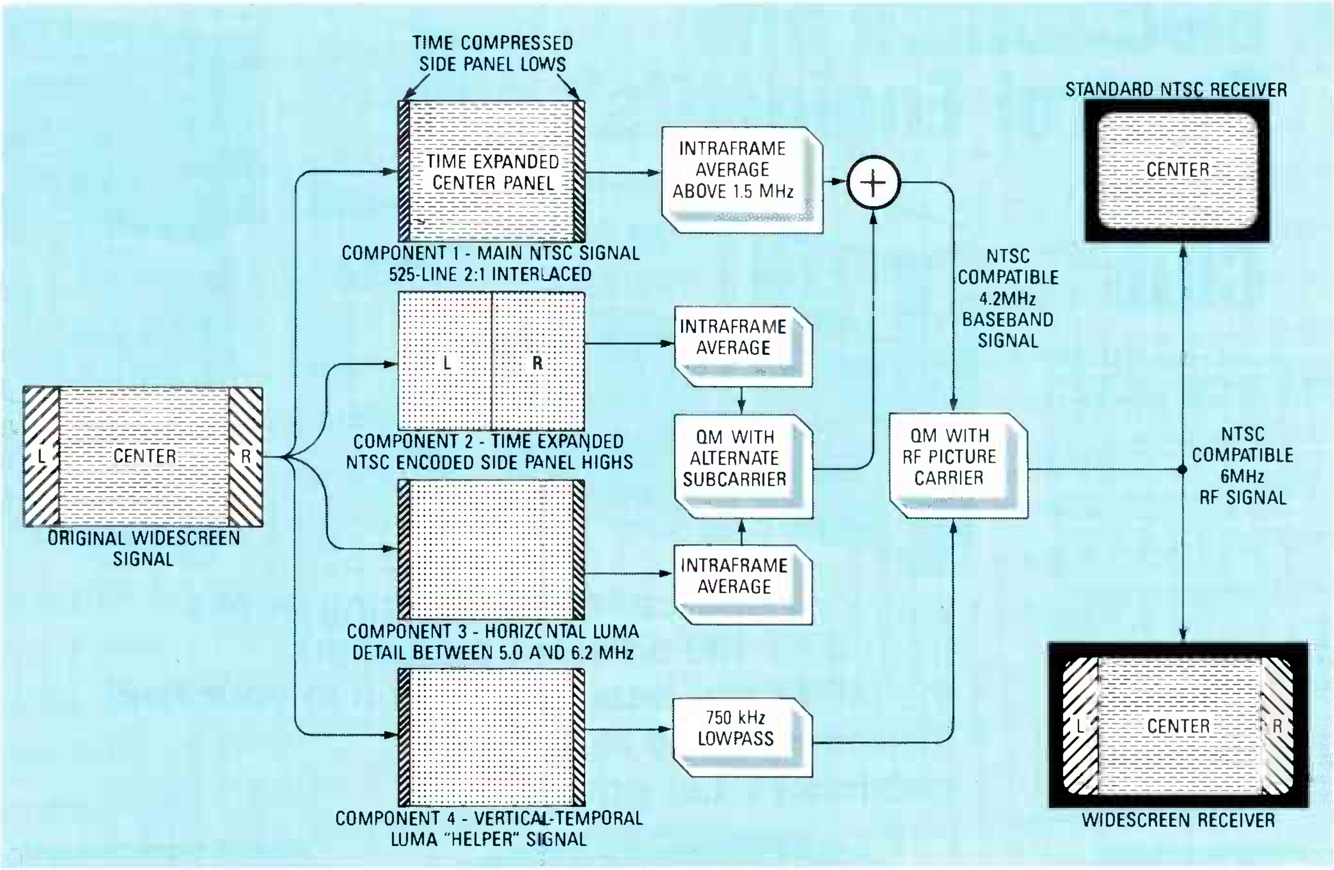


FIG. 5—THIS IS HOW ACTV WORKS: An original wide-screen signal is digitized and encoded into the four components shown.

screen signal, provided from any high-definition source, is first digitized at the studio and encoded into the four components shown in Fig. 5.

1: The first component is a main, NTSC-compatible, interlaced signal with the usual 4:3 aspect ratio. It consists of the central portion of the picture that has been time-expanded to nearly the entire active line time plus the side panel low-frequency horizontal information that has been time compressed into left and right horizontal overscan regions, where they would be hidden from view on most standard home receivers. This signal is color encoded in standard NTSC format.

2: There is an auxiliary 2:1 interlaced signal consisting of side panel high-frequency horizontal information that has been pre-comb-filtered, NTSC encoded, and time expanded to half the active line time. The time expansion reduces the horizontal bandwidth of this component to a little over 1 MHz.

3: The third component is an auxiliary 2:1 interlaced signal consisting of horizontal luminance detail between approximately 5.0 and 6.2 MHz. This band of frequencies is first

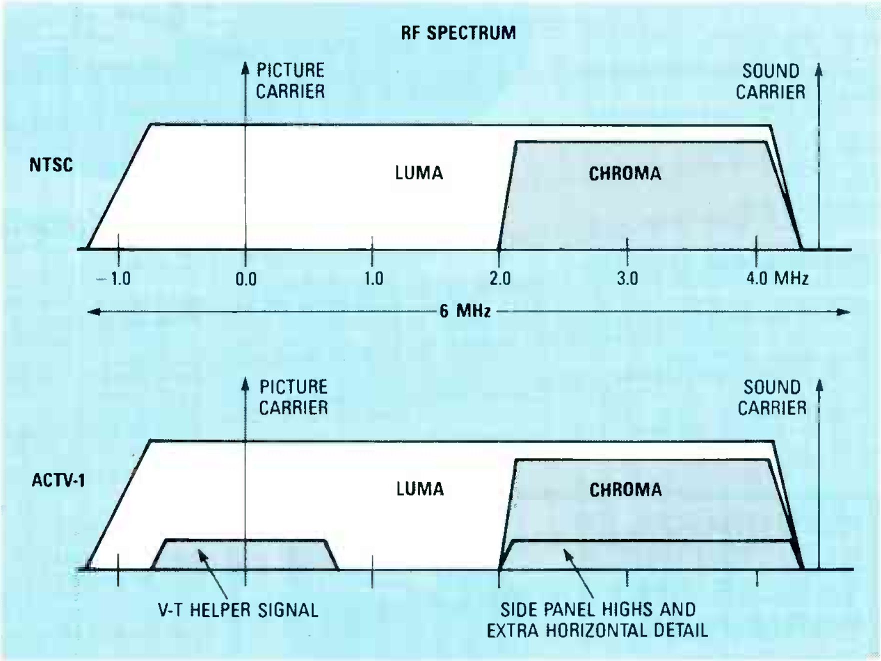
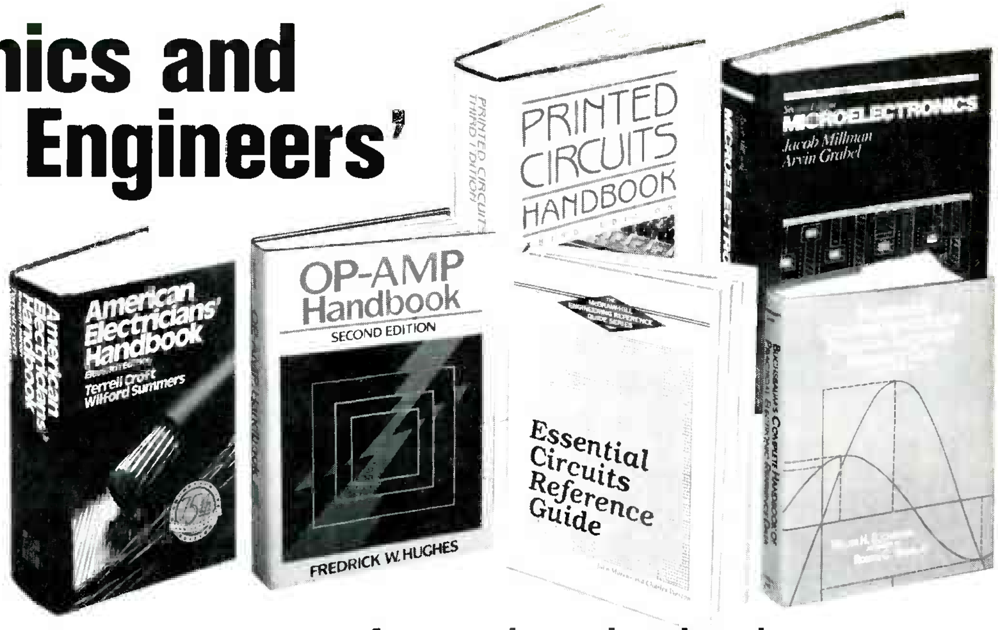


FIG. 6—A 4.2-MHz BASEBAND SIGNAL is RF modulated into a standard 6-MHz NTSC channel.

shifted downward to the range of from 0 to 1.2 MHz.

4: The fourth and last component is an auxiliary 2:1 interlaced "helper" signal, consisting of vertical-temporal (V-T) luminance detail that would otherwise be lost in the down conversion to 525-line interlace. On new, wide-screen receivers, this signal helps to reconstruct missing lines and to reduce or eliminate line flicker artifacts.

Join the **Electronics and Control Engineers' Book Club®**



- your one source for engineering books from over 100 different publishers
- the latest and best information in your field
- discounts of up to 40% off publishers' list prices

New Members!
Take any one of these great professional books for only **$2.89** as a premium with your first selection!

Spectacular values up to **$99.90**

BUCHSBAUM'S COMPLETE HANDBOOK OF PRACTICAL ELECTRONIC REFERENCE DATA, Third Ed. *By* W.H. Buchsbaum, revised by R.C. Genn, Jr. 635 *pp.*, 357 *illus.* & tables. This best-selling reference is invaluable for engineers whose work involves going outside their own area of expertise. Coverage includes digital logic; optoelectronics; antennas and transmission lines; RF and microwave fundamentals; communications systems; television systems; computers; radio; recording; and more.
583880-X Pub. Pr., $34.95 Club Pr., $26.50

PRINTED CIRCUITS HANDBOOK, Third Edition. *By* C.F. Coombs, Jr. *960 pp., 556 illus.* Here in one handy volume is all the information you need to design, manufacture, test, and repair printed wiring boards and assemblies. This new edition features ten all-new chapters, including three on SMT.
126/097 Pub. Pr., $59.50 Club Pr., $45.50

32-BIT MICROPROCESSORS. *Edited by* H. J. Mitchell. 248 *pp.*, 104 *illus.* and tables. A complete survey of the architecture, operation, and applications of today's most important new devices from AT&T, Inmos, Intel, and Motorola.
425/85X Pub. Pr., $45.00 Club Pr., $35.00

MICROWAVE AMPLIFIERS AND OSCILLATORS. *By* C. Gentili. 150 *pp.*, 79 *illus.* A thorough, practical introduction to the theory and design of microwave amplifiers and oscillators, with coverage of the scattering matrix, the gallium arsenide field-effect transistor, and microstrip technology.
229/953 Pub. Pr., $34.95 Club Pr., $27.95

COMMUNICATIONS RECEIVERS: Principles and Design. *By* Ulrich L. Rohde *and* T.T.N. Bucher. *608 pp., 402 illus.* Everything you need to know if you design or work with communications receivers, from theory to practical design approaches. Coverage includes all types of receivers: shortwave, broadcast, radar, military, marine, aeronautical, and more.
535/701 Pub. Pr., $59.50 Club Pr., $44.50

ENGINEERING FUNDAMENTALS FOR THE PROFESSIONAL ENGINEERS' EXAM, Third Ed. *By* L. M. Polentz. 432 *pp.*, 170 *illus.* Features worked-out solutions and full explanations for all sample problems so you can learn how to solve them. It's a dependable way to prepare for the exam or a perfect on-the-job reference.
503/931 Pub. Pr., $36.50 Club Pr., $27.95

AUTOMATIC CONTROL SYSTEMS, Fifth Ed. *By* B. C. Kuo. *736 pp., illus.* Provides an overview of automatic control systems, including in-depth coverage of classical control techniques, optimal control theory, and analog and digital control system design. This updated edition discusses the latest ideas on the use of computers to design control systems and as components of such systems.
583706-4 Pub. Pr., $51.00 Club Pr., $36.95

OP-AMP HANDBOOK, Second Ed. *By* F. W. Hughes. *320 pp., 231 illus.* Organized for on-the-job reference, this handbook covers all facets of op-amps, from stability and protection to signal processing using op-amps. Includes a collection of over 60 practical circuits for a variety of applications, procedures, and experiments.
583651-3 Pub. Pr., $39.00 Club Pr., $27.50

HANDBOOK FOR SOUND ENGINEERS: The New Audio Cyclopedia. *Edited by* G. Ballou. 1,247 *pp.*, over 1,200 *illus.* This giant handbook gives you truly comprehensive coverage of sound—and the methods of producing, reproducing, controlling, changing, reinforcing, and measuring it.
583913-X Pub. Pr., $79.95 Club Pr., $55.95

ESSENTIAL CIRCUITS REFERENCE GUIDE. *By* J. Markus & C. Weston. 528 *pp., illus.* Collects into one convenient volume more than 1,000 ready-to-use circuit diagrams for today's electronics applications. Now you can have the circuit you need in a matter of seconds—without having to reinvent the wheel.
404/623 Pub. Pr., $59.50 Club Pr., $47.50

CIRCUIT DESIGN FOR ELECTRONIC INSTRUMENTATION: Analog and Digital Devices from Sensor to Display, Second Ed. *By* D. Wobschall. 400 *pp.*, 365 *illus.* Brings you the entire process of circuit design in a comprehensive, easy-to-follow format. This new edition reflects the latest in IC technology, including CMOS and ECL devices.
712/31X Pub. Pr., $49.50 Club Pr., $36.95

AMERICAN ELECTRICIANS' HANDBOOK, Eleventh Ed. *By* T. Croft *and* W. Summers. 1,824 *pp.*, 1,560 *illus.* This newly updated handbook shows you how to select, install, maintain, and operate all the latest electrical equipment and wiring. It includes the most recent code requirements, basic formulas, and a wealth of circuit diagrams and illustrations.
139/326 Pub. Pr., $64.50 Club Pr., $49.50

MICROELECTRONICS, Second Ed. *By* J. Millman and A. Grabel. 1,001 *pp.*, 646 *illus.* Takes you from the basics of semiconductor properties to an understanding of the operation of solid-state devices, and then to more advanced topics. Its up-to-date coverage, real-life examples, and practical data make this an ideal reference for the working engineer.
423/30X Pub. Pr., $51.95 Club Pr., $41.50

ENGINEERING MATHEMATICS HANDBOOK, Third Ed. *By* J. J. Tuma. 512 *pp.*, *illus.* This best-selling handbook gives you the essential mathematical tools-formulas, definitions, theorems, tables, and models for computer programming — that you need for your day-to-day engineering calculations.
654/433 Pub. Pr., $46.50 Club Pr., $34.50

HANDBOOK OF ELECTRONICS TABLES AND FORMULAS
Sixth Edition

256 pages, illustrated. 583804-4

Up-to-date mathematical tables and electronic formulas in a convenient desk reference that you'll find indispensable. Included are basic formulas, constants, government/industry standards, symbols and codes, service data, and more. The handbook also has new sections describing how to do your calculations on a computer, and complete computer programs.

A $19.95 Value — Yours ABSOLUTELY FREE when you join!

BASIC TELEVISION AND VIDEO SYSTEMS, Fifth Ed. *By* B. Grob. 592 *pp., illus.* Provides the clearest picture of how television and video systems work, and what to do when they don't. Covers television receivers, VCR's, video cameras, and cable systems—all in readable, practical detail.
249/334 Pub. Pr., $34.95 Club Pr., $24.95

ANALOG ELECTRONIC CIRCUITS. *By* G. M. Glasford. 480 *pp.*, 350 *illus.* Gives you the detailed information and equations you need to create and analyze top quality circuit designs or effectively utilize the designs of others.
583768-4 Pub. Pr., $55.00 Club Pr., $39.50

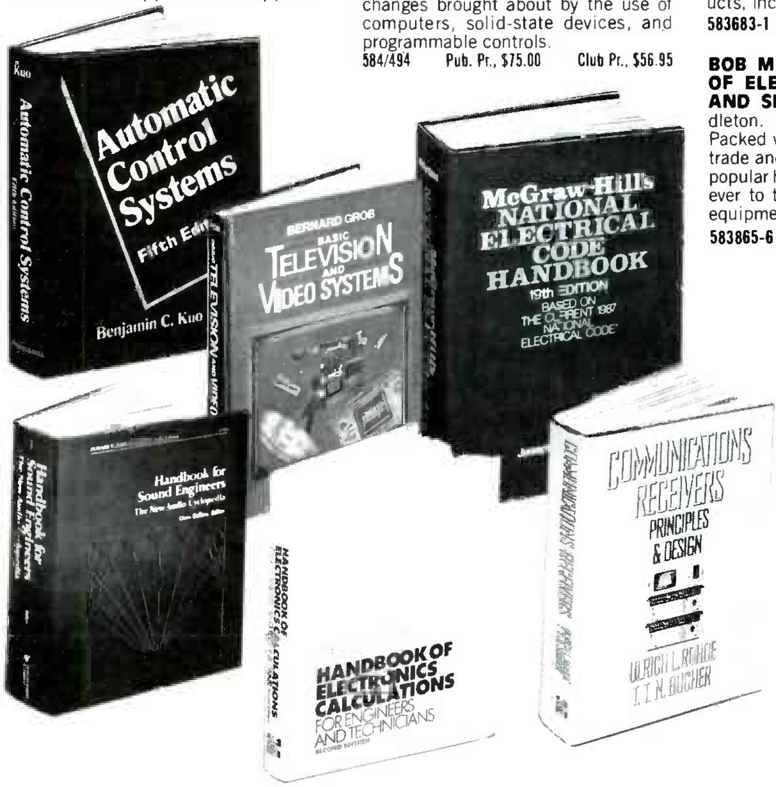
HANDBOOK OF ELECTRONIC NOISE MEASUREMENT AND TECHNOLOGY, Second Ed. *By* C. A. Vergers. 440 *pp.*, 213 *illus.* Provides answers to all your questions about noise origins, causes, effects. Also shows you how to predict and measure noise, and how to design low-noise circuits.
583947-4 Pub. Pr., $39.95 Club Pr., $29.95

SWITCHGEAR AND CONTROL HANDBOOK, Second Ed. *Edited by* R. W. Smeaton. 1,056 *pp.*, 789 *illus.* The only handbook that treats all aspects of switchgear control, including design, applications, safety, and maintenance. Updated to reflect the changes brought about by the use of computers, solid-state devices, and programmable controls.
584/494 Pub. Pr., $75.00 Club Pr., $56.95

ANTENNA APPLICATIONS REFERENCE GUIDE. *Edited by* R. C. Johnson and H. Jasik. 496 *pp.*, 368 *illus.* and tables. Covers the major applications of antenna technology in all areas of communications and their design methods. Emphasizes important new applications such as earth station, satellite, seeker, aircraft, and microwave-relay antennas.
322/848 Pub. Pr., $53.95 Club Pr., $42.50

MICROCOMPUTER DESIGN. *By* M. Hordeski. *406 pp., illus.* Emphasizes the most current, cost effective methods for developing, debugging and testing all types of microprocessor products, including software and hardware.
583683-1 Pub. Pr., $43.00 Club Pr., $29.95

BOB MIDDLETON'S HANDBOOK OF ELECTRONIC TIME-SAVERS AND SHORTCUTS. *By* R.G. Middleton. *378 pp., illus., softbound.* Packed with little-known tricks of the trade and brand-new techniques, this popular handbook makes it easier than ever to troubleshoot radio, TV, audio equipment, CCTV, and more.
583865-6 Pub. Pr., $29.95 Club Pr., $22.50



Be sure to consider these important titles as well!

INTRODUCTION TO RADAR SYSTEMS, Second Ed. By M. I. Skolnik.
579/091 Pub. Pr., $52.95 Club Pr., $42.50

ELECTRONIC TEST EQUIPMENT: Principles and Applications. By TJ Byers.
095/221 Pub. Pr., $39.95 Club Pr., $29.95

OPERATIONAL AMPLIFIERS AND LINEAR INTEGRATED CIRCUITS, Third Ed. By R. F. Coughlin and F. F. Driscoll.
583754-4 Pub. Pr., $40.00 Club Pr., $25.95

McGRAW-HILL'S NATIONAL ELECTRICAL CODE HANDBOOK, 19th Ed. By J. F. McPartland.
457/077 Pub. Pr., $42.50 Club Pr., $31.95

HANDBOOK OF ELECTRONICS CALCULATIONS FOR ENGINEERS AND TECHNICIANS, Second Ed. Edited by M. Kaufman & A. H. Seidman.
335/281 Pub. Pr., $49.50 Club Pr., $37.50

PROBABILITY, SIGNALS, NOISE. By J. Dupraz.
183/309 Pub. Pr., $43.95 Club Pr., $34.95

POWER GENERATION CALCULATIONS REFERENCE GUIDE. By T. G. Hicks.
288/003 Pub. Pr., $36.50 Club Pr., $27.50

HUMAN FACTORS REFERENCE GUIDE FOR ELECTRONICS AND COMPUTER PROFESSIONALS. By W. E. Woodson.
717/664 Pub. Pr., $35.95 Club Pr., $28.50

REFERENCE DATA FOR ENGINEERS: Radio, Electronics, Computer, and Communications, Seventh Ed. *Edited by* E.C. Jordan.
583619-X Pub. Pr., $69.95 Club Pr., $49.95

THE LASER GUIDEBOOK. By J. Hecht
277/338 Pub. Pr., $52.95 Club Pr., $41.50

Here's how the Club works to serve YOU:

■ IMPORTANT INFORMATION . . . WE MAKE IT EASY TO GET!
In our rapidly changing world, those who perform best are those who are best informed. Designed exclusively for the practicing engineer, the Electronics and Control Engineers' Book Club provides you with information that is relevant, reliable, and specific enough to meet your needs. Each Club bulletin comes your way 14-16 times a year and offers you more than 30 books to choose from — the best and newest books from *all* publishers!

■ DEPENDABLE SERVICE . . . WE'RE HERE TO HELP!
Whether you want information about a book or have a question about your membership, our qualified staff is here to help. Just call us *toll-free* or write to our Customer Service. We also make sure you get only the books you want. All you do is simply tell us your choice on the Reply Card and return it to us by the specified date. If you want the Main Selection, do nothing — it will be sent to you automatically. (A small shipping and handling charge is added to each shipment.)

■ CLUB CONVENIENCE . . . WE DO THE WORK!
Beyond the benefit of timely information, Club membership offers many other benefits. For example, you get a wide choice of books that cannot be matched by any bookstore — anywhere. And all your books are conveniently delivered right to your door. You also get the luxury of 10 full days to decide whether you want the Main Selection. If you should ever receive a Main Selection you don't want because the Club bulletin came late, just return it for credit at our expense.

■ SUBSTANTIAL SAVINGS . . . AND A BONUS PROGRAM TOO!
In keeping with our goal to provide you with the best information at the greatest possible savings, you will enjoy substantial discounts — up to 40%! — on every book you buy. Plus, you're automatically eligible for our Bonus Book Plan which allows you *savings up to 70%* on a wide selection of books.

■ EASY MEMBERSHIP TERMS . . . IT'S WORTHWHILE TO BELONG!
Your only obligation is to purchase one more book—at a handsome discount—during the next 12 months, after which you enjoy the benefits of membership with no further obligation. Either you or the Club may cancel membership anytime thereafter.

FOR FASTER SERVICE IN ENROLLING CALL TOLL-FREE 1-800-2-MCGRAW

MAIL THIS COUPON TODAY

McGraw-Hill Book Clubs
Electronics and Control Engineers' Book Club®
P.O. Box 582, Hightstown, NJ 08520-9959

Please enroll me as a member and send me the two books indicated, plus the HANDBOOK OF ELECTRONIC TABLES AND FORMULAS. I am to receive one book for just $2.89, the other at the discounted member's price, plus local tax, shipping and handling charges. I agree to purchase a minimum of one additional book during my first year of membership as outlined under the Club plan described in this ad. I understand that a shipping and handling charge is added to all shipments.

Your FREE Handbook
583804-4

Write Code No. of the $2.89 selection here	Write Code No. for the First selection here

Signature ____________

Name ____________

Address/Apt. # ____________

City ____________

State ____________ Zip ____________

This order subject to acceptance by McGraw-Hill. All prices subject to change without notice. Offer good only to new members. Foreign member acceptance subject to special conditions.

E 34019

FIG. 7—A WIDE-SCREEN RECEIVER recovers and equalizes the picture components and reconstructs the original wide-screen progressive scan signal.

Signal-components 1, 2 and 3 are passed through a special time-variant filter to eliminate V-T crosstalk between the main and auxiliary signals on a wide-screen receiver. The main signal is intra-frame averaged over all horizontal frequencies. Components 2 and 3 are amplitude-compressed in a non-linear manner, quadrature modulated on a phase-controlled subcarrier at 3.108 MHz, and added to component 1. The result is a 4.2-MHz baseband signal that is RF modulated into a standard 6-MHz NTSC channel, as shown in Fig. 6. Component 4, the VT "helper" signal, is modulated in quadrature with the main RF picture carrier.

When received on an existing NTSC receiver, only the central portion of the main signal is seen. A wide-screen receiver, such as that shown in Fig. 7, recovers and equalizes components 1–4 and reconstructs the original wide-screen signal. Relative to NTSC, the reconstructed signal has left and right side panels offering standard NTSC resolution and a central portion with superior horizontal and vertical luminance detail in the stationary sections of the picture.

While ACTV-1, just described, is delivered within the existing 6-MHz broadcast channel, a second version of the system, known as ACTV-2 is envisioned as well, when and if additional spectrum space is allocated. ACTV-2 would require an additional 6-MHz channel of bandwidth. As illustrated in Fig. 8, a TV station might someday transmit both ACTV-1 and ACTV-2 signals. Both systems would offer an aspect ratio (on new sets) of 5:3 or 16:9, and both would have 1050 lines per frame and 29.97 frames per second. However, ACTV-2 would offer still greater improvements in luminance resolution (650 horizontal and 800 vertical, as compared to 410 horizontal and 480 vertical for ACTV-1) and a doubling of chrominance resolution, which, in ACTV-1 is no better than in standard NTSC. The photos in the opening of this article show how a typical scene, transmitted in ACTV-2, would be viewed on a standard NTSC receiver (left) and how it would be seen on a new receiver equipped for ACTV-2 (right).

Philips HDS-NA

The abbreviation stands for *H*igh *D*efinition *S*ystem for *N*orth *A*merica, and the system, developed specifically for NTSC-TV based countries, would be usable on an equal basis for over-the-air broadcasting, CATV, direct-broadcast satellite or even fiber-optic transmission. The signal suitable for broadcasting or CATV has been dubbed HDNTSC and it consists of two major components. The first component carries the standard NTSC signal, while the second carries the additional information required to create the HDTV viewing experience.

As pointed out by Philips and others, an ideal HDTV system with double the present horizontal and vertical resolution and an increased aspect ratio would require about five times the bandwidth or spectral space of the current NTSC signal, or as much as 300 MHz! To reduce those impractical bandwidth requirements, various signal-processing schemes have been proposed by the various HDTV proponents. One class of signal processing is based upon combining several picture frames from both the "past" and "present" in the scene captured by the video camera. In our article last month, we discussed such basic picture-enhancement schemes under the general heading of IDTV, or *I*mproved *D*efinition *T*ele*V*ision systems. Philips has chosen a second approach that applies signal processing without the need for inter-frame picture information. The HDS-NA system can deliver 1.5 times the normal horizontal and vertical resolution of NTSC, wide aspect ratio, plus multiple channels of CD-quality digital sound.

The main HDNTSC signal carries NTSC and is a standard 6-MHz channel. The extra information needed to create the HDTV viewing experience can be transmitted eventually as a digital bit stream with a bandwidth of 3 MHz (or one half the extra width of a present-day NTSC channel). Philips has suggested that the signal energy

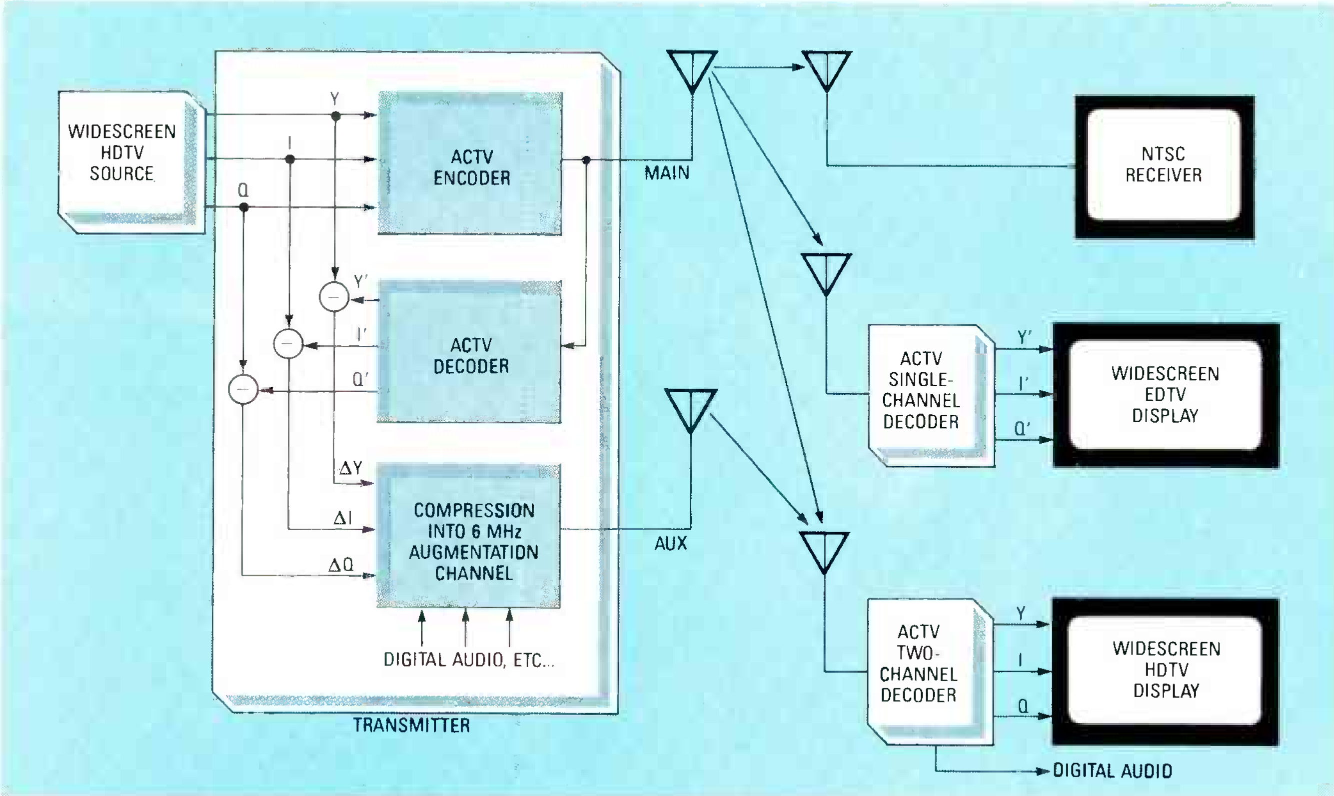


FIG. 8—A TV STATION MIGHT SOMEDAY TRANSMIT BOTH ACTV-1 and ACTV-2 signals. Both systems would offer an aspect ratio (on new sets) of 5:3 or 16:9, and both would have 1050 lines per frame and 29.97 frames per second.

of that extra augmenting channel can be well below the main NTSC signal level. That being the case, the extra signal might even be transmitted via the so-called "tabu" channels in each geographical area.

By "tabu" channels, we mean the TV channels that normally remain unassigned in a given area because they are adjacent to used channels. For example, if Channel 2 is assigned in a given city, Channel 3 remains unassigned. The same holds true for Channel 5 and 6, etc. (Channels 4 and 5, in the New York area, for example, are not really adjacent, as there is a 4-MHz space between them.) If Philips is correct about that, then in the New York area, for example, both Channel 2 and 4 might "share" Channel 3 for their augmentation channel; each using one half (3 MHz) of the otherwise unassigned channel spectrum. Using the tabu channels is not a necessary requirement for the Philips system—it is just one possibility. The augmentation channels could just as easily be positioned at other, non-contiguous frequencies which would have to be assigned for that purpose by the FCC if the Philips system were to prevail. As was true of ACTV, the Philips system is "backward compatible." Owners of older NTSC TV sets will continue to receive "normal" pictures while owners of newer sets designed for the HDS-NA system will receive the benefits of higher definition and a wider aspect ratio.

Battle Of Incompatibles

Finally, we come to the group of HDTV systems that are totally incompatible with our present day NTSC system (and, for that matter, with the PAL and SECAM systems used in other parts of the world). Aside from the incompatibility problems of these systems, there is also the problem of attempting to establish a world-wide

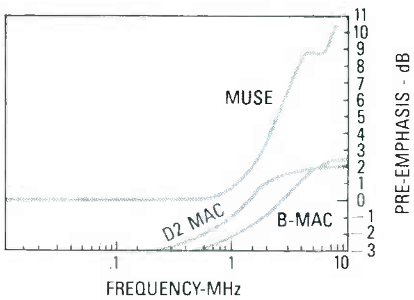


FIG. 9—ALL FORMS OF MAC, including MUSE, employ various amounts of pre-emphasis for the video signals.

standard for a no-compromise HDTV system. That problem arises primarily because of the fundamental difference in TV frame rates between U.S. (and Japanese) NTSC and European PAL. The European frame rate is 25 frames per second while the NTSC frame rate is 30 frames per second.

That difference is a throwback to the early days of TV, when scanning fields were synchronized to the power-line frequencies used (50 Hz in Europe, 60 Hz in North America and many sections of Japan). Today, much more sophisticated systems of vertical synchronization are in use, but, unfortunately, the standard frame rates are well entrenched in their respective counties. Thus, it may well be that two "world" standards may evolve for no-compromise, incompatible HDTV. The European proposal is for a 2:1 increase in number of lines per picture and a doubling of the pixel density or horizontal resolution with respect to their present broadcast systems. The Europeans would retain their present frame rate of 25 Hz. However, much work has already been done to reduce the large area flicker problem that is so noticeable to

continued on page 111

PHONLINK II

Now you can telephone home, listen to household voices, and control your lights and appliances—using any Touch-Tone *phone.*

JANET McNABB and GENE ROSETH

THE ORIGINAL PHONLINK WAS INTRODUCED in the May and June 1987 issues of **Radio-Electronics**. Back then, the Phonlink allowed you to control anything electrical by using a *Touch-Tone* telephone. The only drawback was having to run separate wires to each electrical device to be controlled. The Phonlink II improves on the original design by encoding the *Touch-Tone* commands (from any telephone) onto your household 120-volt AC power line, thereby eliminating the need for external wiring. Those encoded commands are received by any of the common AC plug-in control units that use the *X-10* system, (such as those from Radio Shack, Sears, Leviton, and others) which then switch the desired equipment on or off—thereby eliminating the need for clumsy homemade relay assemblies. Here's an example to illustrate how the Phonlink II works.

Let's suppose you're working late at the office and wish to turn on the exterior security lights of your home. You pick up the telephone, dial your home number and wait for Phonlink II to answer the phone. As its speech synthesizer prompts you, *Touch-Tone* enter your access code, then enter the control codes that instruct Phonlink II to turn on the security lights. Phonlink II verbally acknowledges your request, and outputs a control signal over the 120-volt AC power line in your home. That signal is received by the standard *X-10* AC plug-in module, which connects power to the security lights.

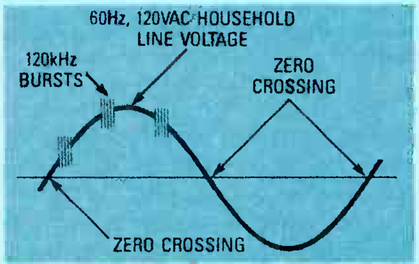


FIG. 1—THE THREE 1-ms BURSTS of 120-kHz frequency are precisely timed to coincide with the 60-Hz line-voltage zero-crossover points.

X-10 plug-in modules

The Phonlink II output signals are compatible with the standard *X-10 Powerhouse* code format, the *de facto* home-control communications standard. Most, if not all, of the household (power-line carrier) home-control systems use the *X-10* modules developed and manufactured by X-10 (USA), Inc., 185A LeGrand Ave., Northvale, NJ 07674, phone (201) 784-9700 or 1-800-526-0027. Compatible systems manufactured and supplied by X-10 (USA) are sold under the name of Radio Shack's *Plug'n Power system*, Sears' *Home Control System*, Leviton's *Decora Electronic Controls*, and Stanley's *LightMaker Home Controls*, and many others.

X-10 Code transmission

Notice that there are two Phonlink II communication paths: First, there's

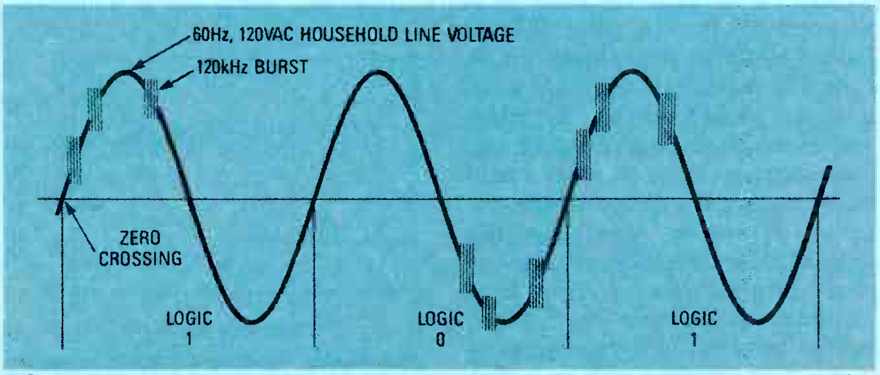


FIG. 2—THE ENCODED LOGIC depends on whether the three 120-kHz bursts are impressed on the positive or negative side of the household voltage.

the communication between you and the Phonlink II system (which includes *Touch-Tone* telephone codes, and Phonlink II's voice-synthesized statements); then there's the control signals between the Phonlink II and the standard *X-10* plug-in modules over the AC wiring. Let's now go into more detail on how the Phonlink II interacts with the *X-10* plug-in modules.

As shown in Fig. 1, the Phonlink II encoded signals consist of a series of three 1-ms 120-kHz bursts, which are impressed onto the household single-phase 60-Hz power line. Even though a typical residential home uses a single-phase electrical system, the *X-10* PLI-513 module will impress a 120-kHz burst at what would be the zero-crossover points in a three-phase system; that's why the actual *X-10* code has three 1-ms 120-kHz bursts. In a three-phase electrical system, each phase is 120 degrees apart. However, a closer study of the three 60-Hz phases will show that the actual zero-crossover points occur every 60 degrees—for example, at exactly 0°, 60°, again at 120°, and so on.

Figure 2 shows a practical scheme for encoding data onto the single-phase 60-Hz power line. A logic "1" is represented by three 1-ms 120-kHz bursts on the positive half cycle, followed by no bursts on the negative half cycle. A logic "0" is represented by just the opposite. As shown in Fig. 3, a complete instruction sequence consists of 11 cycles of the power line: 2 cycles for a *start* code, 4 cycles for the *house* code, followed by 5 cycles of *number* code, or 5 cycles of a *function* code. Each sequence is repeated to ensure reliability.

When Phonlink II transmits a complete command it takes a total of 44 cycles: two 11-cycle sequences of number code, and two 11-cycle sequences of function code. That selects the particular plug-in module, and what the module should do. The *X-10* receiver modules require a silence of 3 cycles of the power line between each 11-cycle sequence of code.

Table 1 lists all the house codes, the number codes, and the function codes defined by the *X-10* standard. Phonlink II uses house code F, number codes 1–5, and function codes ON and OFF. The software allows the house code to be changed easily if necessary.

The PLI Module

Figure 4 shows the PLI-513 (*P*ower *L*ine *I*nterface) module. The *X-10* code transmissions must be synchronized to the zero-crossing point of the AC-power line. How that's done is quite simple. The PLI provides a zero-crossing reference signal (60-Hz square wave) through the black wire at pin 1, which is derived from an opto-coupler directly con-

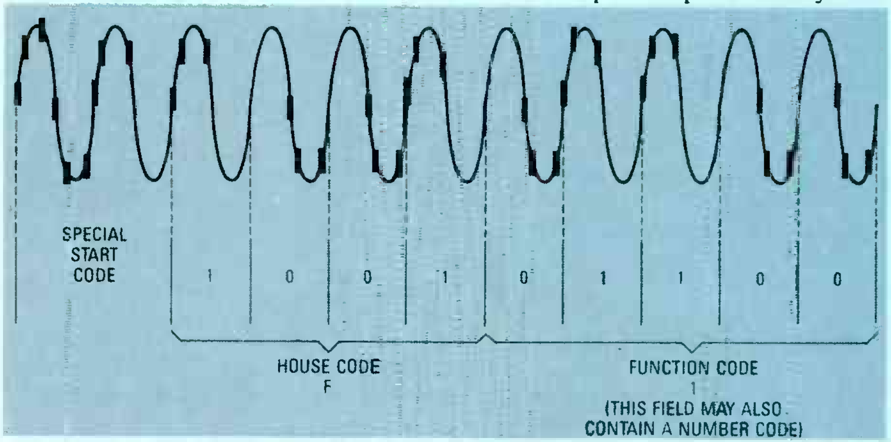


FIG. 3—AN 11-BIT CODE is required to identify a *X-10* module.

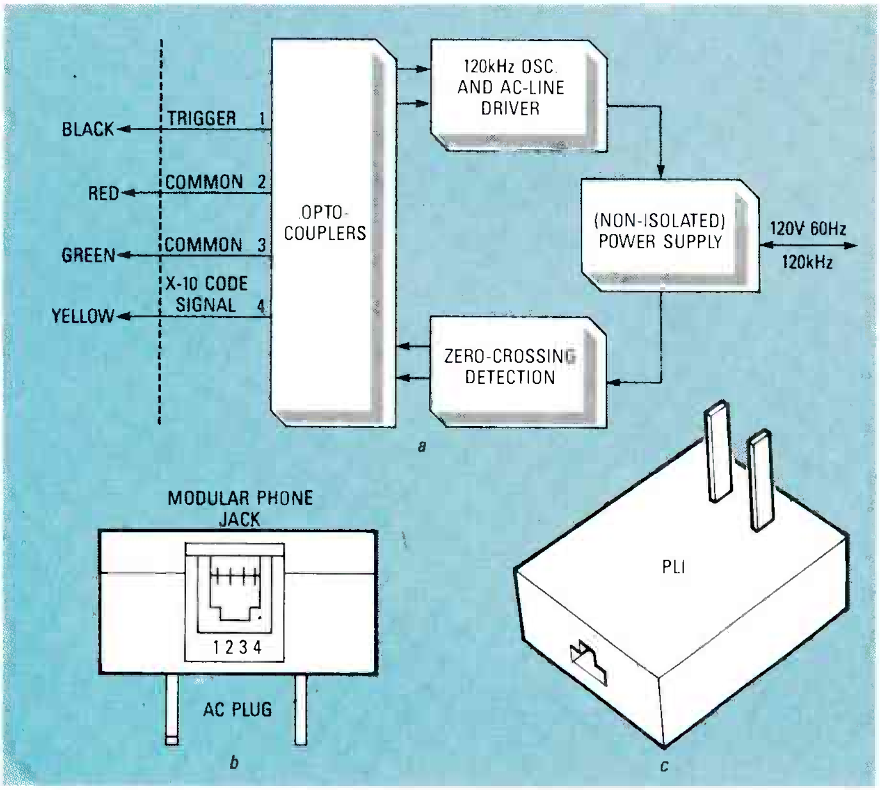


FIG. 4—In *(a)*, the PLI (*P*ower *L*ine *I*nterface) module impresses the *X-10* code onto household voltage, and communicates with the Phonlink II; *(b)* shows the PLI's modular phone-jack and AC wall plug, and *(c)* shows the PLI as viewed from the back.

nected to the AC line. (It is not desirable to derive the zero-crossing from a power-transformer's secondary because some phase shifting is likely to occur.) When Phonlink's II microprocessor detects the zero-crossing trigger, the software-generated *X-10* code will be sent through the yellow wire to pin 4 of the PLI module. The PLI 120-kHz oscillator is free-running, and is gated onto the AC line voltage (through an isolating tuned circuit) by the *X-10* code signals.

The PLI has a power-on LED that also doubles as a transmission-status LED. The LED is normally *on* to indicate the presence of power, and blinks off to indicate that a signal is being transmitted.

The power supply for the PLI is derived from a rectifier and capacitor filter that is directly referenced to the 120-volt AC power line. The zero ref-

TABLE 1

HOUSE CODES		NUMBER CODES		FUNCTION CODES	
A–	0110	1–	01100*	ON–	00101*
B–	1110	2–	11100*	OFF–	00111*
C–	0010	3–	00100*	ALL ON–	00011
D–	1010	4–	10100*	ALL OFF–	00001
E–	0001	5–	00010*	DIM–	01001
F–	1001*	6–	10010	BRIGHT–	01011
G–	0101	7–	01010		
H–	1101	8–	11010		
I–	0111	9–	01110		
J–	1111	10–	11110		
K–	0011	11–	00110		
L–	1011	12–	10110		
M–	0000	13–	00000		
N–	1000	14–	10000		
O–	0100	15–	01000		
P–	1100	16–	11000		

*Code used by PHONLINK II

NOTE: Receiver modules require a "silence" of at least 3 cycles of the power line between each instruction sequence.

PARTS LIST

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

R1—100,000 ohms
R2—250 ohms, 1%
R3—10,000 ohms, 1%
R4, R17, R24, R27, R32, R34, R35—10,000 ohms
R5–R9, R19, R36, R40, R42, R44, R46, R48, R50, R52—33,000 ohms
R10, R15, R38—47,000 ohms
R11, R12, R14—1000 ohms
R13, R20, R21—220,000 ohms
R16, R28, R54, R55—1 megohm
R18, R25—22,000 ohms
R22—330,000 ohms
R23, R30, R31, R33,—100,000 ohms
R26—100 ohms
R29—100 ohms, ½-watt
R37—470 ohms
R39, R41, R43, R45, R47, R49, R51—51,000 ohms
R53—39,000 ohms
R56—150 ohms

Capacitors

C1, C6, C13–C15, C17–C22—.1 µF, ceramic disc
C2, C8, C10—1 µ, molded monolithic ceramic
C3, C4—0.022 µF, dipped-polyester film
C5, C11—10 µF, 16 volts, dipped tantalum
C7—2.2 µF, 35 volts, dipped tantalum
C9, C26—33 µF, 16 volts, solid tantalum
C12—0.1 µF, 200 volts, orange-drop polyester film
C16—4700 µF, 16 volts, electrolytic
C23—470 µF, 16 volts, electrolytic
C24, C25—22 pF, ceramic disc

Semiconductors

IC1—TMPZ84COOP, CMOS Z80 (Toshiba)
IC2—8255A, PIO
IC3—SPO256-AL2, speech synthesizer
IC4—74C04, hex CMOS INVERTER
IC5—74C02, quad CMOS NOR
IC6—27C64, 8K CMOS EPROM
IC7—74C32, quad CMOS OR gate
IC8—ADC0809CCN, A/D converter
IC9—LM324Z, precision current reference
IC10—M-956, DTMF decoder (Teltone)

PARTS LIST

IC11, IC22—unused
IC12, IC15—TLC271, programmable op-amp
IC13—LM324, quad op-amp
IC14—4066, quad analog switch
IC16–IC19—4N32A, opto-isolator
IC20—LM7805CK, 5-volt regulator, TO3 case
IC21—LM7805CT, 5-volt regulator, TO220 case
BR1— 200 volts, bridge rectifier, ½ amp
BR2—50 volts, bridge rectifier, ½ amp
LED1—(*L*ight *E*mitting *D*iode) red
D1, D3–D5—1N914, switching diode
D2—unused
D6–D8—1N5245B, 15 volt, ½-watt Zener diode
Q1—2N2222, NPN small-signal transistor

Other components

F1—125 volts, ½ amp, pigtail leads
MIC1— electret microphone (Radio Shack 270-092B or equivalent)
RY1—relay, 5 volts, 70 mA, (Radio Shack 275-243 or equivalent)
SO1—32-pin edge-card connector
SO2—16-pin DIP socket
T1—12.6 volts, 0.6 amp (Tria F-158XP)
XTAL1, XTAL2—3.58 MHz

Modification parts

Q2—2N2222A transistor
R57—5600 ohms, ¼-watt resistor
R58—3300 ohms, ¼-watt resistor
IC6—27C64 EPROM (KPL-3A)
PLI—(*P*ower *L*ine *I*nterface) *X-10* (USA) Model PL513

Note: The following items are available from STG ASSOCIATES, 2705-B Juan Tabo Blvd., N.E. # 117, Albuquerque, NM 87112: modification kit to update PHONLINK to PHONLINK II (MKPL-1), $30; PHONLINK II complete updated kit, all parts, cabinet and documentation (KPL-1A), $220; updated PC board only (KPL-2A), $36; programmed EPROM (KPL-3A), $19; source code print out (KPL-4A), $10; Please add 5% for postage and handling (10% Foreign). New Mexico residents add appropriate sales tax.

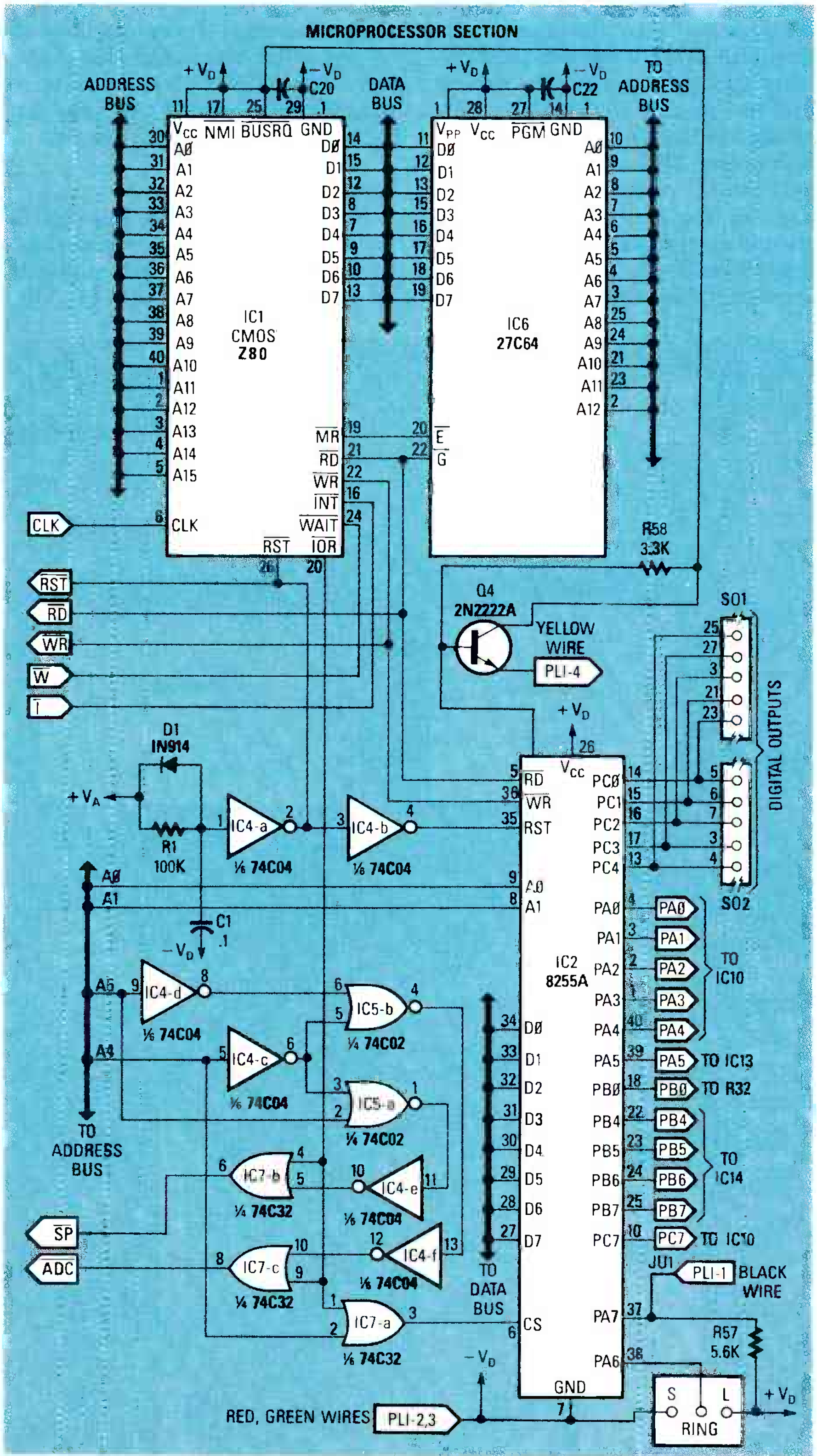


FIG. 5—A Z80 MICROPROCESSOR (IC1) is used as a system controller with its programming contained in an EPROM (IC6).

erence in the PLI is directly connected to the 120-volts AC. DC isolation is one reason why opto-couplers are used between the PLI and Phonlink II connections. Therefore: For safety, an isolating transformer must be used (between the PLI and the AC line) when attempting any internal PLI measurements. The isolating transformer, together with the PLI's diode rectifier and capacitor filter will provide a stable reference ground; that way, there can be no confusion as to which side is ground and which side is power. It's easy to be confused about which side is ground, because the PLI-513 module can easily be plugged in upside down, or your household wiring to that outlet may be wired backwards.

The *X-10* code format is patented.

However, in order to encourage others to take advantage of the large installment base of *X-10* modules, and develop their own systems to control *X-10* modules, X-10 (USA), Inc. offers the PL-513 as a cost-effective way of coupling *X-10*-compatible signals onto the AC power line. License to transmit the *X-10* code format is granted to purchasers of the *X-10* Power Line Interface. The PL-513 relieves the OEM (*O*riginal *E*quipment *M*anufacturer) from any UL (*U*nderwriters *L*aboratory) considerations as all power-line connections are taken care of by X-10 (USA), and all connections between the PL-513 and the OEM equipment are opto-coupled.

Circuit description

Figure 5 shows that the Phonlink II is controlled by a Z80 microprocessor (IC1) with its program code stored in an 8K-byte EPROM (IC6). The 8255A PIO (*P*arallel *I*nput *O*utput) contains three 8-bit ports that interface digital I/O circuits from the real world to the microprocessor.

In Fig. 6, the speech synthesizer SPO256 (IC3) works by storing the fundamental sounds of speech called phonemes. The microprocessor causes the speech synthesizer to output individual phonemes along with their appropriate delays to form complete words and phrases. The speech synthesizer, DTMF (*D*ual *T*one *M*ulti-*F*requency) M-956 (IC10), and also the built-in electret microphone (MIC1) all interface to the telephone line via a 4066 analog switch (IC14), and a few op-amps, opto-isolators, and a bridge rectifier.

The ADC0809 (IC8) analog-to-digital converter has eight analog inputs: Seven inputs are user-definable; however, the eighth is connected to a built-in temperature reference, IC9, an LM334. Just call your home, ask Phonlink II for the room temperature by keying in the correct function code, and a digitally synthesized voice will tell you the temperature. That's a great feature if you're worried about your water pipes freezing in the winter; or better yet, keeping a certain room in your home cool during the summer months for your loving pet, who you'd like to pamper. It's a comfort to know that you can control almost everything while away from home through any *Touch-Tone* phone.

The A/D converter is a successive-approximation type with a resistor voltage-divider connected to each of the first seven inputs (pins 1–4 and 26–28). The divider ratio will allow the Z80 to translate a 0–5-volt input to a 1–100 percent output. For other input-voltage ranges, those resistors must be changed accordingly.

In Fig. 7, the bridge-rectifier BR1 will provide a positive and negative voltage output in the proper orientation regardless of whether the tip and ring phone lines are connected in backward or forward. Relay RY1 serves as the hook switch, which is equivalent to the cradle switch on any telephone. The relay is controlled by Q1, which in turn is controlled via the PIO by the Z80. When the relay is engaged, the output of the speech synthesizer is optically coupled through IC19, which impresses an audio signal onto the DC-biased bridge rectifier. The audio then travels out the phone line.

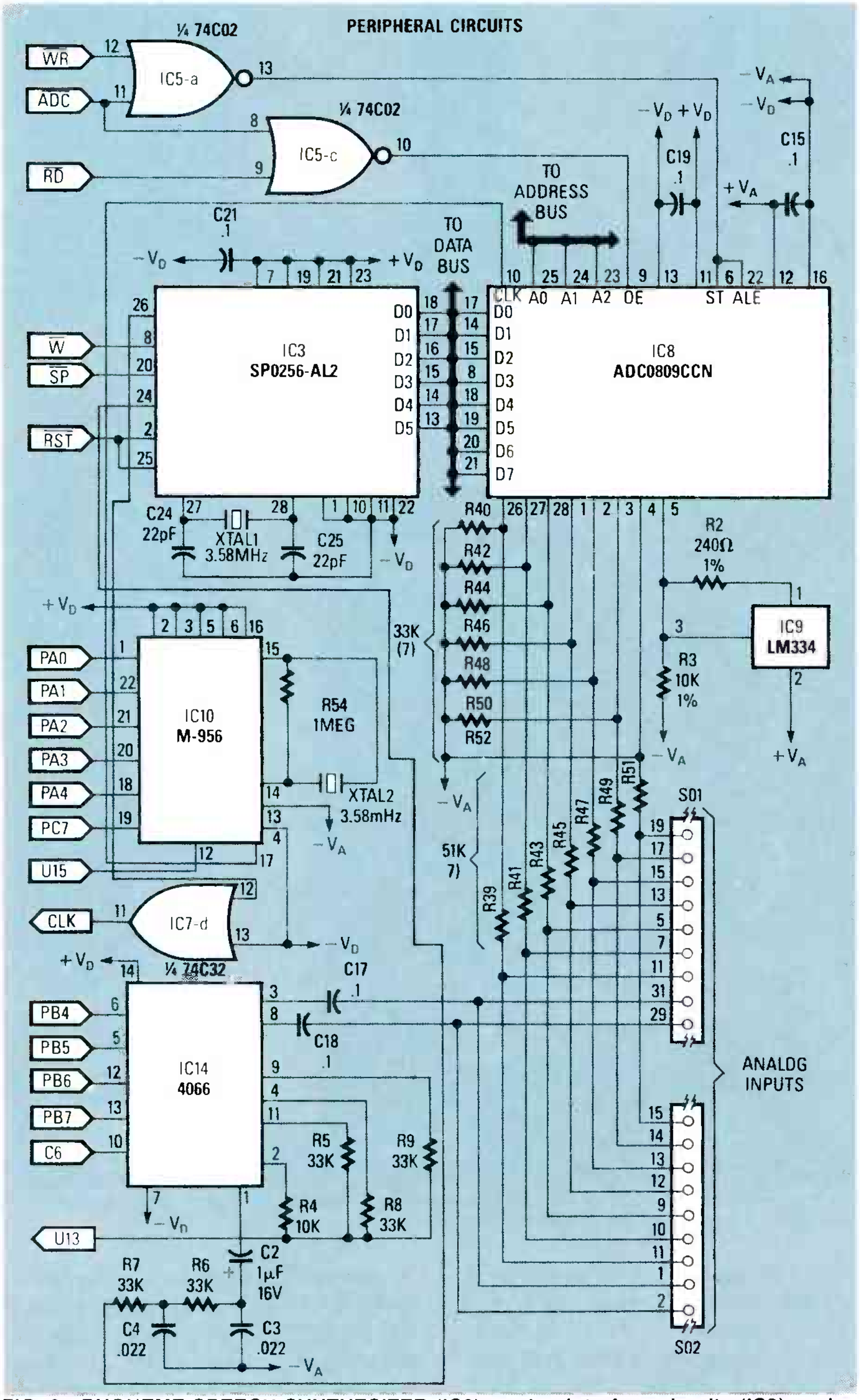


FIG. 6—PHONEME SPEECH SYNTHESIZER (IC3), analog interface circuits (IC8), and a DTMF decoder (IC10) are shown here.

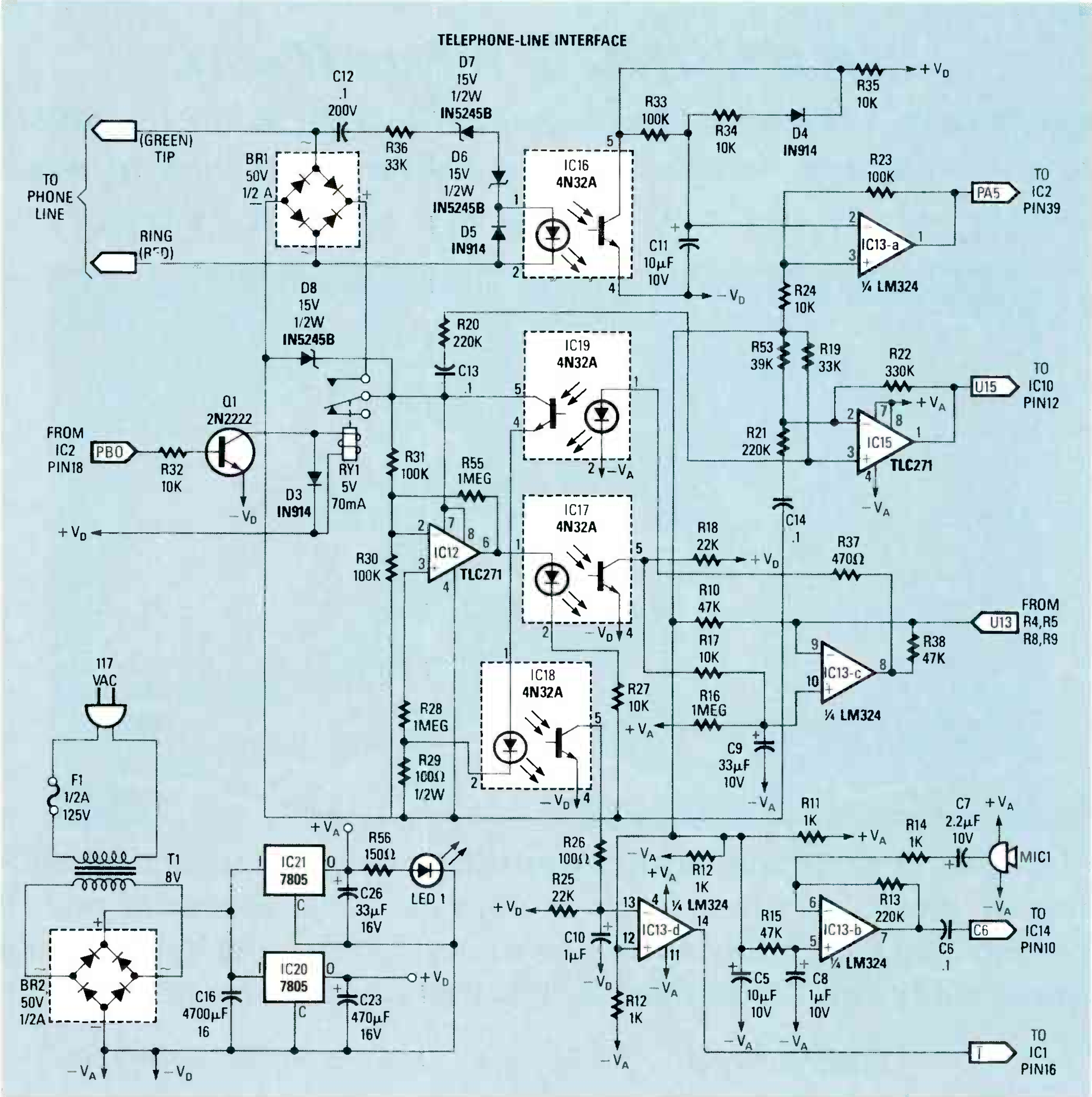


FIG. 7—TELEPHONE-LINE INTERFACE CIRCUITS use opto-couplers, a relay, bridge rectifier, and several op-amps. There are separate power supplies for the digital and analog circuits.

Telephone-line isolation is achieved through using opto-isolators. For example, opto-isolator IC16 and its associated passive components comprise the ring detector. Each time a ring occurs, it causes a negative-going pulse at IC16 pin 5, which is applied to IC13 pin 2. The output of that op-amp is then applied to the PIO, where it can be detected by the Z80 microprocessor.

The purpose of opto-coupler IC18 is to detect the disconnect pulse from the telephone exchange if the caller decides to hang up. That pulse sends an interrupt to the microprocessor, which then terminates the communication.

A closed-loop feedback circuit is composed of IC12, IC17, IC19, IC13-c, and the C9/R16 low-pass filter helps stabilize the sensitive op-amp circuitry and compensate for changes in circuit parameters that may be caused by slight variations in component temperatures.

Notice that there are two separate 5-volt power supplies: one for the analog and one for the digital circuits. Now you know why the power connections to some IC's in the previous figures are labeled $\pm V_D$ and others labeled $\pm V_A$. The analog and digital ground are connected together only at one point; otherwise, the analog and digital grounds use separate runs around the board.

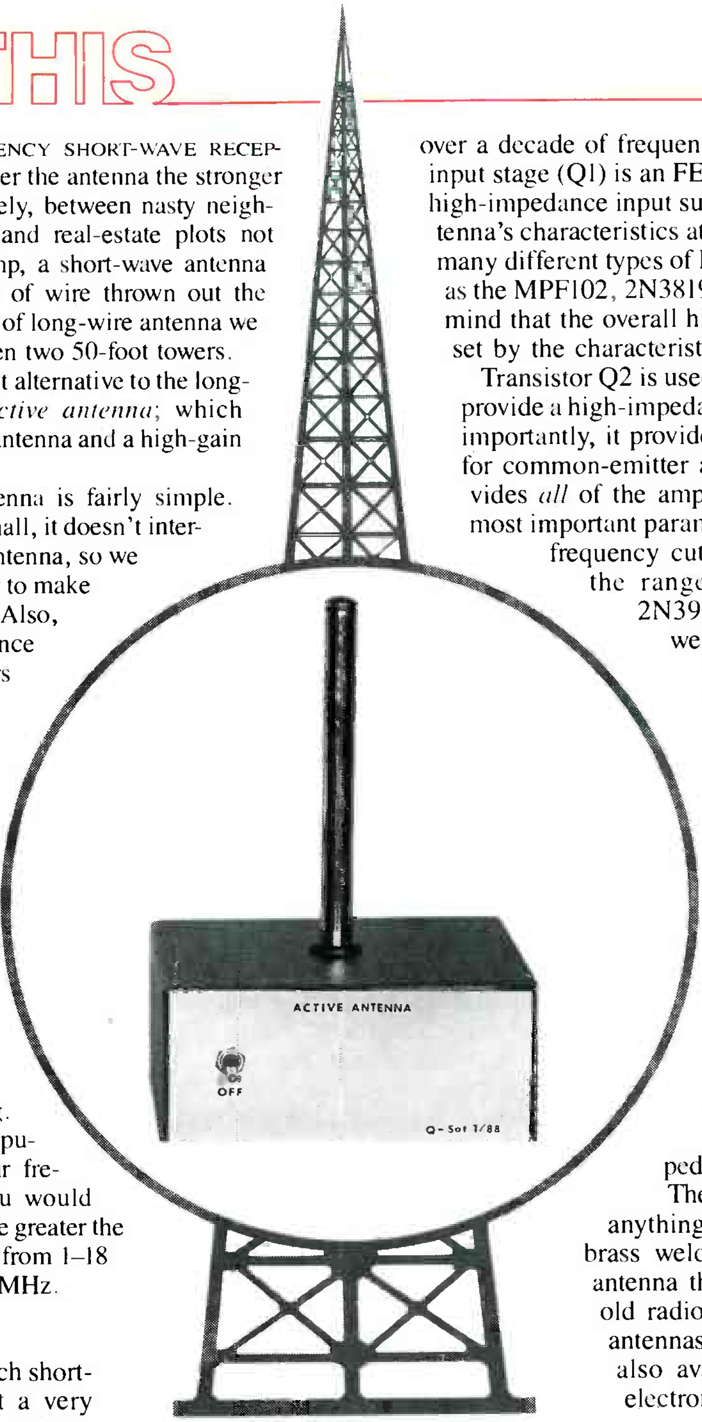
That's all we have space for now. However, we'll continue next month with a discussion on the software, and the modifications necessary to get Phonlink II up and running. **R-E**

BUILD THIS

ACTIVE ANTENNA

When fate or nasty neighbors prevent you from stringing a long-wire receiving antenna, you'll find that this pocket-size active antenna will give the same, or even better, reception.

RODNEY A. KREUTER



FOR CONVENTIONAL ALL-FREQUENCY SHORT-WAVE RECEPtion, the general rule is "the longer the antenna the stronger the received signal." Unfortunately, between nasty neighbors, restrictive housing rules, and real-estate plots not much larger than a postage stamp, a short-wave antenna often turns out to be a few feet of wire thrown out the window—rather than the 130 feet of long-wire antenna we would really like to string between two 50-foot towers.

Fortunately, there's a convenient alternative to the long-wire antenna, and that's an *active antenna*; which basically consists of a very short antenna and a high-gain amplifier.

The concept of an active antenna is fairly simple. Since the antenna is physically small, it doesn't intercept as much energy as a larger antenna, so we simply use a built-in RF amplifier to make up for the apparent signal "loss." Also, the amplifier provides impedance matching, because most receivers are designed to work with a 50-ohm antenna.

Active antennas can be built for any frequency range, but they are more commonly used from VLF (10 kHz or so) to about 30 MHz. The reason for that is because full-size antennas for those frequencies are often much too long for the available space. At higher frequencies, it is quite easy to design a relatively small high-gain antenna.

The active antenna shown in Fig. 1 provides 14–20 dB gain at the popular short-wave and radio-amateur frequencies of 1–30 MHz. As you would expect, the lower the frequency the greater the gain. A gain of 20 dB is typical from 1–18 MHz, decreasing to 14 dB at 30 MHz.

Circuit design

Because antennas that are much shorter than ¼ wavelength present a very small and highly reactive impedance that is dependent on the received frequency, no attempt was made to match the antenna's impedance—it would prove too difficult and frustrating to match impedances over a decade of frequency coverage. Instead, the input stage (Q1) is an FET source-follower, whose high-impedance input successfully bridges the antenna's characteristics at any frequency. Although many different types of FET's may be used—such as the MPF102, 2N3819, or the 2N4416—bear in mind that the overall high-frequency response is set by the characteristics of the FET amplifier.

Transistor Q2 is used as an emitter-follower to provide a high-impedance load for Q1, but more importantly, it provides a low drive impedance for common-emitter amplifier Q3, which provides *all* of the amplifier's voltage gain. The most important parameter of Q3 is f_T, the high-frequency cut-off, which should be in the range of 200–400 MHz. A 2N3904, or a 2N2222 works well for Q3.

The most important of Q3's circuit parameters is the voltage drop across R8: The greater the drop, the greater the gain. However, the passband decreases as Q3's gain is increased.

Transistor Q4 transforms Q3's relatively moderate output impedance into a low impedance, thereby providing sufficient drive for a receiver's 50-ohm antenna-input impedance.

The antenna can be almost anything; a long piece of wire, a brass welding rod, or a telescopic antenna that was salvaged from an old radio. Telescopic replacement antennas for transistor radios are also available from most retail electronic-parts distributors.

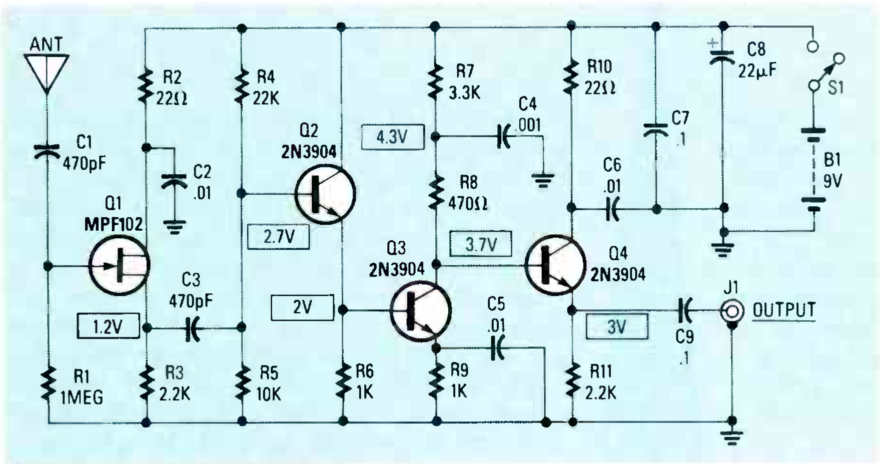


FIG. 1—THIS ACTIVE ANTENNA provides between 14- and 20-dB gain over the range of 1–30 MHz.

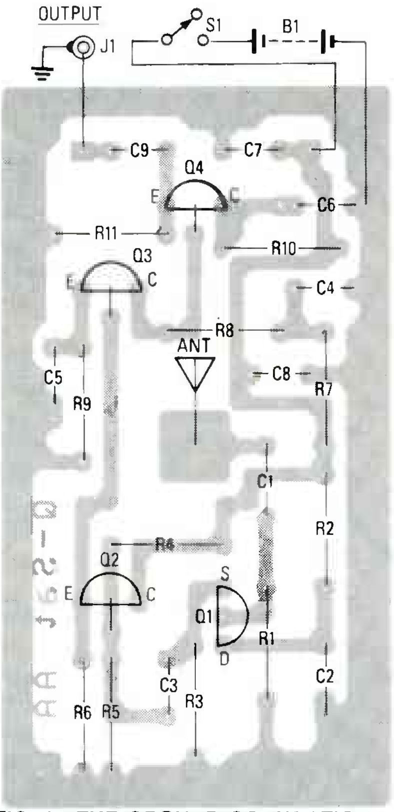


FIG. 2—THE GROUND CONNECTION for J1 is the metal cabinet. The cabinet is connected to the PC board's ground by the metal spacers at each mounting screw.

Construction

The amplifier for the prototype unit uses a printed-circuit board, for which a template is provided in "PC Service." The amplifier can be assembled on a perforated wiring board, but because there is *some* sensitivity to the parts layout, we strongly suggest that you use a PC board for best results.

The parts-placement diagram is shown in Fig. 2. Take note that although the battery's negative (ground) lead is returned to the PC board, output-jack J1 has a connection to the cabinet ground. The ground connection between the PC board and the cabinet is made through the metal standoffs or spacers that are used to mount the PC board in the cabinet. Do not substitute plastic standoffs or spacers because they won't provide a ground connection between the PC board, the cabinet, and J1. If you decide to use a plastic cabinet to house the amplifier, make certain that J1's ground connection is returned to the ground foil running around the edge of the PC-board.

A telescopic antenna mounts in the center of the PC board. From the foil side of the board, pass its mounting screw through the hole in the PC board and then solder the head of the screw to its foil pad. For both insulation and support, use a plastic or rubber grommet between the antenna and the hole in the cabinet's cover through which the antenna passes. In a pinch, several turns of a good-quality plastic tape wrapped around the antenna's shaft can be substituted for the rubber grommet.

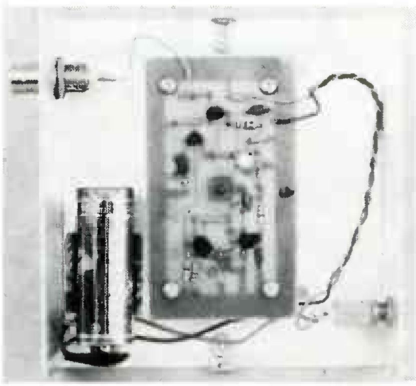


FIG. 3—THE AMPLIFIER IS SO SMALL that it almost gets lost in a 4-inch × 4-inch metal cabinet. The battery is held in place with a U-clamp. The output jack is anything that matches the receiver's antenna connection.

If you decide to make provision for a wire antenna, install a 5-way binding post on the cabinet. Then, be sure to connect a short length of wire between the antenna's foil pad and the binding post.

Modifications

If you are interested in a smaller frequency range than 1–30 MHz, resistor R1 can be replaced with an LC circuit tuned to the center of the desired range. The LC circuit will also improve the rejection of signals outside your range of interest, but remember that it won't improve the gain of the amplifier.

If your particular interest is the very-low frequencies (VLF), the amplifier's low-frequency response can

PARTS LIST

Resistors ¼-watt, 10%
R1—1 megohm
R2, R10—22 ohms
R3, R11—2200 ohms
R4—22,000 ohms
R5—10,000 ohms
R6, R9—1000 ohms
R7—3300 ohms
R8—470 ohms
Capacitors rated at least 16-WVDC
C1, C3—470 pF
C2, C5, C6—0.01 μF
C4—0.001 μF
C7, C9—0.1 μF
C8—22 μF, electrolytic
Semiconductors
Q1—FET, MPF102 or 2N3918 (see text)
Q2, Q3, Q4—NPN transistor, 2N3904, or equivalent
Other components
B1—9-volt battery
J1—Jack to match receiver cable
S1—SPST switch
ANT—Telescopic antenna or wire
Miscellaneous: Cabinet, printed-circuit materials, solder, etc.
Note: The following can be ordered from Q-Sat, P.O Box 110, Boalsburg, PA 16827: A printed-circuit board, $6 plus $1 shipping and handling; a complete kit (less case, switch, battery, and connectors), $15 plus $2 shipping and handling. Pennsylvania residents must add appropriate sales tax.

be improved by increasing the values of capacitors C1 and C3. (You'll have to experiment with the values.)

Although a 9-volt battery is the recommended power source, the amplifier should work well using 6–15 volts. The inside of the cabinet of the completed prototype, using a 9-volt battery as the power supply, is shown in Fig. 3.

Troubleshooting

Circuit voltages for a 9-volt power supply are shown in Fig. 1. If the voltages in your unit differ by more than 20% from those in the schematic, try changing resistor values to get the voltages in their proper range. For example, if the voltage drop across R8 measures only 0.3 volt, you must decrease R4's value (the exact value is up to you to figure out) in order to increase Q3's base voltage and collector current.

The only critical voltages are those across R3 and R8. Performance should be fine if they are even close to the values on the schematic. If you decide to operate the amplifier from other than 9 volts, the values of R3 and R4 must be modified to obtain the indicated voltages.

Since it's almost impossible to measure the voltage from the gate to the source (VGS) of an FET, you can measure the voltage that is present across R3, because it is the same as VGS. Adjust R3's value accordingly, if the voltage is not within the range of 0.8–1.2 volts.

Limitations

Use of the amplifier above 30 MHz is not recommended because of sharply reduced gain. While operation above 30 MHz can be accomplished by using tuned circuits in place of the resistive loads, that modification is beyond the scope of this article. Therefore, such modifications are purely experimental.

Take care when handling the FET (Q1). A common belief is that FET's and CMOS devices are safe from static damage after having been installed in a circuit, or after being mounted to a PC board. Although it's true that they are better protected from static electricity when installed in a circuit, they are still susceptible to damage by static; so never touch the antenna before discharging yourself to ground by touching some grounded metallic object. **R-E**

CARRIER CURRENT RECEIVER

WILLIAM SHEETS and RUDOLF F. GRAF

Complete your carrier-current audio system with an AM or FM receiver.

LAST MONTH WE WENT OVER the operating theory of a carrier-current transmitter, and then showed you how to build one. Now we will describe two receivers that can be used with that transmitter. One receiver is a simple AM unit, best suited for applications where some noise can be tolerated (such as speech), and the other one is for wideband FM use. Both receivers have an output that can be connected directly to a speaker.

AM receiver

Figure 1 shows the AM-receiver schematic. It is a TRF- (*T*uned *R*adio *F*requency) type receiver, meaning that there is no signal mixing or heterodyning; the unit is tuned only once upon calibration, and then left alone. It has a sensitivity of about 1 millivolt at the input for an audio output of ½-watt.

Capacitor C22 couples audio signals from the power line to the PC board—it *must* be rated at 600-volts DC. R8 will cause F1 to blow if C22 shorts. As another safety precaution, the chassis of the unit must be grounded. If an older two-wire electrical system is used, the receiver must be grounded to a cold-water pipe.

The signal from C22 goes to a tuned network (C1–C5 and L1 and L2) that has a 20-kHz bandwidth, which allows only the desired signal to pass through. A jumper (J) between the line (antenna) and the input network can be removed for reception of very strong signals if distortion (overload) becomes a problem.

IC1 is a "gain block" IF chip, normally used for TV IF applications, but it is useful at low frequencies as well. It has AGC (*A*utomatic *G*ain *C*ontrol) capability and approximately 60 dB of gain. Components C8, C9, and L3, which are placed across the output of IC1, are broadly resonant around 280 kHz. C10 couples RF to detector-diode D1, which is used as an envelope detector.

AGC, which keeps the receiver output relatively constant, is obtained in the following manner: The cathode of D1 is connected to the variable resistor R5. A voltage from 4 to 6 volts appears on the cathode of D1 even with no received signal. When a signal is received, the DC voltage at the anode of D1 increases. That DC voltage appears across C14 (the detector output), and is then fed through R3 and C13, which remove audio components, to the base if Q1. The voltage at the emitter of Q1 is fed to pin 5 of IC1. A more positive voltage tends to reduce the gain of IC1, which in turn reduces the signal fed to D1 and subsequently the DC voltage at pin 5.

The detector output is taken from C14, which sets the upper frequency limit at about 10 kHz or so. By reducing the value of C14, a higher frequency response can be obtained; but using the FM receiver, which will be described later, is a better approach. The detector output is connected to an external jack. Audio components are fed to audio-gain control R6, through C16 to IC2, an audio amplifier. C18 couples up to ½-watt of audio to an external speaker.

Power for the AM receiver is supplied via T1, D2, and IC3. The power supply formed by those components provides a regulated 12-volts DC across C19.

FM receiver

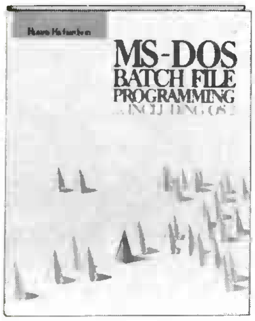
The schematic of the FM receiver is shown in Fig. 2, and it operates as follows: Input signals from the power line are coupled through C23 and R19 to the input filter network. As with the AM transmitter, C23 *must* be rated at 600 volts. Switch S2 is used as an attenuator. It is provided to prevent receiver overload in case it is located too close to the transmitter. Signals above about 500 kHz are rejected by C1, which reduces the tendency for the filter network to "leak" signals at frequencies far above the passband. Components C2–C7, L1–L3, and R1 and R20 form a triple-tuned bandpass filter having a passband from 220–340 kHz. Signals from the filter are fed to pin 4 of IC1, an MC1350P "gain block" IC, which is used as a tuned RF amplifier. C8 and C9 provide internal bypassing for the chip. R2 biases IC1 so that it operates at maximum gain. An amplified signal appears at pin 8 of IC1. L4 provides DC bias and high RF impedance to pin 8, and D1 and D2 provide amplitude

Electronics Engineers & Designers!

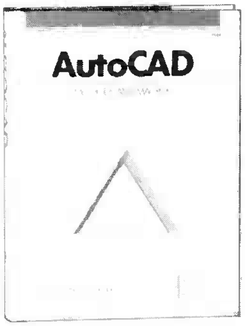
3 books for only $1^{95} (values to $141.90)

Quality, Affordable Professional Books

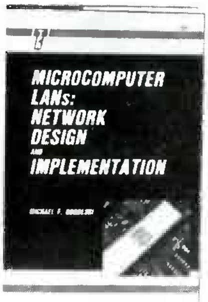
COMPUTER SCIENCE



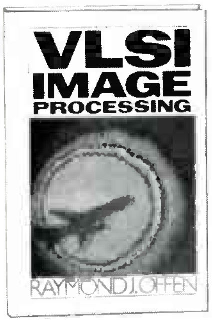
3028 **$27.95**
Hands-on guide to explore the power of batch file programming under PC-DOS, MS-DOS, and OS/2. 320 pp.



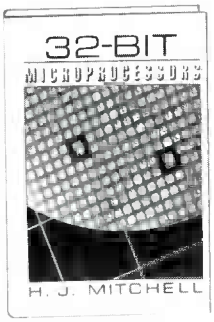
2989 **$29.95**
An authoritative tutorial on the bestselling computer-aided design software. 296 pp.



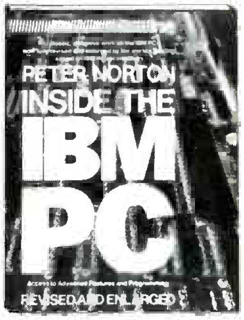
2888 **$28.95**
How computer networks work, how to make them work for you. 340 pp.



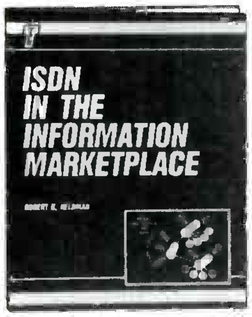
9832 **$36.95**
An in-depth, essential guide bringing together VLSI and Image Processing. 326 pp.



9829 **$45.00**
An inclusive overview for electronics engineers and computer scientists. 248 pp.

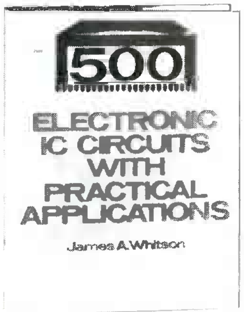


9762P **$21.95**
The classic definitive work on the IBM PC—fully revised and enlarged. 387 pp.

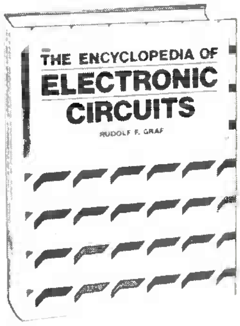


3015 **$34.95**
A detailed look at the technical and marketing aspects of ISDN. 352 pp. *Counts as two.*

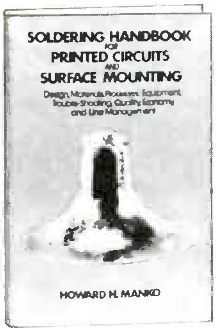
ELECTRONIC CIRCUITS



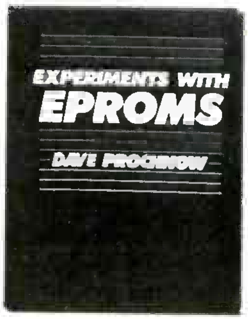
2920 **$28.95**
600 diagrams, schematics, and tables showing IC circuits. 352 pp.



1938 **$60.00**
Over 1,300 useful and versatile electronic circuit designs. 768 pp. *Counts as two.*

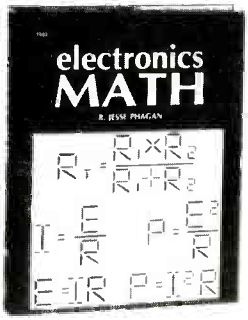


9825 **$49.95**
A comprehensive manual for soldering and cleaning printed circuit boards. 430 pp.

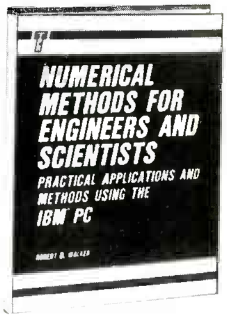


2962 **$24.95**
Complete schematic diagrams, parts lists, and photos for building a variety of projects. 296 pp.

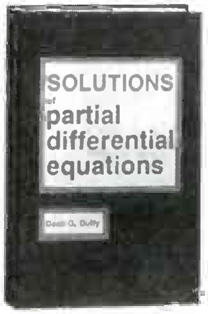
ENGINEERING MATH



1962 **$22.95**
247 illustrations, a practical reference to basic electronics math usage. 256 pp.



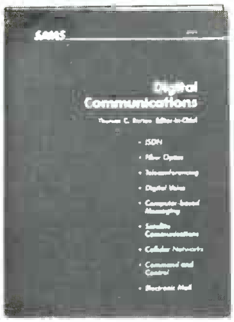
2697 **$19.95**
Ready-to-run math programs & subroutines for scientists and engineers. 304 pp.

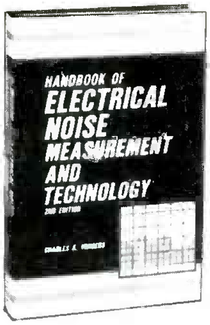


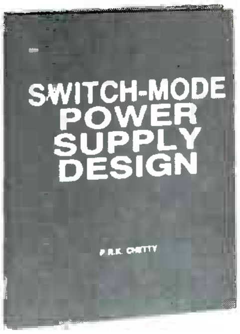
2612 **$25.95**
102 illustrations, step-by-step methods for solving real-world partial and differential equations. 560 pp.

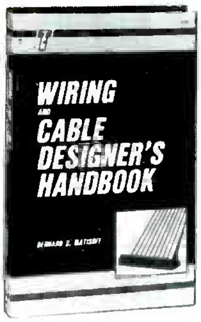
2727 **$24.95**
Perform complex calculations with simple analog circuits. 200 pp.

STATE-OF-THE-ART









9773 **$44.95**
Examines the significant advances in communications technology. 406 pp.

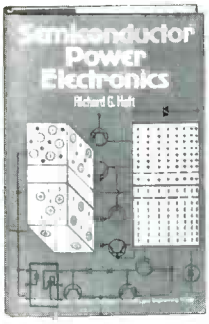
2802 **$39.95**
Completely revised and expanded—a classic sourcebook in its field. 440 pp.
Counts as two.

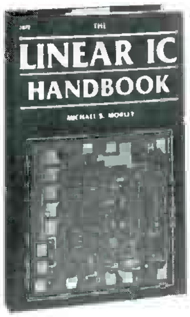
2631 **$22.95**
196 illustrations, a practical sourcebook complete with applications examples. 192 pp.

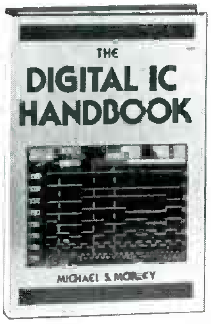
2720 **$32.50**
State-of-the-art design techniques and manufacturing methods. 250 illustrations. 304 pp.

9821 **$38.95**
An authoritative and provocative look at the state of today's software engineering. 340 pp.
Counts as two.

ELECTRONIC COMPONENTS







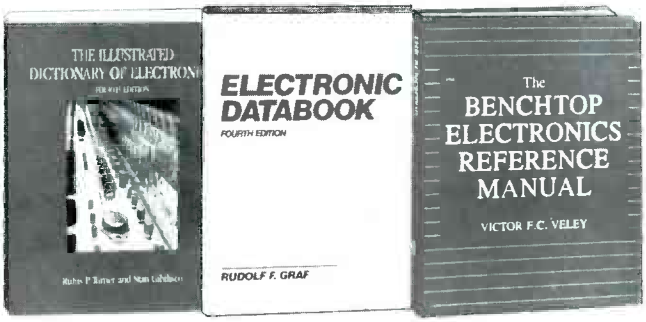
9820 **$46.95** **2672** **$49.50** **3002** **$49.50**

9820 Covers transistor and thryistor circuits for power electronics systems. 324 pp.

2672 Linear integrated circuits—specifications, prices & data. 614 pp. *Counts as two.*

3002 Fast, accurate information guaranteed to simplify your search for the right IC. 624 pp. *Counts as two.*

REFERENCE



2900 **$36.95** **2958** **$34.95** **2785** **$39.95**

2900 "An excellent dictionary for all levels of users, from the hobbyist to the researcher."-*Libraries Unlimited*, 584 illus., 656 pp. *Counts as two.*

2958 "A rich fund of reliable, easy-to-use data . . ."—*Engineering Societies Library*, 560 pp. *Counts as two.*

2785 Easy-to-use reference to 160 electronic principles: ac/dc, solid-state, oscillators, amplifiers and radio communications. 620 pp. *Counts as two.*

How the Club Works

YOUR BENEFITS: You get 3 books for $1.95 plus shipping & handling when you join. You keep on saving with discounts up to 50% as a member.

YOUR PROFESSIONAL BOOKSTORE BY MAIL: Every 3-4 weeks, you will receive the EE&D Book Club News describing the Main Selection and Alternates, as well as bonus offers and special sales, with hundreds of titles to choose from.

AUTOMATIC ORDER: If you want the Main selection, do nothing and it will be sent to you automatically. If you prefer another selection, or no selection at all, simply indicate your choice on the reply form provided. As a member, you agree to purchase at least 3 books within the next 2 years and may resign at any time thereafter.

BONUS BOOKS: Starting immediately you will be eligible for our *Bonus Book Plan* with savings of up to 80% off publishers' prices.

IRONCLAD NO-RISK GUARANTEE: If not satisfied with your books, return them within 10 days without obligation!

EXCEPTIONAL QUALITY: All books are quality publishers' editions especially selected by our Editorial Board.

All books are hardcover unless number is followed by a "P" for paperback. (Publishers' Prices shown)

ELECTRONICS ENGINEERS & DESIGNERS BOOK CLUB®
Blue Ridge Summit, PA 17294-0860

YES! Please accept my membership in the *Electronics Engineers & Designers Book Club®* and send me the volumes I have listed below, billing me only $1.95 plus shipping and handling charges. I understand that the books are sent on a 10-Day Free Examination basis. If dissatisfied in any way, I may return the books within 10 days and incur no further obligation. Otherwise, I agree to pay the enclosed invoice promptly and to receive regular club bulletins as described in "How the Club Works." To complete my membership obligation I need only purchase 3 additional books at regular members' prices during the next 2 years, and may resign at any time thereafter.

NAME ______________________

ADDRESS ______________________

CITY ______________________

STATE ______ ZIP ______ PHONE ______

SIGNATURE ______________________

Valid for new members only. Foreign applicants will receive special ordering instructions. Canada *must* remit in U.S. funds. This order is subject to acceptance by the *Electronics Engineers & Designers Book Club®*.
DRE289

PARTS LIST

AM RECEIVER

All resistors are ¼-watt, 10%, unless otherwise noted.

R1—4700 ohms
R2—1000 ohms
R3—47,000 ohms
R4, R8—47 ohms
R5—10,000 ohms, potentiometer
R6—50,000 ohms, potentiometer
R7—10 ohms
R9—680 ohms

Capacitors

C1, C5—33 pF, NPO
C2, C4—3–40 pF trimmer
C3—3 pF, NPO
C6, C7, C17—0.1 µF, 50 volts, Mylar
C8, C9—330 pF, NPO
C10, C14, C21—0.01 µF, disc
C11, C15—10 µF, 16 volts, electrolytic
C12, C13, C16—1 µF, 50 volts, electrolytic
C18—470 µF, 16 volts, electrolytic
C19, C20—2200 µF, 16 volts, electrolytic
C22—0.1 µF, 600 volts

Semiconductors

IC1—MC1350P gain block IF
IC2—LM386 audio amplifier
IC3—LM7812 12-volt regulator
D1—1N914B silicon diode
D2—1N4002 or 1N4007 rectifier diode
LED1—red light-emitting diode
Q1—2N3565 NPN transistor

Other components

L1, L2, L4—4.7 mH inductor
L3—470 µH inductor
F1—1-amp fuse
S1—SPST switch
T1—12-volt, 450-mA transformer
J1–J4—RCA jack
Miscellaneous: PC board, cabinet, hardware, grounded AC line cord, etc.

PARTS LIST
FM RECEIVER

All resistors are ¼-watt, 10%, unless otherwise noted.

R1, R10—15,000 ohms
R2, R4–R7, R17—4700 ohms
R3, R19—47 ohms
R8, R15—10,000 ohms
R9—10,000 ohms, potentiometer
R11—2200 ohms
R12—22 ohms
R13—10 ohms
R14, R20—22,000 ohms
R16—100,000 ohms
R18—50,000 ohms, potentiometer
R21—680 ohms

Capacitors

C1—0.0015 µF, 50 volts, Mylar
C2, C4, C6—56 pF, NPO
C3, C5—24 pF, NPO
C7—150 pF, NPO
C8, C9, C22—0.1 µF, 50 volts, Mylar
C10, C17, C18—1 µF, 50 volts, electrolytic
C11, C24, C26, C27—0.01 µF, disc
C12, C13—10 µF, 16 volts, electrolytic
C14, C29—0.001 µF, 50 volts, Mylar
C15—47 pF, NPO
C16—0.01 µF, Mylar
C19, C20—470 µF, 16 volts, electrolytic
C21—0.0033 µF, 50 volts, Mylar
C23—0.1 µF, 600 volts
C25, C28—2200 µF, 16 volts, electrolytic

Semiconductors

IC1—MC1350P gain block IF
IC2—LM565 PLL detector
IC3—LM386 audio amplifier
IC4—LM7812 12-volt regulator
D1, D2—1N914B silicon diode
D3–D6—1N4002 rectifier diode
LED1—red light-emitting diode
Q1, Q2—2N3565 NPN transistor

Other components

L1–L4, L6—4.7 mH inductor
L5—470 µH inductor
F1—1-amp fuse
S1, S2—SPST switch
T1—12-volt, 450-mA transformer
J1, J2—RCA jack
Miscellaneous: PC board, cabinet, hardware, grounded AC line cord, etc.

Note: The following items are available from North Country Radio, P.O. Box 53, Wykagyl Station, New Rochelle, NY 10804. A kit of parts containing a PC board and everything that is installed on it; For the AM receiver: $28.50. For the FM receiver: $38.50. A PC board for either receiver is available for $10.00 each. Add $2.50 to any order for postage and handling. NY residents must include sales tax.

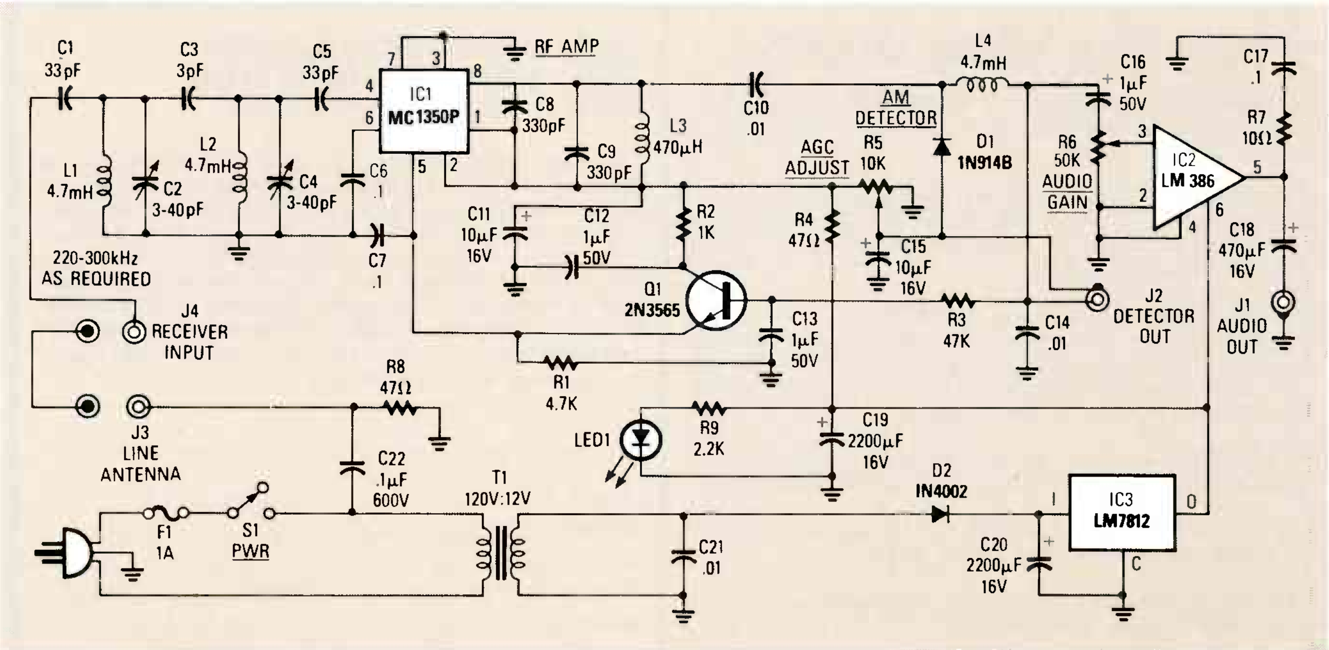


FIG. 1—THE AM RECEIVER. Shown here is the complete, and rather simple circuit, which is best suited for receiving speech.

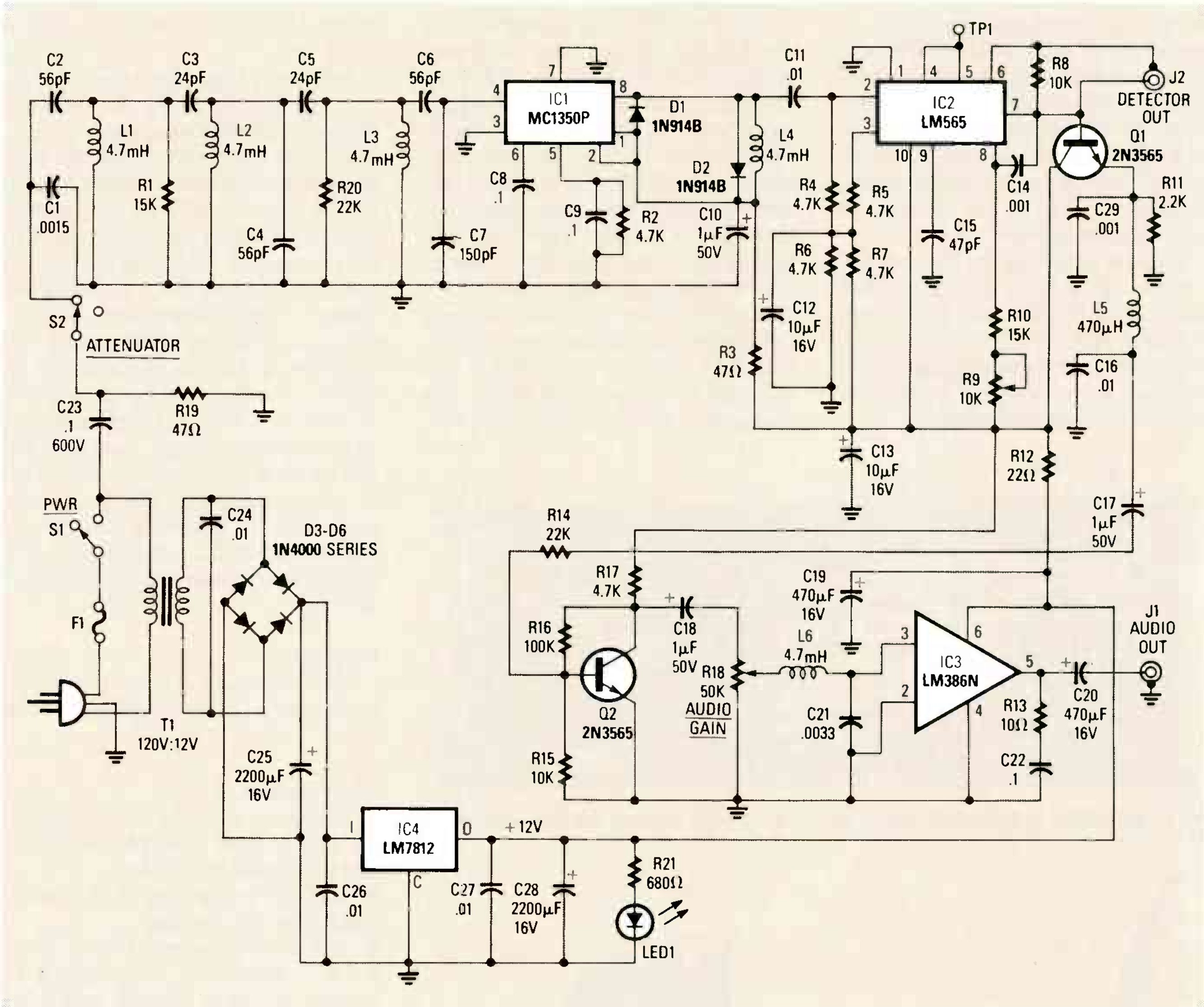


FIG. 2—THE FM RECEIVER. This receiver is slightly more complex than the AM receiver.

limiting of the FM signal. C10 and R3 form a decoupling network, and C11 couples the signal from IC1 to IC2, and also blocks DC.

IC2, an LM565 PLL, is used as an FM demodulator. Pins 8 and 9 are connected to an internal VCO (*V*oltage *C*ontrolled *O*scillator), and components R9, R10, and C15 set the VCO's free running frequency. The output of the VCO appears at pin 4, and is fed right back in to pin 5, which is the input to the internal phase detector (the test point between those two pins is used for setting the PLL's VCO frequency—280 kHz in this application). The VCO signal and the input signal (from pin 2) are compared in the phase detector. The output from the phase detector is internally amplified, and then appears at pin 7. The output at pin 7 is a replica of the original modulation on the FM input

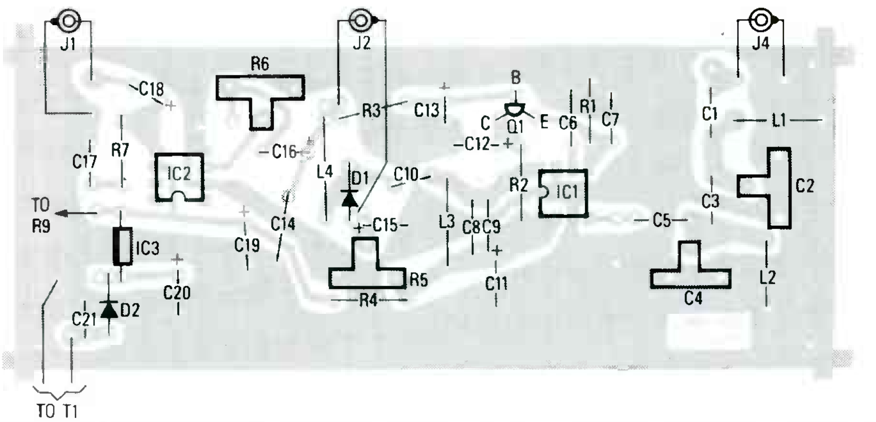


FIG. 3—AM PARTS PLACEMENT. Follow this diagram when building the PC board for the AM receiver.

signal to the receiver; the output (pin 7) is therefore the recovered audio. (The outputs from pins 6 and 7 are externally available for future interface purposes.)

The detector output at pin 7 is coupled to Q1 and R11. Components C16, C29, and L5 form a low-pass filter that eliminates 280-kHz components from IC2's output. C17 and R14 couple audio to the base of Q2, which, in conjunction with R15, R16, R17, and

C18, form an audio amplifier that brings the recovered audio up to around 1-volt peak-to-peak. R18 is a volume control, and L6 and C27 suppress any remaining 280-kHz components. The signal is then fed into IC3, an LM386N audio amplifier, which can deliver up to ½-watt of audio, coupled via C20, to any standard 8-ohm external speaker.

A power supply for the FM receiver is made up of T1, a bridge rectifier made up of D3–D6, and the 12-volt regulator, IC4. The power-supply requirements concerning ripple and noise are more stringent for the FM receiver than the AM receiver.

Construction

The Parts-Placement diagrams for the AM and FM receivers are shown in Figs. 3 and 4 respectively. You can build the receivers using PC boards made from the foil patterns given in PC Service, or else by using the ready-made PC boards that are available from the source mentioned in the Parts List. Complete parts kits containing all components that mount on the PC boards are also available from that same source for either receiver. Otherwise, all of the components, with the exception of the chokes and coils, are readily available from many suppliers. Of course you only need the parts for one of the receivers—either AM or FM, unless you want to build both.

Following Figs. 3 and 4 as a guide, start by first installing the fixed resistors, and then the capacitors. Next, install the coils and potentiometers, and the IC's last. It's always a good idea to leave the IC's for last, as they are susceptible to static damage. Use only rosin-core solder, and be sure to carefully inspect the PC board for shorts, solder bridges, and poor solder joints before applying power. All components that are not mounted on the PC board should be mounted to the chassis or soldered onto a terminal strip, as shown in Figs. 5 and 6. In the FM receiver, as you can see from Fig. 6, voltage-regulator IC4 is actually heat-sinked by mounting it to the bottom surface of the metal cabinet; IC4 is electrically grounded to the cabinet as well.

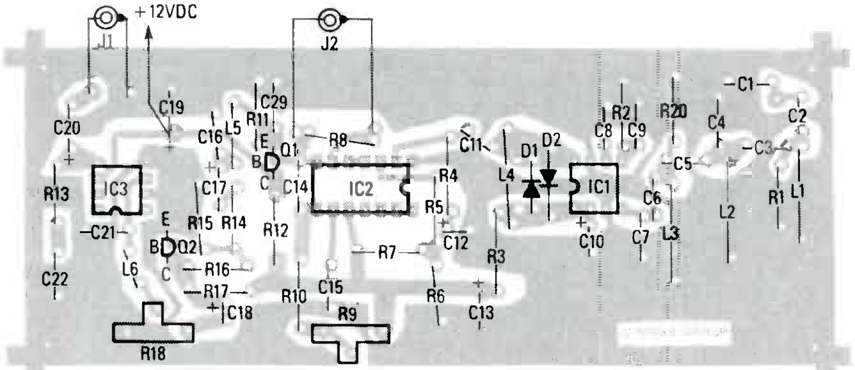


FIG. 4—FM PARTS PLACEMENT. Follow this diagram when building the PC board for the FM receiver.

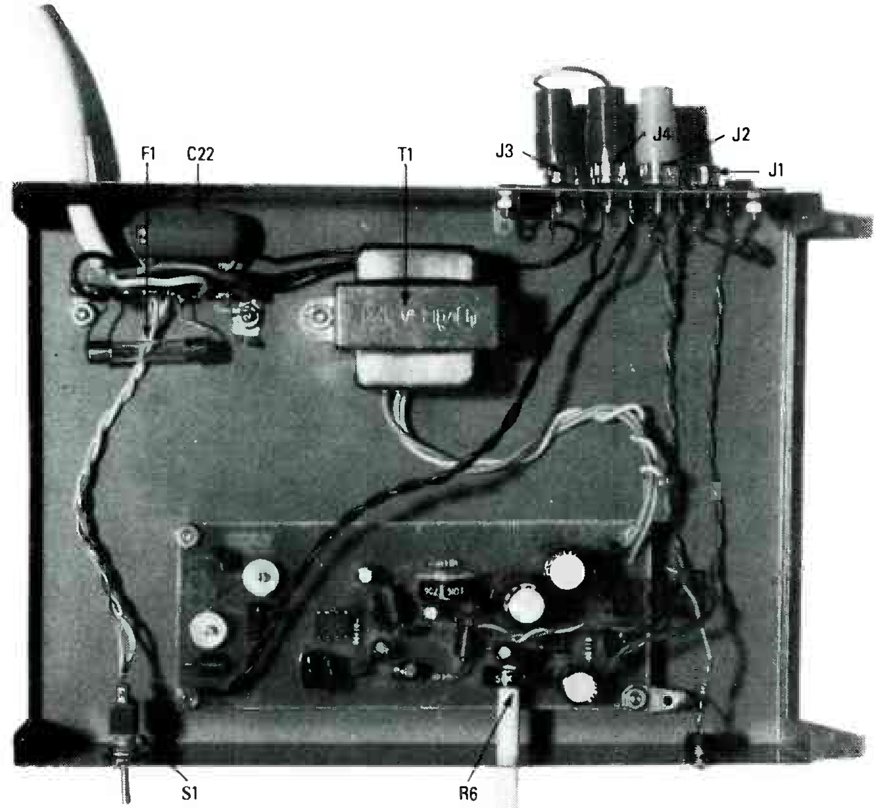


FIG. 5—THE PC BOARD for the AM receiver is installed inside the cabinet as shown. Notice the components that are *not* on the PC board.

Checkout

The following checks should be made before power is applied to either board:

AM receiver

- Check all coils for DC resistance: L1, L2, and L4 should be 48 ohms, and L3 should be 22 ohms.
- IC2, pin 6 to ground: 500 ohms or more (after 10 seconds).
- IC2, pin 5 to ground: 10K or more.
- IC1, pins 1, 2, 4–6, and 8 to ground: no shorts (should read more than 500 ohms).
- Make sure that D1 and D2 are correctly polarized.

Set all potentiometers at halfway, apply DC power, and check for the following positive voltages (all measurements are made with respect to ground):

- Across C20: 16 volts.
- Across C19: 12 volts.
- IC2 pin 5: 6 volts.
- IC1 pins 1, 2, and 8: 11.8 volts.
- Q1 collector: 11 volts.
- Q1 emitter: 6 volts (varies with R5).
- IC1 pin 5: 5 volts (varies with R5).

FM receiver

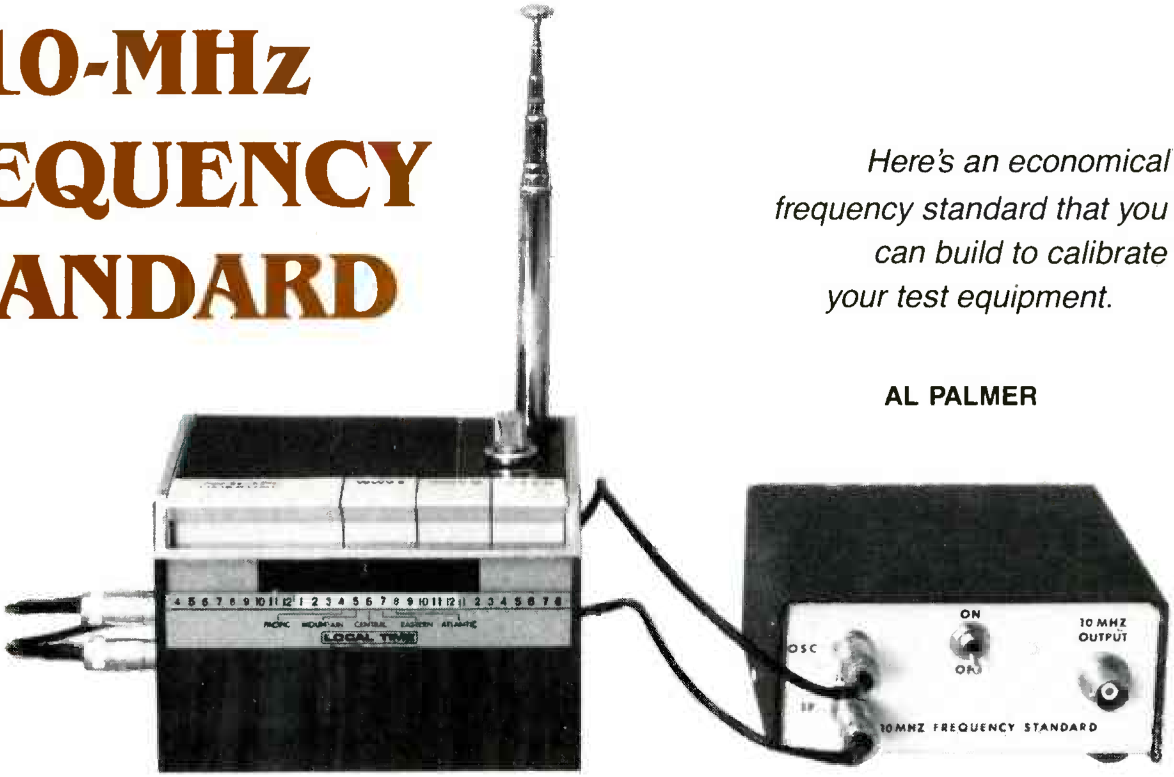
- Check all coils for DC resistance: L1–L4 and L6 should be 48 ohms, and L5 should be 22 ohms.
- IC3 pin 6 to ground: more than 500 ohms (after 10 seconds).
- IC3 pin 5 to ground: more than 10K.

continued on page 94

10-MHz FREQUENCY STANDARD

Here's an economical frequency standard that you can build to calibrate your test equipment.

AL PALMER



YOUR FREQUENCY COUNTER IS GOING TO need calibration—if not today, then in the near future. That's also true for any test instrument that uses a built-in reference oscillator, such as an oscilloscope or signal generator. Calibration means adjusting the instrument's built-in reference oscillator until it matches a known frequency standard. Unfortunately, a highly accurate frequency standard, such as one traceable to the National Bureau of Standards, NBS, is far beyond the budget of most technicians and electronics hobbyists.

With the absence of an NBS-traceable standard, hobbyists usually decide to calibrate their frequency counters against a similar working model. After several calibrations, usually one against another, the law of averages dictates that eventually a frequency counter will end up calibrated to itself. The end result is that no standard at all is being maintained.

The frequency standard detailed in this article resolves the dilemma by providing a calibrator that is accurate, inexpensive, and simple enough to build. The calibrator's output is a 10-MHz square wave that is phase-locked to the WWV 10-MHz radio transmission that's traceable to the NBS in Boulder, Colorado. And, if you want more versatility, later on we'll show you how to modify the unit to phase-lock on to the WWV 2.5-MHz and 5-MHz radio transmission.

Theory of operation

Figure 1 is a block diagram of our 10-MHz frequency standard. It consists of a *Time Kube* superheterodyne AM radio which contains an RF amplifier, a mixer, a local oscillator, two IF amplifiers, a detector, and an audio amplifier. We add to that a circuit containing a mixer and PLL. (We'll call that circuit our "main circuit.")

Let's take a closer look at each stage of the radio receiver. The incoming WWV 10-MHz signal is amplified in the RF amplifier stage, and then sent to the mixer stage where it is combined with the 10.455-MHz output from the local oscillator. Because the mixer is a non-linear device, the two frequencies are heterodyned together creating two additional frequencies in the output; the sum frequency of 20.455 MHz, and the difference frequency 0.455 MHz (or 455 kHz), which is the one we are most interested in (see Table 1). The IF frequency is chosen to be 455 kHz, and the local oscillator is designed to operate 455 kHz above the frequency that's being received.

The purpose of the IF amplifiers is to select out, and amplify, only the difference signal at 455 kHz. The output of the second IF amplifier will be a narrow band of frequencies centered around 455 kHz, which contains all of the audio information present in the original transmission. The IF is then detected, amplified, and heard over the speaker.

Although the WWV 10-MHz incoming frequency to the RF amplifier is extremely accurate, the 455-kHz IF frequency is only as stable as the local oscillator. That means: If the local oscillator drifts 100 Hz off frequency, the center frequency of the IF will also drift 100 Hz off frequency. Although that amount of drift is acceptable as far as listening to audio is concerned, the IF frequency is not accurate enough to be used as a frequency standard unless the drift is compensated for.

As shown in Fig. 1, the main circuit

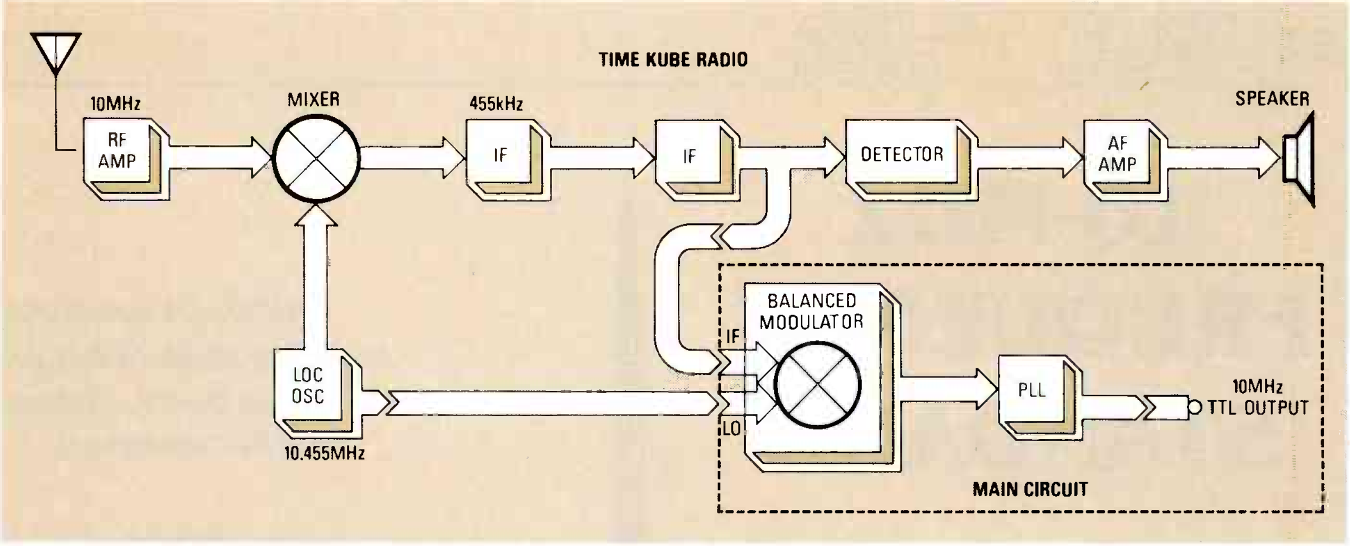


FIG. 1—THIS IS A BLOCK DIAGRAM OF the *Time Kube* radio and the main circuit. However, you can use any superheterodyne AM radio capable of receiving WWV's radio transmissions.

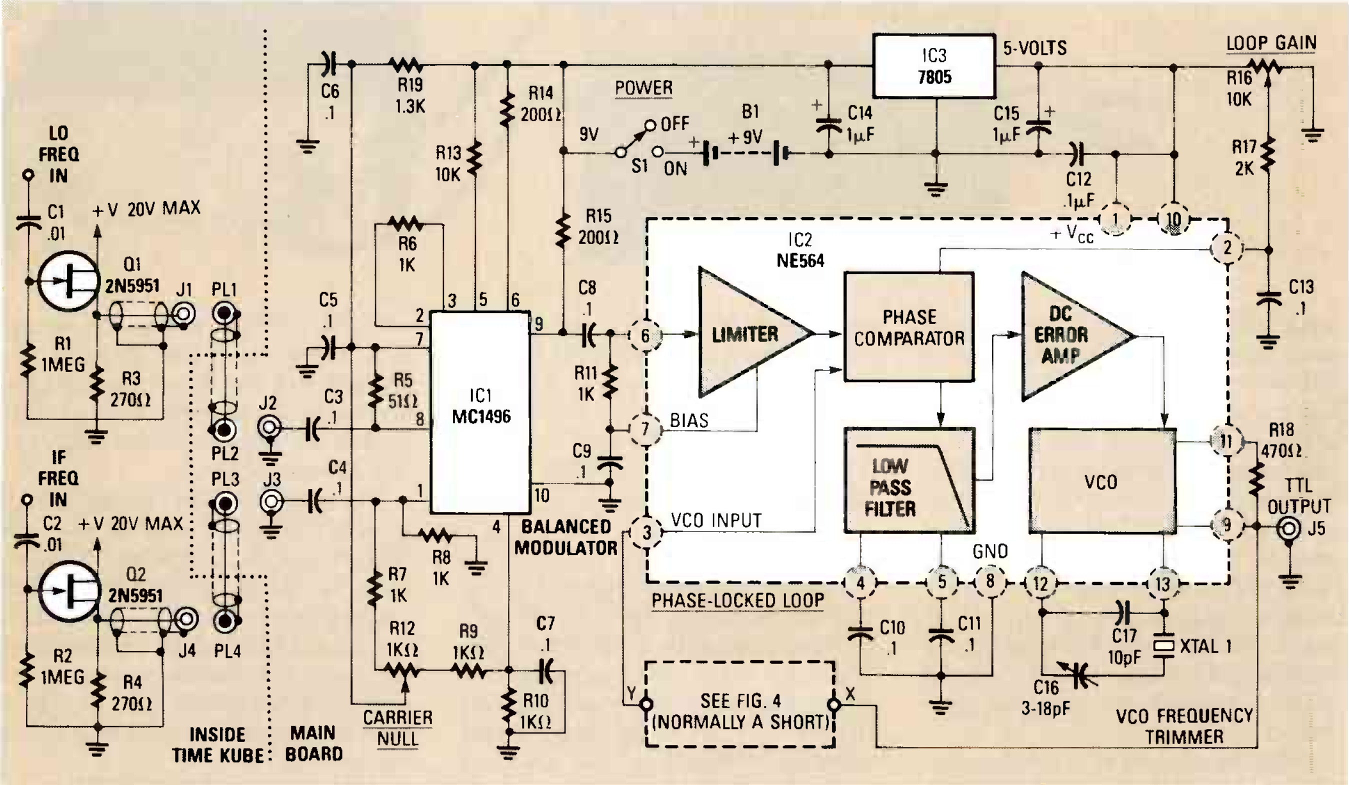


FIG. 2—SCHEMATIC OF THE 10-MHz FREQUENCY STANDARD. FET's Q1 and Q2 are installed inside the radio, and the rest of the components are installed on the main board.

consists of a balanced modulator, which is a type of mixer, and a phase-locked loop. Those two stages cancel any frequency error caused by drifting of the local oscillator, and recreates a signal as accurate as the original WWV 10-MHz signal. For example, if the local oscillator drifts up 100 Hz (10.456 MHz), and then heterodyned with the 10-MHz WWV signal, the IF-difference frequency will now be 456 kHz. When the new IF and local oscillator frquency are heterodyned in the balanced modulator (10.456 MHz − 0.456 MHz), the result is still 10 MHz. In that manner, the balanced modulator will cancel out any drifting in the radio's local oscillator.

The advantage of that approach lies in its simplicity. Any single-conversion superheterodyne short-wave receiver will work, even one where the local oscillator is not crystal-controlled. But the Radio Shack *Time Kube* is self-contained, and relatively inexpensive.

10-MHz frequency standard

Figure 2 is the schematic for the 10-MHz frequency standard. The two FET transistors are installed inside the *Time Kube*, and are used to pick up the IF and the output of the local oscillator without loading down the radio's circuitry. The balanced modulator (IC1) and phase-locked loop (IC2) are part of the main circuit board that we are going to assemble.

Instead of a diode or other nonlinear device, a balanced modulator is used, because that type of mixer produces only two frequencies instead of the usual four; it outputs only the sum and difference frequencies. The two original input frequencies are balanced out and do not appear at the output.

By using a balanced modulator, neither the 10.455-MHz input from the local oscillator, nor the 455-kHz input from the IF amplifier will be present at the output. The closest output frequency of any magnitude will be the 10.91-MHz sum frequency, but 10.91 MHz is far enough away from 10.0 MHz so as not to cause any interference. The phase-locked-loop will lock onto the 10-MHz output of the balanced modulator, and produce a 5-volt peak square wave at the WWV 10-MHz carrier frequency.

A rather unconventional crystal-controlled phase-locked loop is used for two reasons: **1**—the crystal-controlled VCO will not lock up on the wrong frequency (ie. 10.91 MHz); and **2**—even if the WWV-propagated signal is too weak for the PLL to frequency-lock, the output frequency's stability would be controlled by the crystal. (The crystal's accuracy is at least ±0.005%, or 50-parts-per-million, a viable reference for low accuracy of calibration when propagation of WWV is poor.)

Figure 3 shows an AC power supply that you can use in place of the 9-volt battery shown in Fig. 2. Simply connect the 12-volt output to S1, instead of the battery. The foil pattern that we'll show you shortly already has the power-supply components incorporated into it. If you want to use the foil pattern, but would prefer to use a bat-

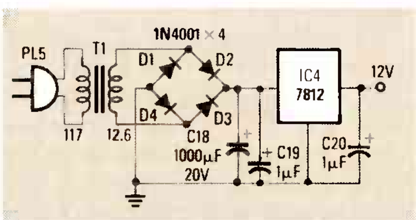


FIG. 3—HERE IS A POWER SUPPLY that you can use if you would prefer not to use a battery.

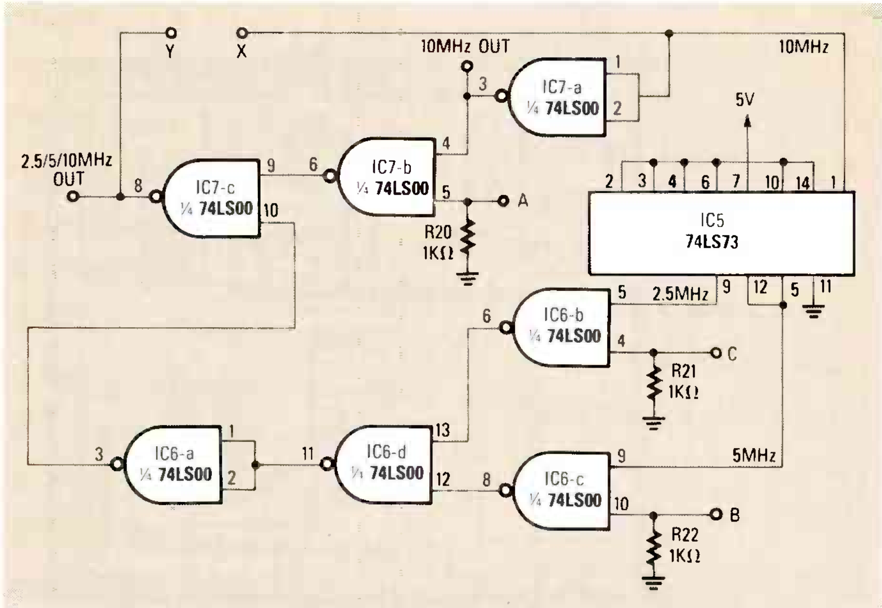


FIG. 4—THIS ADDITIONAL CIRCUITRY will enable your frequency standard to receive the 2.5- and 5-MHz WWV signals. Point "A" must be pulled high for 10 MHz, "B" high for 5 MHz, and "C" high for 2.5 MHz.

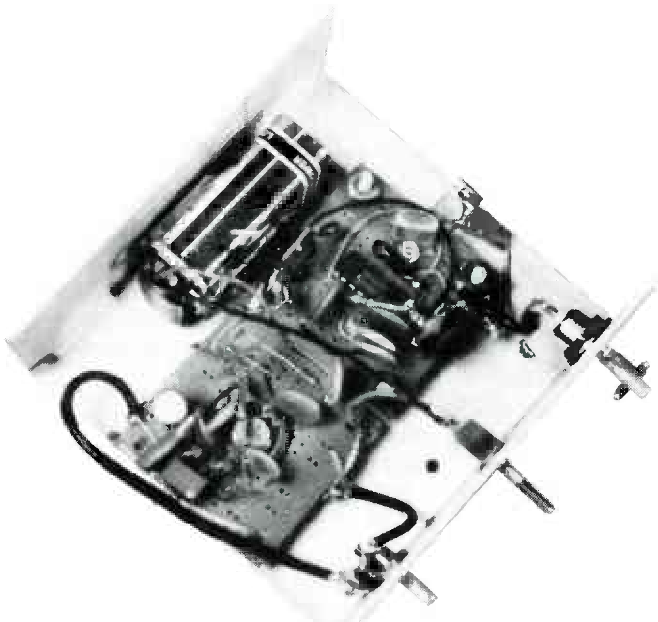


FIG. 5—THE COMPONENTS CAN BE MOUNTED on perforated-wiring board. To help shield the components, a large braided grounding wire runs around the board.

TABLE 1—IDEAL MIXER OPERATION

MIXER

INPUT	OUTPUT
10.0000 MHz RF CARRIER	10.0000 MHz (ORIGINAL)
10.4550 MHz LOCAL OSCILLATOR	10.4550 MHz (ORIGINAL)
	20.4550 MHz SUM
	.4550 MHz DIFFERENCE (IF)

BALANCED MODULATOR

INPUT	OUTPUT
.4550 MHz IF FREQUENCY	10.9100 MHz SUM
10.4550 MHz LOCAL OSCILLATOR	**10.0000 MHz DIFFERENCE**

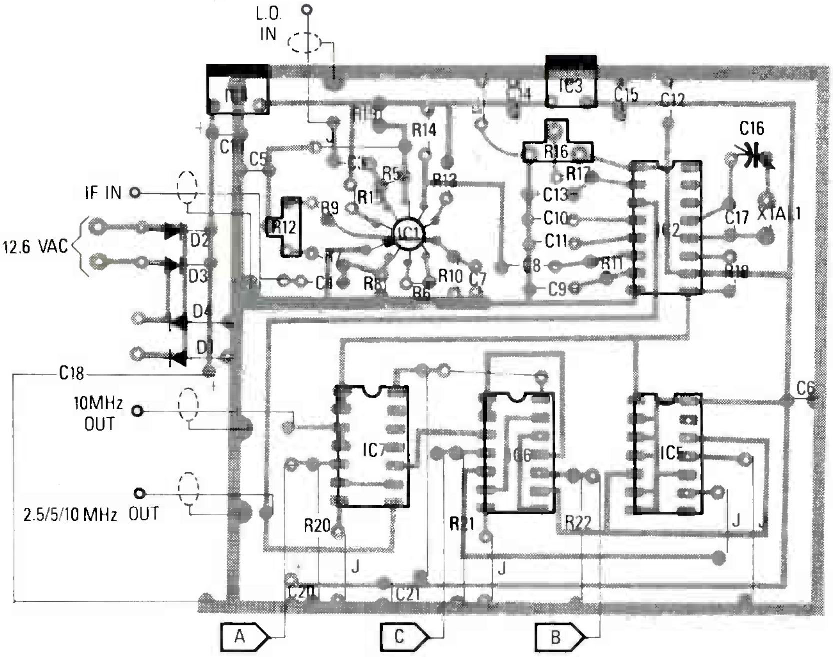


FIG. 6—PARTS PLACEMENT DIAGRAM. The foil pattern in PC Service is being used here, but the parts inside the dashed box are optional. If you don't use them, be sure to put a jumper between pins 9 and 3 of IC2.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.
R1, R2—1 Megohm
R3, R4—270 ohms
R5—51 ohms
R6–R11—1000 ohms
R12—1000 ohm potentiometer
R13—10,000 ohms
R14, R15—200 ohms
R16—10,000 ohm potentiometer
R17—2000 ohms
R18—470 ohms
R19—1300 ohms
Capacitors
C1, C2—0.01µF, ceramic disc
C3–C13, C21—0.1µF, ceramic disc
C14, C15—1µF, 35 volts, tantalum
C16—3–30pF trimmer
C17—10pF, 5%, silver-dipped mica
Semiconductors
IC1—MC1496, balanced modulator, metal-can package
IC2—NE564, phase-locked loop
IC3—7805, 5-volt regulator
Q1, Q2—2N5951, FET transistor
Other components
XTAL1—10 MHz
B1—9-volt battery
S1—SPST toggle switch
J1–J4—phono jacks
J5—BNC jack
PL1–PL4—phono plugs
Miscellaneous: Perforated-construction or PC board, hardware, metal chassis, 50-ohm coax cable, and battery clip.
The following components are for the optional power supply.
C18—1000µF, 20 volts, electrolytic
C19, C20—1µF, 35 volts, tantalum
D1–D4—1N4001 rectifier diode
IC4—7812, 12-volt regulator
T1—117/12.6 volt, 1 amp transformer
PL5—AC plug and line cord
The following components are optional. They are to be used only if you would like to be able to receive all three of the WWV frequencies.
R20–R22—1000 ohms
IC5—74LS73, dual JK flip flop
IC6, IC7—74LS00, quad nand gate

tery, just leave the power-supply components out, and connect the battery as indicated in Fig. 2.

We mentioned before that we would show you how to modify the frequency standard to receive other WWV broadcasts. If your radio has trouble receiving the 10-MHz signal, WWV broadcasts the same information on 2.5, 5, 10, 15, and 20 MHz (we're only concerned with 2.5, 5, and 10 MHz), and perhaps either 2.5 or 5 MHz is coming in better. You will notice in Fig. 2, the connection between pins 9 and 3 of IC2 contains a dashed box that says "see Fig. 4." Normally (if you only want to receive WWV 10-MHz broadcast)that dashed box would be a direct short. However, if you want to have the added versatility of being able to receive three WWV frequencies, the circuitry in

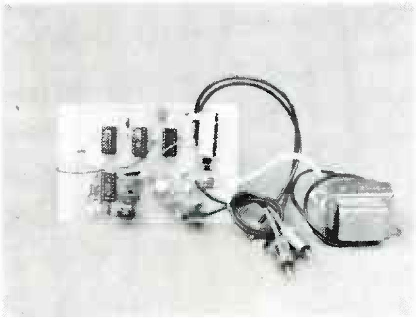


FIG. 7—SHOWN HERE is the completely assembled PC board. Note that this board contains all of the components.

Fig. 4 should be added between points "X" and "Y."

An ancillary benefit from the modification is the ability to select a 2.5 MHz or 5-MHz calibrated output, instead of just the 10-MHz PLL output.

With the modifications, the unit will operate as follows: Assume that the *Time Kube* is tuned in to 5 MHz. The RF input is now 5 MHz, the local oscillator is now 5.455 MHz, and the IF is 455 kHz. The output from the balanced modulator is the difference between the local oscillator and the IF—exactly 5 MHz. The PLL has a free-running frequency of 10 MHz, so in order for it to lock on to the WWV 5-MHz signal, the 10-MHz signal has to be divided by two; to receive the WWV 2.5-MHz signal, the 10-MHz signal has to be divided by four.

When you wish to receive the WWV 10-MHz signal, point "A" must be pulled high; when you wish to receive the 5-MHz WWV signal, point "B" must be pulled high; and when you wish to receive the WWV 2.5-MHz signal point "C" must be pulled high. At the same time, the corresponding frequency must be selected on the *Time Kube* radio. (Note that not all radios can receive the three mentioned frequencies.) Use Fig. 4 as a wiring guide for the additional switches that are required, and mount the board and switches in a cabinet as you see fit.

Construction

Two FET transistors, Q1 and Q2, are used to prevent the main board from loading down the radio's circuits. The FET's should be mounted inside the radio cabinet, using the shortest possible lead lengths to keep them from de-tuning the radio's local oscillator and IF amplifier. Terminate the outputs with RCA jacks mounted on the radio's cabinet. (See the pho-

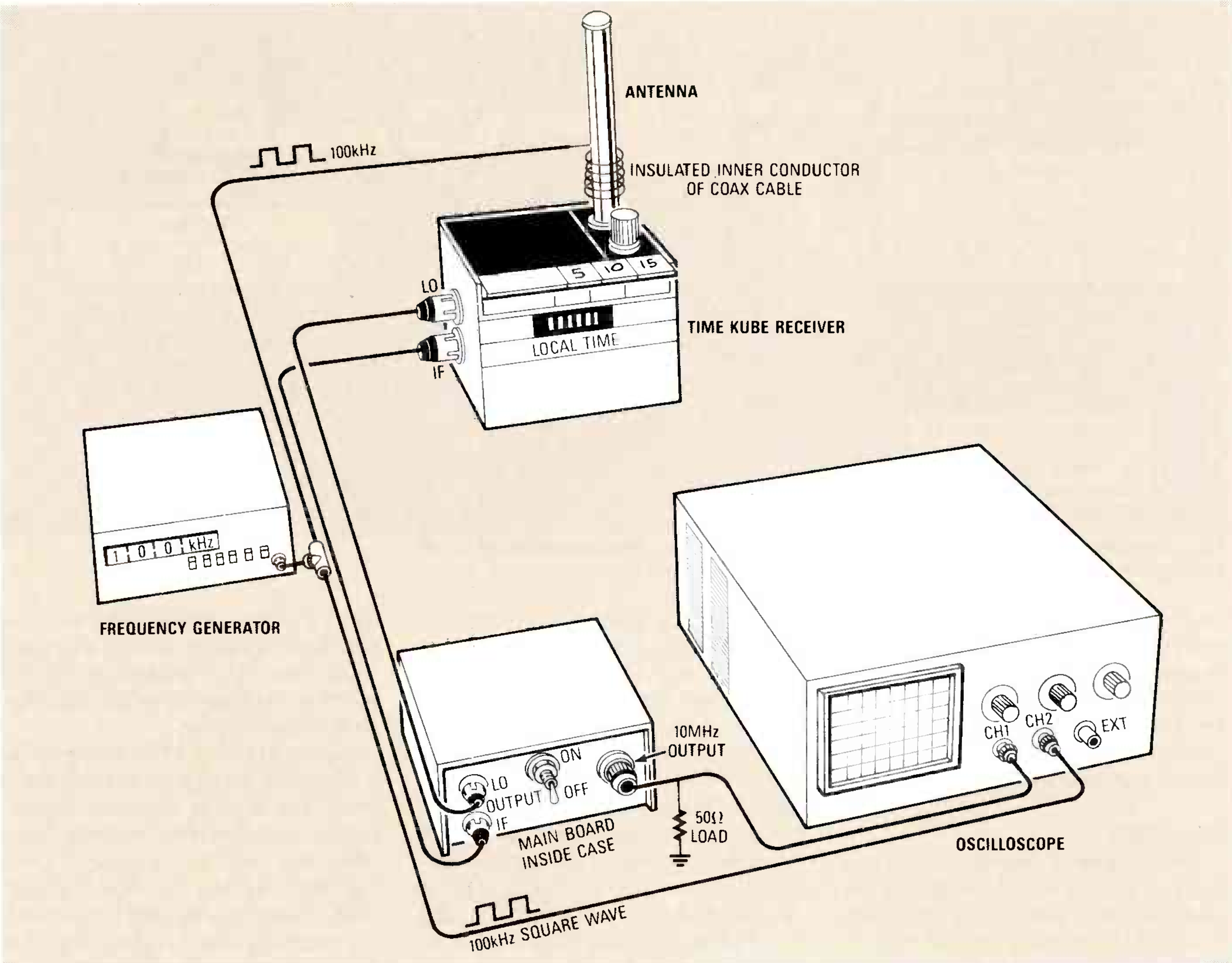


FIG. 8—TEST SETUP for the 10-MHz frequency standard.

tograph in the opening of this article.) The power consumed by the FET transistors is minimal, and can be tapped from the radio's power supply as long as it's less than 20 volts.

Now you have to figure out where to tap off the *Time Kube's* local oscillator and IF frequencies. Whether you use Radio Shack's *Time Kube 12-158*, or the *Weather Time Kube 12-148*, the local oscillator and IF connection points are the same. The points are easy to locate if you have Radio Shack's service manual showing the schematic and the parts layout. In both radios, the local oscillator is a single-transistor and crystal-controlled. The transistor's emitter is the best point to tap off the local-oscillator frequency. In both radios, the IF signal can be tapped off from AM-detector D1's cathode, which immediately follows the second (last) IF transformer.

In constructing the main board, you can use perforated construction board and point-to-point wiring (if you wish) as shown in Fig. 5. However, another alternative is to use the foil pattern shown in PC Service. That pattern is for the 3-output frequency standard, and if you want to use it for the 1-output unit you have to connect a jumper between pins 9 and 3 of IC2, and leave the additional components off the board.

A Parts-Placement diagram is shown in Fig. 6. Note that the parts specified in the Parts List for use only with the 3-output unit are optional. If you leave them out, just be sure to put a jumper between pins 9 and 3 of IC2. Also note, that the 3–30 pF variable capacitor, C16, may need a bit of customizing in order to make it fit on the board. Just make sure that the middle terminal, and one of the side terminals, are soldered to the appropriate pads. Figure 7 shows a photograph of the fully assembled PC board.

If you use point-to-point wiring, it is important to ensure that a good ground is available all around the board. That is best accomplished by running a piece of thickly braided shielding around the edge of the perforated circuit board. The braiding is attached to the metal chassis by heavy screws at both ends, and at the center of the perforated wiring board. The component layout is not critical; however, lead lengths should be kept as

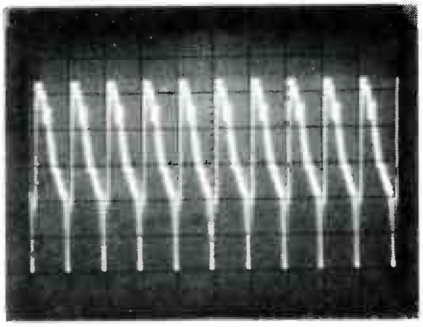


FIG. 9—HERE IS THE PLL's 5-volt peak TTL-compatible output.

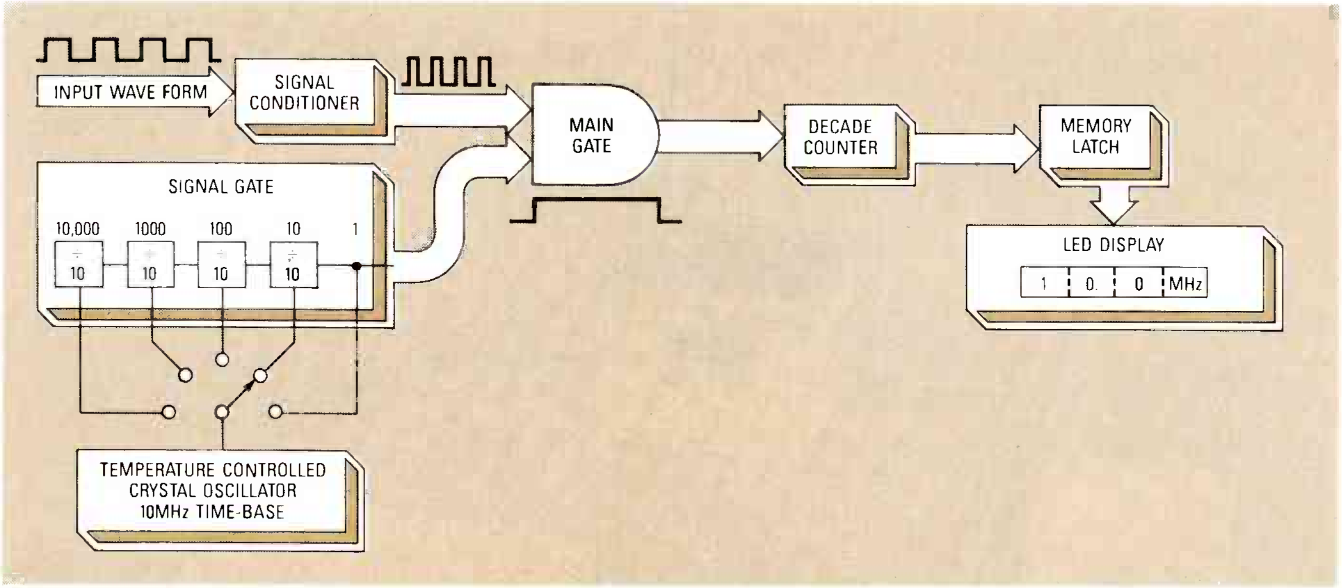


FIG. 10—HERE IS A BLOCK DIAGRAM of a frequency counter. The ultimate accuracy of your counter depends on the accuracy and stability of its time base.

short as possible (see Fig. 5). The perforated wiring board should be mounted in a metal box that is connected to the power supply's ground. For best results, an outside antenna should be connected to the receiver to ensure maximum signal strength.

Alignment

For alignment purposes, you will need an oscilloscope for waveform analysis, and a plastic alignment tool to adjust the trimmer components.

The first step is to balance the two inputs to IC1. Connect the radio's local-oscillator output, *but not the IF output*, to the main board via 50-ohm coax cable. Adjust the balance potentiometer (carrier null), R12, for a minimum-amplitude signal at pin 9 of IC1. The reasoning behind that adjustment is quite simple. When only one signal is input to a balanced modulator there is no heterodyning—therefore, no sum-and-difference output frequencies—and the original input frequency is highly attenuated.

The second step is to adjust the free-running frequency of the PLL's VCO to as close to 10 MHz as possible. That can be done using an oscilloscope, by adjusting trimmer-capacitor C16 so that the period of one complete output cycle is 0.1 μs.

Testing

Before attempting to lock onto the actual 10-MHz WWV signal, let's first test the 10-MHz *Time Kube* receiver and the locking ability of the PLL circuitry. That way you know that the calibration system is working. If you extend the receiver's antenna and the audio output is unintelligible, the chances are that WWV reception is poor. In that case, you'll want to use a directional outdoor antenna, or possibly try WWV reception at different times of the day or night.

Figure 8 shows the test setup. The frequency generator outputs a 100-kHz square wave. By wrapping the insulated center conductor (that carries the square wave from the generator) around the *Time Kube's* antenna, the 100th harmonic will be inductively coupled to the radio's antenna input, which is tuned to 10 MHz. Connect the *Time Kube's* local oscillator and IF outputs, via 50-ohm coax cable, to the main board's inputs. The Phase-Lock-Loop 10-MHz square-wave output is then coupled to CH-1 of your oscilloscope using a 50-ohm termination.

While triggering off the frequency generator's 100-kHz square wave on CH-2, tune the generator in and out a little. Eventually you will find a spot where the 10-MHz harmonic is picked up and the PLL output will lock-up (the 10-MHz signal will be displayed on CH-1). Adjust the PLL's loop-gain trimmer, R16, until the calibrator output can most easily lock onto the 10-MHz input signal. The PLL's 10-MHz output is a 5-volt square wave, as shown in Fig. 9.

Your frequency counter

A digital frequency counter is an instrument that can measure the frequency of any periodic waveform—a sine wave, a square wave, a triangular wave, etc. The frequency of that waveform is then shown on the counter's digital display.

Figure 10 shows a block diagram of a digital frequency counter. Keep in mind that it's the counter's crystal-controlled reference oscillator (time base) that will be calibrated. Once calibrated against the WWV signal, your counter can be used as a secondary reference source (now traceable to NBS) to measure other repetitive waveforms.

The input to the counter is fed into a signal conditioner that outputs one electrical pulse per input cycle. Those pulses having a constant amplitude and width drive the decade counters that follow. The signal-gate output controls the length of time that the main gate will allow the input pulses to pass into the decade counters. For example, when you set the counter for 0.1μs divisions, you're adjusting the length of time that the signal gate asserts the main gate. The frequency counter's time-base oscillator is used as a clock, and therefore must be as accurate as possible.

A counter's accuracy is dependent upon several factors, but it's the time-base generator that determines the ultimate accuracy of your measurement. Quite often, the difference in cost of one counter over another depends on the quality of the time base. You can consult the time-base specifications of your counter for its performance data.

Counter calibration

Now it's time to calibrate your frequency counter. First, connect the calibrator's 10-MHz square-wave output to the input of your counter, just as if you were going to measure the frequency of any other signal. Adjust the counter's time-base trimmer until the digital readout displays 10 MHz. That's it! Your frequency counter is now calibrated to the National Bureau of Standards WWV 10-MHz radio transmission, and is accurate enough to be used to calibrate your other test equipment.

Parts-per-million

Oscillator accuracy is usually expressed in parts-per-million (ppm), or sometimes as a percentage. One ppm is equivalent to 1×10^{-6}, or 1 divided by 1,000,000. That is equal to ±0.000001. To get the accuracy in percentage, simply multiply by 100; that gives you ±0.0001%. If the time-base has a frequency of 1 MHz, and an accuracy of 1 ppm, then it can be off by ±1 Hz and still be within specifications.

As another example, suppose that a time base is specified as having an accuracy of 5%. That percentage represented as a decimal is equal to 0.05, or 5 parts per hundred, or 50 parts per thousand, or 50,000 parts per million. If you have a 1-MHz time base with an accuracy of 5%, then your oscillator's frequency can be off by ±50 kHz, and still be within specifications. That doesn't sound too good for a 1-MHz oscillator, but if the time base is an audio oscillator, then 5% accuracy might be acceptable. In that case, the accuracy is 50 parts per thousand, or ±50 Hz at 1 kHz.

The WWV radio transmission

The most obvious sounds heard on WWV are the pulses that mark the seconds in each minute. At alternate minutes during most of each hour, a 500-Hz or 600-Hz tone is broadcast. A 440-Hz tone (the musical note "A" above middle "C") is broadcast once each hour, and can provide an hourly marker for chart recorders.

There has been a controversy over the years regarding whether the WWV signal, as received via ionospheric propagation, is accurate enough to calibrate the reference oscillators used in today's moderately priced frequency counters. A letter from John Henning that appeared in the "Letters" column of the June 1982 issue of **Radio-Electronics** takes the position that: "WWV as received via ionospheric propagation is not accurate enough to adjust the standard contained in many of today's moderately priced frequency counters." In contradiction to that statement, contacts at the Oscillator Characterization, Time and Frequency Division, Center for Basic Standards at NBS in Boulder Colorado say: "The WWV signal as received via ionospheric propagation is accurate enough to calibrate moderately priced (below $250) commercial frequency counters." Let's examine the reasoning behind that statement.

The RF transmission at WWV, which is controlled by their cesium atomic clock, is transmitted on 2.5, 5, 10, 15, and 20 MHz, and has an accuracy of at least 1 part per 100 billion at the time of transmission. However, the RF wave propagates by skipping between Earth and the ionosphere. The ionospheric skip is principally caused by the F_2 layer, whose height and density above Earth varies at different times of the day and night. The most stable propagation occurs during the daylight hours and during nighttime. (Most signal corruption occurs at sunrise and sunset, when the ionosphere's height above Earth is moving either up or down.) That movement causes a Doppler shift in the WWV RF-carrier as it is refracted back to Earth. The worst case would yield an RF-carrier accuracy of 0.1 parts-per-million (±1 Hz per 10 MHz), but usually the accuracy would be much better.

Let's assume the WWV carrier's worst-case accuracy is 0.1 part per million. As a rule of thumb, to calibrate any device, your frequency standard should have an accuracy one order of magnitude better than the oscillator your calibrating. Therefore, because most moderately priced frequency counters have a reference-oscillator accuracy from 1 to 10 parts-per-million, the 10-MHz WWV RF transmission is useful as a calibration signal. On the other hand, if your reference oscillator is accurate to 0.1 part per million, or better, then the WWV signal is not accurate enough for your purposes. **R-E**

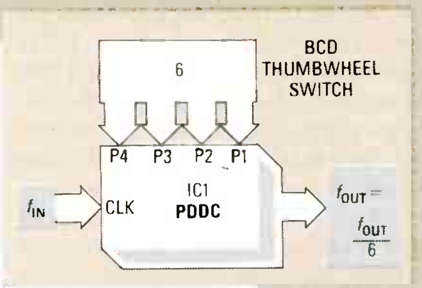


FIG. 1—A PROGRAMMABLE DECADE down-counter (PDDC) can count/divide by any BCD number fed into its PRESET pins.

DOWN-COUNTER COOKBOOK

Presettable down-counters do more than you think.

RAY MARSTON

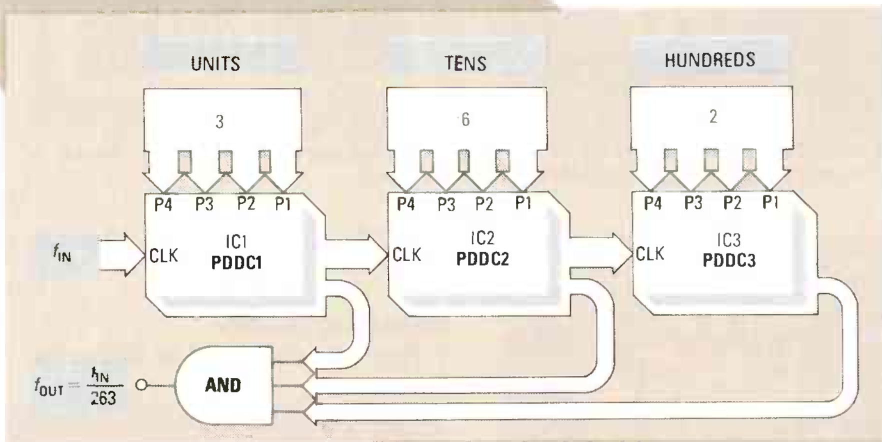


FIG. 2—PDDC's HAVE *PROGRAMMABLE CASCADABILITY*; the output is equal to the sum of the individual division ratios.

LET'S EXAMINE PRESETTABLE DOWN-counters; how to design frequency dividers, frequency synthesizers, and alpha-numeric displays.

Jam inputs

By feeding a binary number into their PRESET pins—often called JAM pins—those counter IC's can be externally programmed to divide-by any binary number: either *B*inary *C*oded *D*ecimal (BCD), or straight binary form. For example, Fig. 1 shows a *P*rogrammable *D*ecade *D*own *C*ounter (PDDC) having a BCD code fed into its PRESET inputs via a thumbwheel switch.

The unique feature of the PDDC is known as *programmable cascadability*. As shown in Fig. 2, the *hundreds* counter is set to divide-by-2, the *tens* counter is set to divide-by-6, and the *units* counter is set to divide-by-3, which has an overall division ratio of 200 + 60 + 3, or 263. On the other hand, Fig. 3 shows that when conventional counters are cascaded with the same division ratios they would, of course, have a resultant of 200 × 60 × 3, or 36,000. We see that the presettable-types output the sum of the division ratios, while the conventional-types output the product of the division ratios.

Practical PDDC's can be programmed by a variety of methods. The two most common are electromechanical programming via thumbwheel switches, and there's electronic programming via microprocessor control.

Preset truth table

Figure 4-*a* shows a PDDC 4-stage synchronous down-counter, which shifts down one count for each positive transition of the CLOCK signal. Note however, as shown in Fig. 4-*b*, that when the down count reaches BCD 0 (ØØØØ), the next arriving clock pulse causes the counter to jump to BCD 9 (1ØØ1).

Other features of the PDDC include the following: The CLOCK signal can be disabled by a high level on the INHIBIT control. A decoded ZERO OUTPUT goes high only when the Q4-Q1 outputs are in the ØØØØ state. Also, by applying a high level to the LOAD pin, the counters are forced to take up the BCD states of the PRESET inputs.

Programmable down-counter

Figure 5 shows a PDDC hookup that will count down from a BCD number loaded into the PRESET pins, by depressing the *start* button. For example, suppose the BCD number 6 (Ø11Ø) is loaded via the *start* button. On the arrival of each CLOCK pulse, the IC counts down one step, going through the numbers 5, 4, 3, 2, 1 and, finally, on the arrival of the 6th pulse, to 0, at which point the ZERO OUTPUT pin goes high. That logical high is fed back to the INHIBIT pin, causing all further CLOCK pulses to be ignored. The count sequence is now completed, but can be restarted only by depressing the *start* button once again.

Figure 6 shows how two PDDC's can be cascaded to make a down-counter having a count of 26. Notice that the ZERO OUTPUTS of both IC's are inputs to a logical AND gate that triggers the INHIBIT control of PDDC1. Also, the CLOCK signal of PDDC2 comes from the Q4 output of PDDC1. When the *start* button is depressed, counting action of the circuit is as follows: The BCD number 2 (ØØ1Ø) is loaded into the *tens* counter; the BCD number 6 (Ø11Ø) is loaded into the *units* counter; after which, the CLOCK input signal is initiated. PDDC1 counts down from 6 to 0 through the first six clock pulses. But then, because both IC's ZERO OUTPUTS are not high, PDDC1 is not inhibited. Instead, it starts acting as a divide-by-10

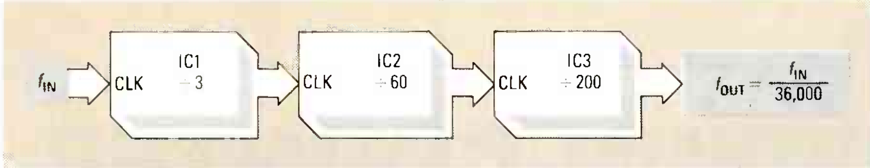
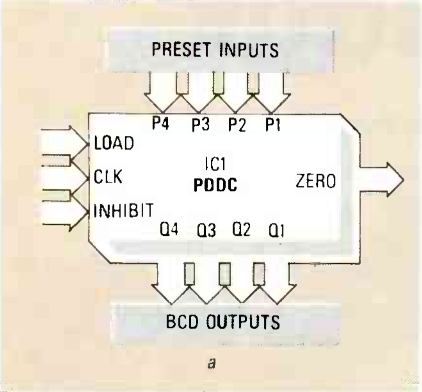


FIG. 3—WHEN CONVENTIONAL COUNTERS ARE CASCADED, the final output is equal to the product of the individual division ratios.



COUNT SEQUENCE	Q4	Q3	Q2	Q1	BCD NUMBER
	OUTPUTS				
n+1	1	0	0	1	9
n+2	1	0	0	0	8
n+3	0	1	1	1	7
n+4	0	1	1	0	6
n+5	0	1	0	1	5
n+6	0	1	0	0	4
n+7	0	0	1	1	3
n+8	0	0	1	0	2
n+9	0	0	0	1	1
n	0	0	0	0	0

b

FIG. 4—FUNCTIONAL DIAGRAM OF A PDDC. A 4-stage synchronous down counter is shown in (*a*), together with its truth table shown in (*b*).

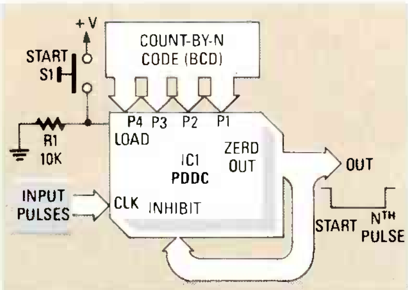


FIG. 5—PDDC CONNECTED AS a programmable down-counter.

counter, and counts down from BCD number 9 (code 1ØØ1) on the arrival of the 7th pulse, simultaneously sending a single CLOCK pulse to PDDC2 as Q4 output switches high. Ten pulses later (on the 17th pulse), PDDC1 sends another CLOCK pulse to PDDC2, causing its ZERO OUTPUT to go high. Nine pulses later (on the 26th pulse), the ZERO OUTPUT of PDDC1 also goes high, at which time the output of the AND gate goes high, inhibiting further counting action.

Figure 7 shows how to connect a single PDDC as a programmable timer. The output goes high as soon as the *start* button is depressed, but goes low again after a programmed amount of time. The circuit is the same as Fig. 5, except that the final output is inverted, and the CLOCK signal is taken from a fixed time-reference source (1 pulse/second). Looking back, Fig. 6 can also be made to act as a programmable timer by similarly inverting its final output, and taking the CLOCK signal from a fixed time-reference source.

Frequency division

Figure 8 shows how to connect a PDDC as a programmable frequency-divider. The divide-by-N code is fed to the PRESET pins. The output of the counter is taken from the ZERO OUTPUT pin, and is coupled back to the LOAD pin. Suppose the starting BCD number 4 (Ø1ØØ) has been loaded into the counter. On the arrival of the 1st CLOCK pulse, the counter decrements to 3, on the 2nd pulse to 2, on the 3rd pulse to 1, and on the 4th pulse to 0. At which point, the ZERO OUTPUT goes high, and that loads the BCD number 4 (Ø1ØØ) back into the counters. Now the whole sequence starts over again, and the ZERO OUTPUT switches back low. Thus, the counter repeatedly counts by the number set on the PRESET inputs, and the output (from the ZERO OUTPUT pin) takes the form of a narrow pulse only a few hundred nanoseconds wide.

Figure 9 shows a PDDC connected as a simple divide-by-10 counter/divider. The LOAD pin is grounded, so the PRESET codes have no effect and the counter repeatedly cycles through its basic BCD count from 9 to 0, and then back to 9 again, and so on. The output is taken from the ZERO OUTPUT

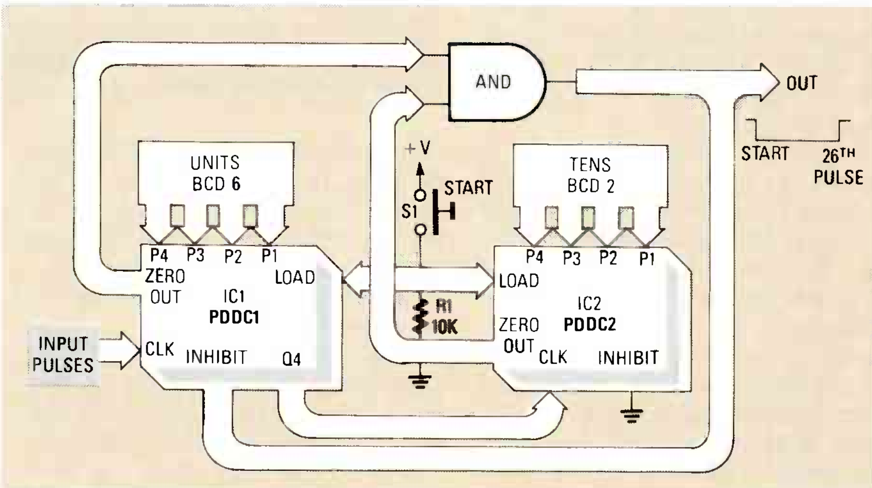


FIG. 6—TWO-IC (CASCADED) PROGRAMMABLE DOWN-COUNTER that is set for count 26 operation.

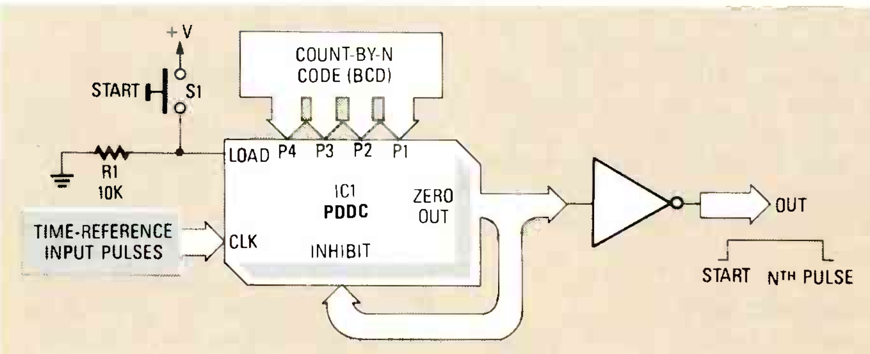


FIG. 7—PDDC CONNECTED AS A programmable timer.

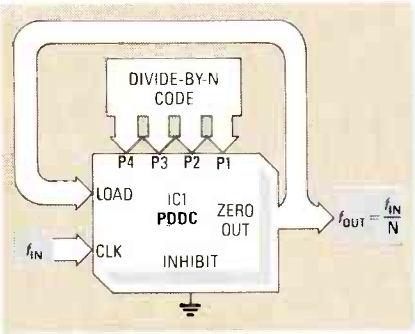


FIG. 8—PDDC CONNECTED AS A PROgrammable frequency-divider. The PDDC counts down to 0000 from the PRESET inputs—the ZERO OUTPUT pin is a narrow pulse of a few nanoseconds.

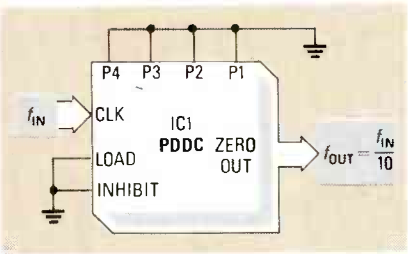


FIG. 9—PDDC CONNECTED AS A decade frequency-divider. The LOAD pin is grounded, so the PRESET pins have no effect on the circuit, consequently, the counter cycles through its basic decade count, from 9 to 0.

pin, which remains low until the all-zero count, when it pulses high for a few nanoseconds.

Figure 10 shows how to cascade two PDDC's to make a programmable frequency-divider. The ZERO OUTPUTS of the two counters are inputted to an AND gate to provide the LOAD action, and the CLOCK signal of PDDC2 is derived from the Q4 output of PDDC1. For example, assume that at the start of the count cycle the BCD number 24 (0010,0100) is loaded into the counters. For the first few counts, PDDC1 counts down from 4 to 0, and then the ZERO OUTPUT goes high. However, because PDDC2's ZERO OUTPUT is low, the AND gate's output does not go high; that would reload the counters. But instead, PDDC1 reverts to the normal divide-by-10 mode, jumping to the 9 state, simultaneously feeding a clock pulse to PDDC2 as Q4 output switches high. That action continues until the arrival of the 24th pulse, when the ZERO OUTPUTS of both IC's go high together. At that time, the output of the logical AND gate goes high (for a few nanoseconds), and reloads the BCD number 24 back into the counters. The whole sequence then starts over again.

Frequency synthesis

The main application of programmable frequency-dividers, as shown in Fig. 11, is in frequency synthesizers when used in conjunction with a (PLL) *P*hase *L*ocked *L*oop. Notice that the output of a *V*oltage *C*ontrolled *O*scillator (VCO) is fed, via the programmable divide-by-N counter, to one input of a phase detector. The other phase-detector input is taken from a (fixed frequency) crystal-controlled reference generator. The phase detector produces an output voltage proportional to the difference between the two input frequencies. That voltage is filtered into a DC voltage, and fed to the VCO's control input that automatically adjusts the VCO's frequency. When the output of the divide-by-counter is the same as the reference generator, the PLL is said to be locked.

Notice that in Fig. 11, the output frequency of the VCO is N-times the value of the frequency reaching the input of the phase detector. Consequently, when the PLL is locked, the output frequency of the VCO is equal to N-times the reference frequency; for example, if N = 236, and the reference frequency = 1 kHz, then the VCO frequency output equals 236 kHz, and also has crystal accuracy.

4522B/4526B down counters

The best-known family of CMOS programmable (cascadable) down-counters is shown in Fig. 12; it is composed of the 4522B (decimal) and the 4526B (binary) 4-bit IC's, which both have the same pinout. Those IC's are almost identical to Fig. 4, except that the counters can be synchronously set to the zero state by forcing the MR (master reset) pin high. The AND gate is built into the ZERO OUTPUT line, so the ZERO OUTPUT can only go high if the CF (cascade feedback) pin is also high; that enables cascading without external gates.

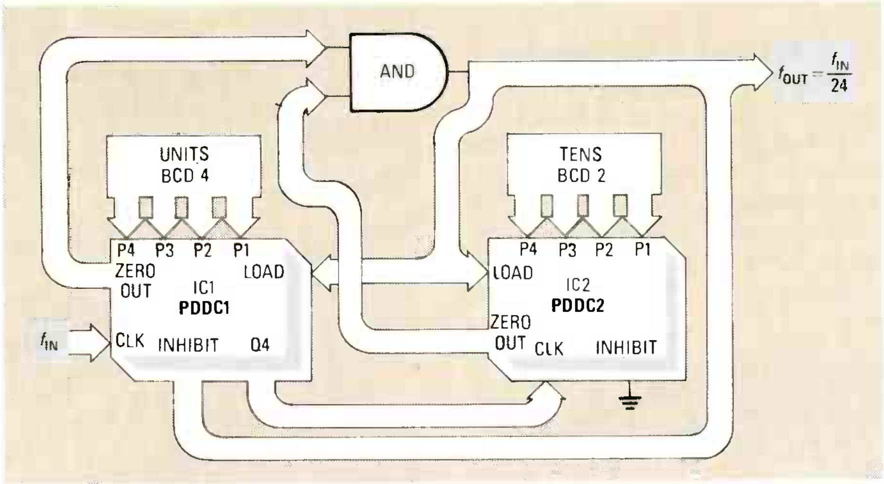


FIG. 10—TWO-IC (CASCADED) PROGRAMMABLE FREQUENCY-DIVIDER, set for divide-by-24 operation.

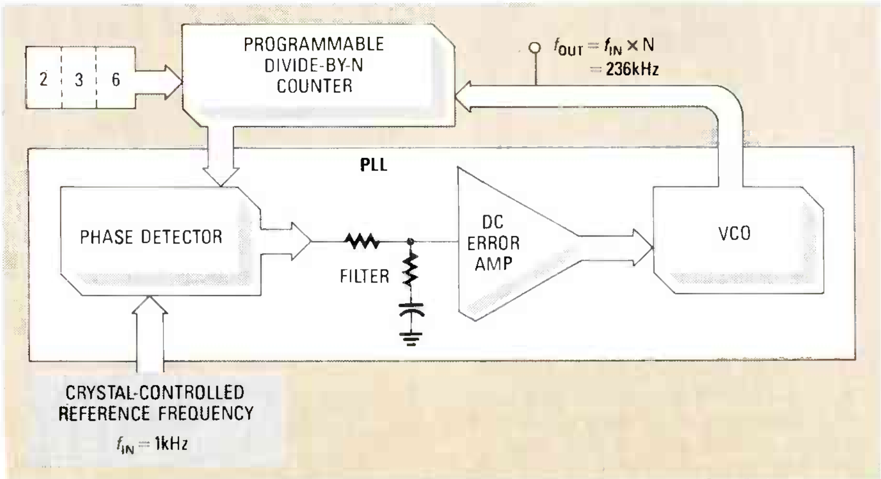


FIG. 11—A PROGRAMMABLE FREQUENCY-SYNTHESIZER can be constructed using a divide-by-N counter in conjunction with a PLL.

The 4522B and 4526B can be used in the same ways as the counters shown in Figs. 5 to 11, except that the MR pin is normally grounded, and the AND gate is built into the IC. When those IC's are used alone, the CF pin must be tied high to enable the ZERO OUTPUT. When cascading two or more IC's, tie the ZERO OUTPUT of the *M*ost *S*ignificant *D*igit (MSD) IC to the CF pin of the IC that is used for the next most significant digit, repeating the process until the *L*east *S*ignificant *D*igit (LSD) IC is reached. Figure 13 shows the hookup for making a 2-stage programmable down-counter, and Fig. 14 shows the connections for a 2-stage programmable frequency-divider.

When using those IC's, notice that all unused inputs, including PRESETS, must be tied high or low, as appropriate. Also, the outputs of all internal counter stages are available through the Q output pins, enabling the counter states to be decoded by using external circuitry.

40102B/40103B down counters

Each IC in the 40102B and 40103B family of devices (see Fig. 15-*a*) effectively act as a pair of presettable 4-bit down counters, cascaded in a single package. The ZERO OUTPUT that goes low under the zero-count condition is the only externally available counting signal. That's in contrast to the Q outputs typically available on other counter IC's. The truth table in Fig. 15-*b* is common to both IC's. The 40102B is a 2-decade BCD down-counter, while the 40103B IC is an 8-bit (or two 4-bit words) binary counter. Both types of counters clock down on the positive transition of the CLOCK signal.

Codes that are applied to the eight

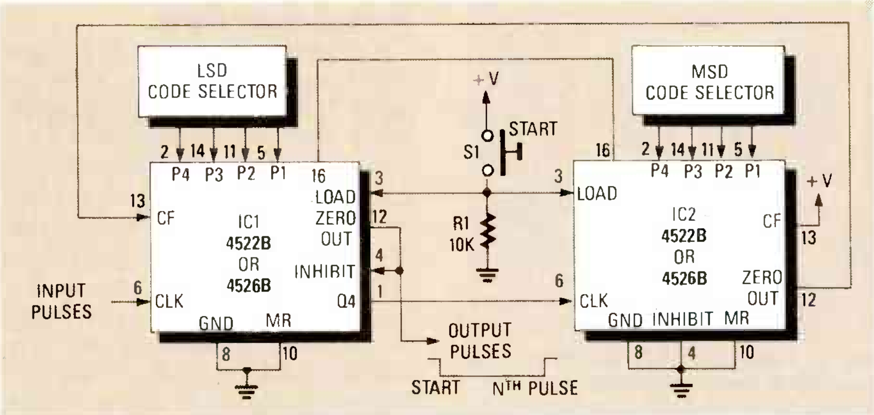


FIG. 13—TWO-IC (CASCADED) PROGRAMMABLE DOWN-COUNTER using the 4522B or 4526B.

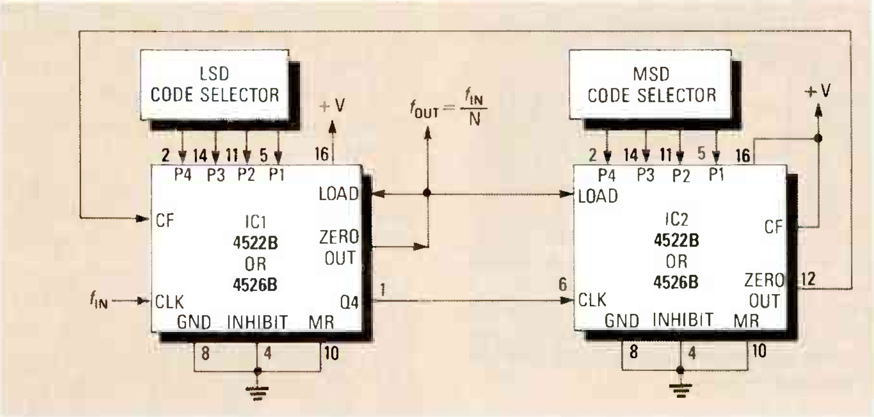
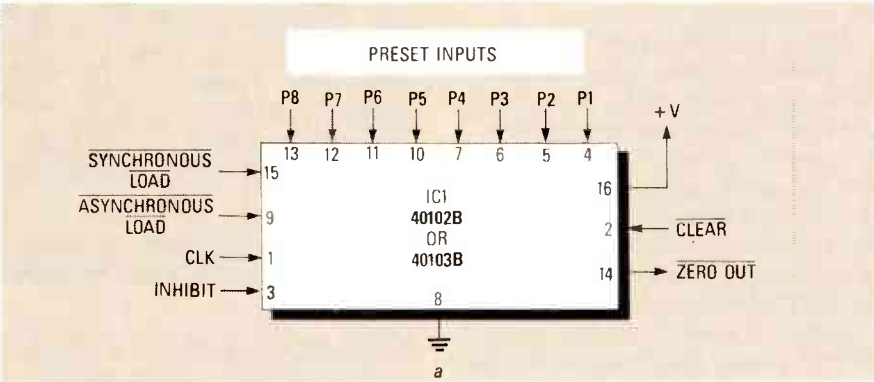


FIG. 14—TWO-IC (CASCADED) PROGRAMMABLE FREQUENCY-DIVIDER using the 4522B or 4526B.



CONTROL INPUTS CLR	AL	SL	INH	LOAD MODE	ACTION
1	1	1	1	SYNC	INHIBITS COUNTER
1	1	1	0	SYNC	COUNT DOWN
1	1	0	X	SYNC	LOAD ON NEXT CLK PULSE
1	0	X	X	ASYNC	LOAD ASYNCHRONOUSLY
0	X	X	X	ASYNC	CLEAR TO MAXIMUM COUNT

b

FIG. 15—FUNCTIONAL DIAGRAM *(a)* AND TRUTH TABLE *(b)* of the 40102B dual-decade and 40103B 8-bit binary down-counters.

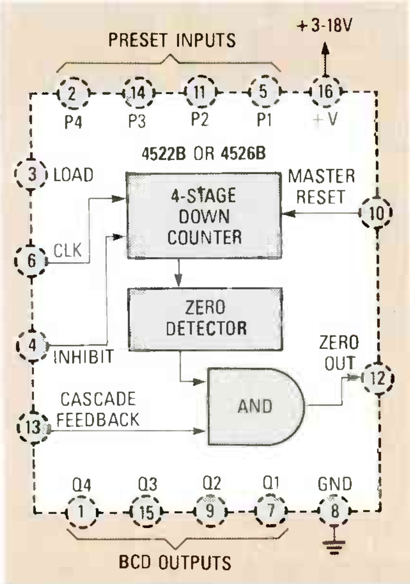


FIG. 12—THE 4522B (DECADE), AND 4526B (BINARY) programmable down-counters. Those are the same as the PDDC counters except that the AND gate that's used when cascading IC's is integrated into the IC.

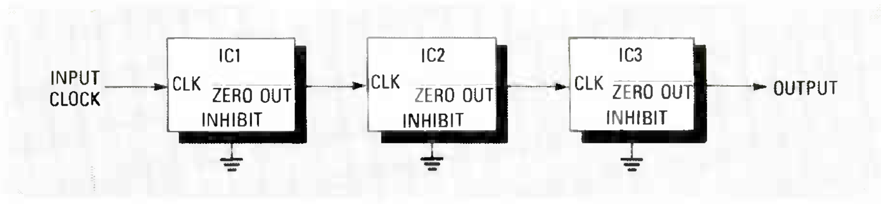


FIG. 18—METHOD OF RIPPLE CASCADING 40102B or 40103B counters.

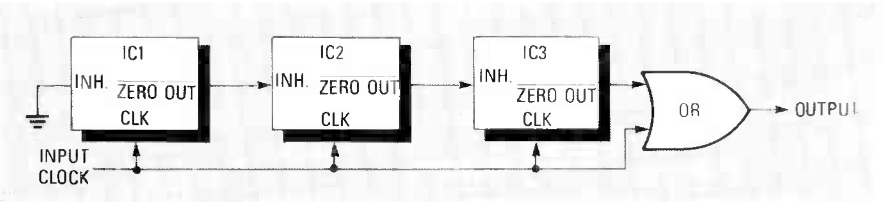


FIG. 19—METHOD OF SYNCHRONOUS CASCADING 40102B or 40103B counters.

PRESET pins of those IC's can be loaded asynchronously by pulling the $\overline{AL}$ pin low, or synchronously on the arrival of the next CLOCK pulse by pulling the $\overline{SL}$ pin low. When the $\overline{CLR}$ input is pulled low, the counter asynchronously clears to its maximum count. When the INH control is pulled high, it inhibits both the CLOCK counting action, and the ZERO OUTPUT action. The INH control thereby acts as a CARRY-IN pin for cascading counter IC applications.

Figures 16 to 19 show four ways of using that family of presettable down-counters. Figure 16 shows the connection for making a programmable 8-bit, or 2-word timer, or down-counter. Figure 17 shows the circuit of a programmable frequency-divider that has divide-by-(N + 1) operation. Its ZERO OUTPUT going low for one full clock cycle under the zero-count condition. True divide-by-N operation can be obtained by tying $\overline{SL}$ high and connecting ZERO OUTPUT to $\overline{AL}$; the output pulses will have widths of only a few hundred nanoseconds.

Finally, Figs. 18 and 19 show the basic connections that are used to cascade 40102B or 40103B stages in large-word programmable applications. Figure 18 shows the counter hookup for the fully synchronous clocking that's needed when used for high-speed applications.

Decoders

Most of the counter/dividers that we've looked at have 4-bit coded outputs, which take the standard code forms shown in Fig. 20-*a*. Thus, when the counters are in the BCD-5 state, they have an output code of Ø1Ø1. When in the BCD-7 state, they have an output code of Ø111 (read with Q4 to the left). Individual output states of the counters can easily be decoded and used for driving external display units or control lines, by using the basic logic technique shown in Figs. 20-*b* and 20-*c*. The decoder outputs that are high (logic-1) in the desired code state are fed directly to the inputs of a 4-input AND gate, and those that are low are fed through an inverter. If BCD numbers are to be decoded, and the numbers fall between 2 and 7 inclusive, the Q4 code can be ignored, and a 3-input AND gate can be used.

If more than three code states are to be decoded, it's economical to use dedicated CMOS decoder IC's, such as the 4028B, 4514B or 4515B. The 4028B in Fig. 21 is a 4-bit BCD-to-Decimal decoder that has direct decoding of the ten possible input BCD numbers 0 to 9 inclusive. Only one of the ten decoded outputs will go high with the remaining outputs low. The 4514B and 4515B in Fig. 22 are full 4-bit binary decoders having an individual output for each of the sixteen possible code numbers. The 4514 has *active high* outputs; that means that all outputs are low except the decoded line, which is high. The 4515B has *active low* outputs. Those IC's are considerably more sophisticated than the 4028B type, and they have their FOLLOW/$\overline{LATCH}$ control on pin-1, and they have a DECODE INHIBIT control on pin-23.

When the DECODE INHIBIT pin is brought high, all decoding functions are disabled; it drives all outputs low in the 4514B, or all outputs high in the 4515B, irrespective of the states of all other pins. When the FOLLOW/$\overline{LATCH}$ pin is high, the IC's act as straight decoders; but when the pin is pulled low, it latches the prevailing input code into memory and retains it, irrespective of the subsequent states of the input code.

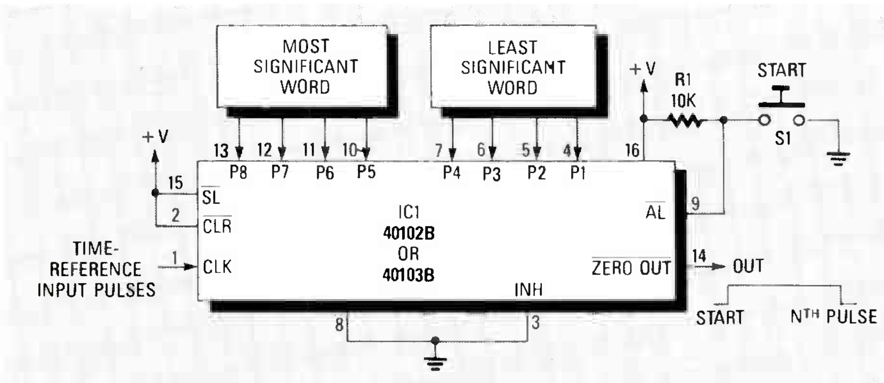


FIG. 16—PROGRAMMABLE TIMER using a 40102B or 40103B.

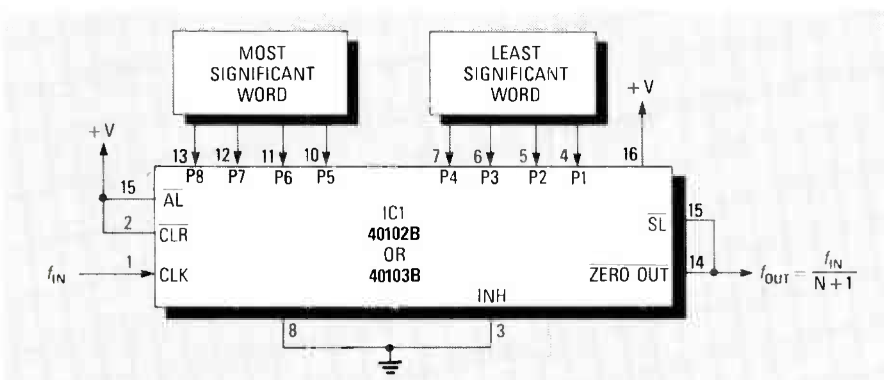


FIG. 17—PROGRAMMABLE FREQUENCY DIVIDER (divide-by-N + 1).

DECIMAL	Q4	Q3	Q2	Q1
		OUTPUTS		
0	0	0	0	0
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
10	1	0	1	0
11	1	0	1	1
12	1	1	0	0
13	1	1	0	1
14	1	1	1	0
15	1	1	1	1

4-BIT BCD CODES (0–9); 4-BIT BINARY CODES (0–15)

a

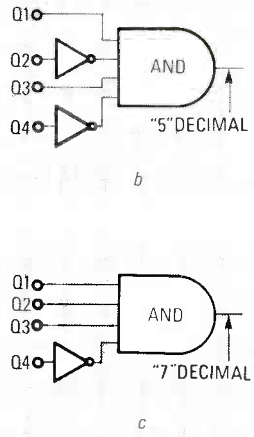


FIG. 20—THE CODED Q4-Q1 OUTPUTS of a 4-bit counter are shown in *(a)*, while *(b)* and *(c)* show how to decode the numbers 5 and 7, respectively.

The most popular CMOS IC for driving 7-segment LED displays is the 4511B BCD-to-7-segment decoder/LED-driver, shown in Fig. 24. That IC is ideally suited for driving common-cathode displays because its outputs can each source up to 25 milliamperes of current.

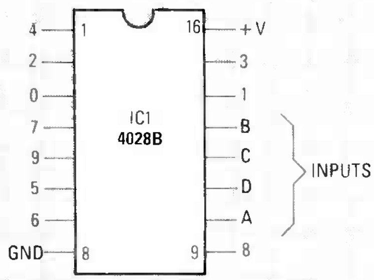


FIG. 21—PINOUT OF THE 4028B bcd-to-decimal (1-of-10) decoder.

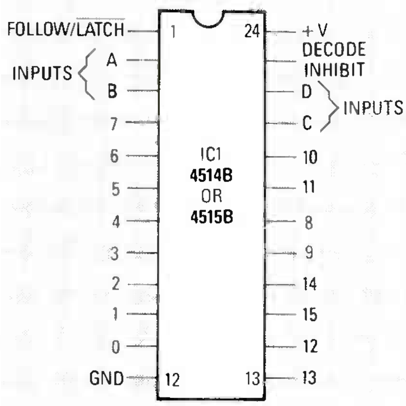
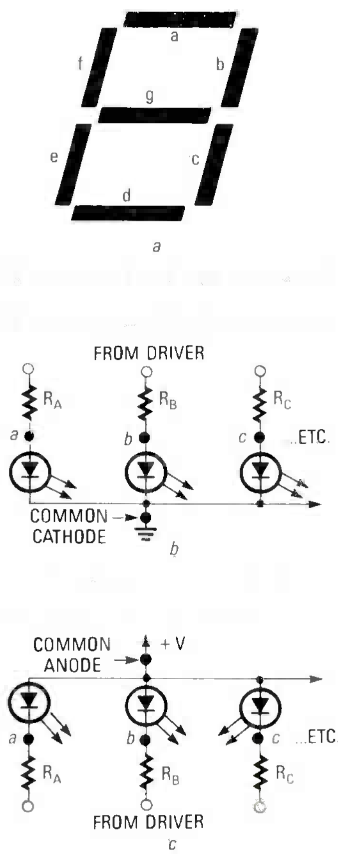


FIG. 22—PINOUT OF THE 4-BIT BINARY (1-of-16) decoders, the 4514B (active-high output) and the 4515B (active-low output).

BCD-to-7-segment decoder

The BCD outputs of decade counters can easily be decoded and used to drive 7-segment (*l*ight *E*mitting *D*iodes) LED's, or (*L*iquid Crystal *D*isplays) LCD's, by using suitable decoder/driver IC's. The 7-segment displays have the standard format and pin notations shown in Fig. 23-*a*, with each LED segment having its own individual pin. LED 7-segment displays are available in either common-cathode form shown in Fig. 23-*b*, or common-anode form shown in Fig. 23-*c*. Common-cathode types must be driven by IC's that can source significant current, while common-anode types must be activated by devices that can sink a significant amount of current. Notice that a current-limiting resistor must be wired in series with each LED segment.



IG. 23—THE 7-SEGMENT LED (OR LCD) DISPLAYS have the standard segment format shown in *(a)*. The LED types are available as either common-cathode *(b)*, or commom-anode *(c)* types.

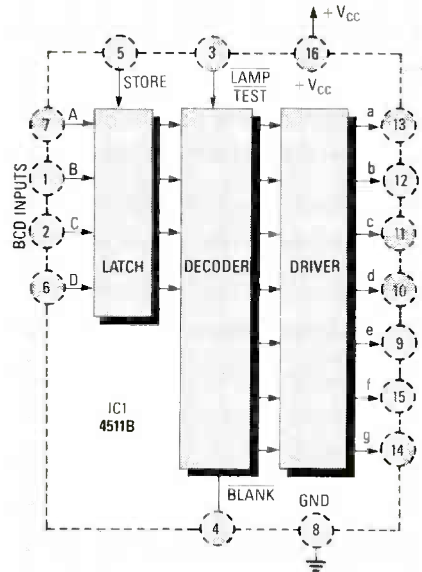


FIG. 24—THE 4511B BCD-TO-7-SEGMENT Latch/Decoder/LED-Driver. This single IC has the combined capability of a 4-bit data latch, a BCD-to-7-segment decoder, and a transistor-driver output for LED displays.

The 5411B is an easy IC to use. It has 4 pins as a BCD input, an output driving pin for each of the seven LED segments, and only three input control pins. The LAMP TEST input pin is normally tied high; when pulled low, it turns on all seven segments of the display, irrespective of the input code. The BLANK input pin is also normally tied high; when pulled low, it turns off all display segments, irrespective of the input code. The STORE control enables the IC to have either transparent or latched decoder operation. When STORE is low, the IC has transparent decoding of the BCD inputs. When STORE is switched high, the BCD input that is present at the moment of switching is latched into an internal memory and then decoded. That BCD number is held as long as STORE remains high.

7-segment LCD drivers

The 7-segment LCD's (*L*iquid Crystal *D*isplays) have the same format as LED types, except that their common pin is known as the *back-*

plane (BP). LCD's must be driven by AC signals that have virtually no DC components. In practice, the AC signal takes the form of a square wave with a frequency in the 30-Hz to 200-Hz range.

Old-style LCD drivers relied on the use of dual power supplies to provide the AC drive. Modern types, however, use the bridge-supply technique, shown in Fig. 25-*a*, to provide the necessary AC drive. When a segment is turned on using the bridge supply, the segment and backplane are driven by antiphase square waves. The resulting voltage across the LCD is AC as far as the display is concerned; it's the value of segment voltage relative to the backplane voltage that is important. Lets examine how that works. In Fig. 25-*b*, part **A** of the waveform shows the segment to be 10-volts positive to the backplane; in part **B**, it is 10-volts negative to the backplane. Therefore, the LCD is effectively driven by an AC signal with a peak-to-peak value of 20 volts, and with no DC component. In that LCD driving system, when a segment is turned off, it is simply shorted to the backplane of the display.

The most popular CMOS IC for driving 7-segment LCD's is the 4543B BCD to 7-segment decoder/LCD-driver, which uses the bridge power-supply technique. Figure 26 shows the 4543B. That device has to have its PHASE pin connected to the backplane of the display, and must be driven form a symmetrical external square wave. The BLANK pin is normally grounded; that pin blanks the entire display when pulled high. The $\overline{\text{STORE}}$ control causes transparent decoding when pulled high, or causes latched decoding when pulled low.

In conclusion, all of the devices that we have discussed in this article are intended for use in fairly simple applications such as the ones shown. For dedicated applications such as frequency meters, or digital clocks, you should consider the potential applications for the special VLSI IC's. **R-E**

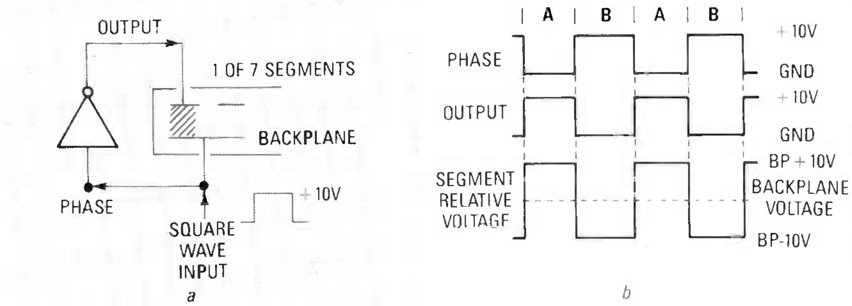


FIG. 25—VOLTAGE-DOUBLING BRIDGE METHOD of driving *L*iquid *C*rystal *D*isplays (LCD). A square wave is inputted to the phase inverter and backplane (BP) shown in *(a)*. That creates an AC voltage across the backplane shown in *(b)*.

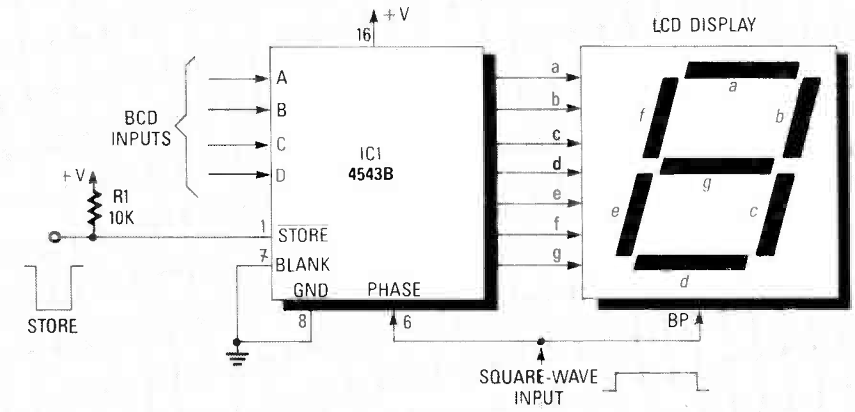


FIG. 26—THE 4543B BCD-TO-7-SEGMENT Latch/Decoder/LCD-Driver. The decoder outputs (*a-g*) are connected directly to the LCD display.

HARDWARE HACKER

White noise software
Top octave generators
High definition television
Pseudorandom sequences
Electronic music resources

HDTV—an alternative viewpoint

MANY THANKS FOR ALL THOSE CALLS and letters I got on the patents and patenting topics that we covered back in the October issue. Of the 415 responses to date, far and away the majority were in the "right on" or else the "if only I had known that six years ago" category, and I thank you for them.

You'll be seeing other viewpoints on that from time to time over in the letters column. Since arguing one-on-one in the letters column is just not my usual style, I'll repeat our key point here—For most of you hardware hackers most of the time, any involvement whatsoever with patents and patenting will almost certainly prove to be a monumental waste of time, energy, and money—not to mention the resulting headaches.

The overwhelming evidence for that is based on (A) my lifetime of experience directly involving inventions, patenting, creativity, design, and product development; (B) the independent and very thoroughly documented third-party studies of patent productivity; and above all, (C) the dozens of horror stories from current **Radio-Electronics** hardware hackers who have already gotten ground into hamburger by all of the absurdities that surround the patent process today.

I am sorry if I did offend one or two patent attorneys, and one or two others who seem to be personally profiting from this very sorry state of affairs. I also extend my apologies to their BMW dealers.

Well, now that we got that hornet's nest kicked out of the way, let's take a swipe at another one. Which involves...

High definition television

The FCC recently mandated that all the future high-resolution video images done in this country will have to be NTSC-compatible. NTSC (which I jokingly define as *N*ever *T*he *S*ame *C*olor) has been a thirty-year-old compromise which never worked properly. It was long ago flushed by all of the personal-computer manufacturers.

Besides its being monumentally stupid, insanely protectionist, and incredibly hindsighted, this ruling is precisely the same as asking a consortium of trolley-car manufacturers to dictate a mandatory new standard for the personal vehicular transport of the nineties.

Any disinterested outsider might conclude that a new generation of fully digital and internationally standard "35 millimeter theater quality" interactive home video with eight multi-lingual stereo audio channels is an obvious product that should have a tremendous world-wide demand for the next several decades.

Where would the programming for true HDTV come from? Well (1) from local cable systems; (2) from upcoming generations of videotape rentals; (3) from video-tape ownership; (4) from home video cameras; (5) from satellite reception; and at least in several other countries, (6) from direct-broadcast satellites that go straight to the end-user.

While only minuscule at present, I feel that a (7) interactive computer-based Hypermedia will eventually become a most dominant source for HDTV programming. Once a HDTV standard exists, all of those major personal computers suppliers are likely to adopt it, eliminating the artificial gulf between home video and home computing, along with that plethora of less-than-HDTV monitor standards that exist today.

What about (8) network-broadcast TV? At best, that would be a distant and eighth-rate source for the HDTV program material, and could be ignored entirely.

I personally feel that there has not been anything worth watching on network-broadcast TV for the last twenty years, and certainly nothing worth improving the definition of. To allow those people to enforce a lower quality and non-international poor patchwork "unstandard" at the expense of the ultimate videophile is unthinkable, inexcusable, and an outright atrocity.

As with streetcars, there comes a time when it is a good idea to tear up the tracks.

Further, virtually all of the HDTV receivers will now include a microprocessor, a new frame grabber, great heaping bunches of additional RAM memory, and possibly even a digital signal processor.

Which means that real-time video compression and decompression should be fairly cheap and simple to add to virtually any trans-

NEED HELP?
Phone or write your **Hardware Hacker** questions to:
Don Lancaster
Synergetics
Box 809-RE
Thatcher, AZ 85552
(602) 428-4073

mission medium. Thus, we might easily end up with HDTV transmission bandwidths that are ridiculously *lower* than the present NTSC standards.

Most newer HDTV displays will probably be able to accept older NTSC, PAL, RGB, or SECAM program inputs, and even spruce them up a tad before displaying them. The key question is whether an older NTSC television set that inadvertently got plugged into some HDTV program source has to be able to display something viewable. The present ruling makes about as much sense as requiring that all CD-ROM disks be able to output low-fidelity audio when played with a cactus needle on a 78-RPM turntable.

As per usual, I do welcome your comments on this. In fact, let's have us another contest. Write me with your thoughts on HDTV. There will be all the usual *Incredible Secret Money Machine* books for the best dozen or two entries, with an all expense paid (FOB Thatcher, AZ) *tinaja quest* for two for the best entry of all. Naturally, you do not have to agree with me, but the more thought-out and the more coherent your written response, the better will be your odds of winning.

Do send your entries directly to me per the *Need Help?* box, rather than over to the **Radio-Electronics** editorial offices. And, hey, no fair sending the "right on" responses to me and the "up yours" ones over to the letters column.

Pseudo-random sequences

I have long been fascinated with both random and pseudorandom numbers and their generation.

Truly random numbers are quite difficult to generate, and it is very easy to introduce all sorts of subtle bias into them. One fact that many hardware hackers refuse to accept is that virtually any and all attempts at making something more random will nearly always have the exact opposite of the intended effect.

A *pseudorandom* sequence is some long string of numbers that eventually will exactly repeat, but any short portion of which will appear totally random, and apparently obey all the rules of random

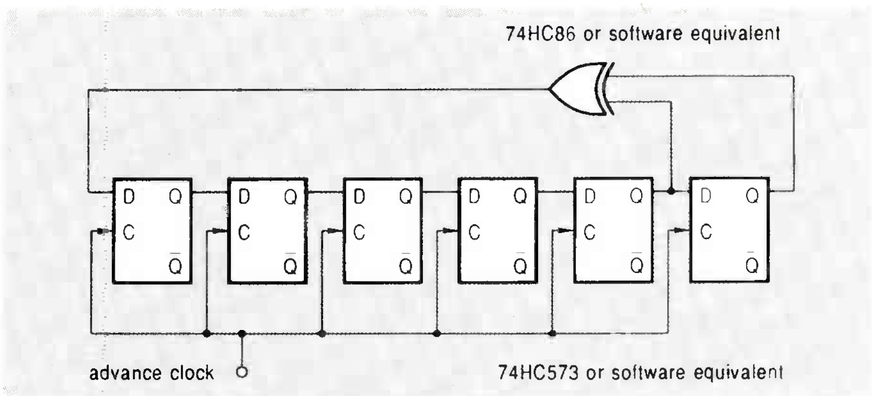


FIG. 1—A SIX-STAGE PSEUDORANDOM sequence generator produces 63 six-bit binary numbers in an apparently random, yet exactly repeating order.

number distributions. The concept of "noise that repeats" is especially handy for industrial testing, for military radars, for security systems, and for such things as a re-deal of the same card hand in a computer game or simulation.

To generate a new pseudorandom sequence, you can use, of all things, a *pseudorandom sequence generator*. Golly gee, Mr. Science.

To do that, you take a plain old hardware or software shift register. You then will choose a few of the outputs and XOR (exclusive-OR) them together and use the resulting one or zero as an input for the next clocking cycle.

One of two things is likely to happen. If you pick the wrong feedback combinations, then the shift register will shortly hang in its all-ones or all-zeros state. But with just the right combination, the shift register will become some sort of a counter of some length, that goes through a series of count values in a repeating and predictable order.

The trick is to pick out the longest possible sequence length for any shift register by finding just the right "magic" feedback combinations.

That is called a *maximal length sequence* and it's always *one less than* the total possible number of states in the register. Shorter groupings within one of those maximal length sequences will appear to be random and obey most of the properties of real random numbers.

Figure 1 shows you a six-stage pseudorandom generator that will generate a sequence that is 63 counts long. You might like to list all of the states to prove that, sure enough, short samples do appear random, even though the whole sequence does repeat once each 63 clocks. I used that back in my *Psyctone* project, which seems like eons ago, in the "golden age" of **Popular Electronics**.

You can create up to four related maximal-length sequences, a "forward" one and its complement, and a "backward" one and its complement. There is one big gotcha: You must never start with the "all

ELECTRONIC MUSIC RESOURCES

Audio Amateur
Box 576
Peterborough, NH 03458
(603) 924-9464

Devtronix Organs
6101 Warehouse Way
Sacramento, CA 95826
(916) 381-6203

Electronic Musician
19725 Sherman Way, Ste 160
Canoga Park, CA 91306
(818) 709-4662

Keyboard
20085 Stevens Creek Blvd
Cupertino, CA 95014
(408) 446-1105

Journal AES
60 East 42nd Street, Rm 2520
New York, NY 10165
(211) 661-2355

Journal ASA
335 East 45th Street
New York, NY 10017
(212) 661-9404

Mix Bookshelf
6400 Hollis Street #12
Emeryville, CA 94608
(415) 653-3307

Music, Computers & Software
190 East Main Street
Huntington, NY 11743
(516) 673-3243

Music Technology
22024 Lassen Street, Ste 118
Chatsworth, CA 91311
(818) 407-0744

Musician
1515 Broadway
New York, NY 10036
(212) 764-7300

Rolling Stone
8500 Wilshire Blvd, Ste 926
Beverly Hills, CA 90211
(213) 659-1242

Speaker Builder
Box 494
Peterborough, NH 03458
(603) 924-9464

zeros" state or your generator will hang, permanently outputting zeros.

For many uses, you'll want to use much longer sequences. Figure 2 lists the magic feedback combinations needed for various maximal-length sequences. A very few of the longer ones aren't "quite" maximal, but they are the best that anyone has ever found so far.

STAGES	LENGTH	FEEDBACK
2	3	1, 2
3	7	2, 3
4	15	3, 4
5	31	3, 5
6	63	5, 6
7	127	6, 7
8	255	4, 5, 6, 8
9	511	5, 9
10	1023	7, 10
11	2047	9, 11
12	4095	6, 8, 11, 12
13	8191	9, 11, 12, 13
14	16,383	4, 8, 13, 14
15	32,767	14, 15
16	65,535	4, 13, 15, 16
17	131,071	14, 17
18	262,143	11, 18
19	524,287	14, 17, 18, 19
20	1,048,575	17, 20
21	2,097,151	19, 21
22	4,194,303	21, 22
23	8,388,607	18, 23
24	16,777,215	17, 22, 23, 24
25	33,554,431	22, 25
26	67,108,863	20, 24 25, 26
27	134,217,727	22, 25, 26, 27
28	268,435,455	25, 28
29	536,870,911	27, 29
30	1,073,741,823	7, 28, 29, 30
31	2,147,483,647	28, 31

FIG. 2—HERE ARE THE "MAGIC" FEEDBACK connections for many maximal length pseudorandom sequences. If two feedback numbers are shown, you XOR (exclusive-or) them together. If four numbers are shown, you XOR by pairs and then XOR the two intermediate results. Either hardware or software may be used.

A very interesting pseudorandom generator for computer use appears in Fig. 3. This is a 31-stage register, giving you a sequence length of 2,147,483,687 before it repeats. Yet, it is able to deliver an apparently random one or zero in 40 microseconds or less with most personal computers.

The all time whiz-bang expert on random or pseudorandom anything is Donald Knuth in his *Art of Computer Programming* volumes. They are available at any large technical library. I've also gotten into that rather extensively in my *Apple Assembly Cookbook*, where you will find several ways around the fatal flaws in that Applesloth random-number generator, along with lots of useful ways to generate and test random and pseudorandom numbers of any size.

A white noise source

As a quick and dirty example of a 31-stage pseudorandom generator, Fig. 4 shows you a short machine-language routine that makes an Apple IIc, IIe, or IIgs sound as if it is frying itself in its own grease. I'll leave it up to you to dream up some of the more fiendish and unusual uses for this short code module.

On every binary one, the speaker cone gets whapped, while it stays where it is on a zero. As shown, the code is very slightly pinkish, rather than a pure white noise. I'll let you add the few extra bytes needed to equalize the timing so each loop takes exactly the same time, regardless of when the cone gets moved.

You can use similar code to explore other pseudorandom lengths. As the lengths get shorter, you will first note some structure. For even shorter lengths, actual tonal color will result.

And here's something not quite related that you might like to play with: If you take any old 30-bit digital word and whop the speaker on the ones and not whop it on the zeros, different *timbre*, or tonal values will result depending on the strengths of the harmonics you are listening to.

For instance, getting a very strong fundamental and no low harmonics should result in a flute-like sine wave, while any waveform with a strong third, fourth, and fifth, but a weak first and second should give a major chord, *although you are only pushing a speaker cone all the way in or out.*

Thus, you can easily generate a pure tone, as well as two or three apparent notes at once by using that simple technique.

Now, it is easy to pick words at random and listen to the results, but how do you *purposely* design your selected word for the desirable harmonic structure?

Fourier series anyone?

Resources for electronic music

As with any other field, the bookstores, tech journals, and popular magazines that service electronic music interests are your starting place. It also helps if you can carry a tune in a bucket.

The *Electronic Music Resources* sidebar lists some of the more important and more interesting places to go to get started.

Probably the best collection of the electronic music, synthesizer, MIDI, audio, and video production books in the world is available through the *Mix Bookstore*. Their free catalog is an absolute must.

Of all the publications that are listed though, I think the *Journal of the Audio Engineering Society* has the best long-term track record on both the tech fundamen-

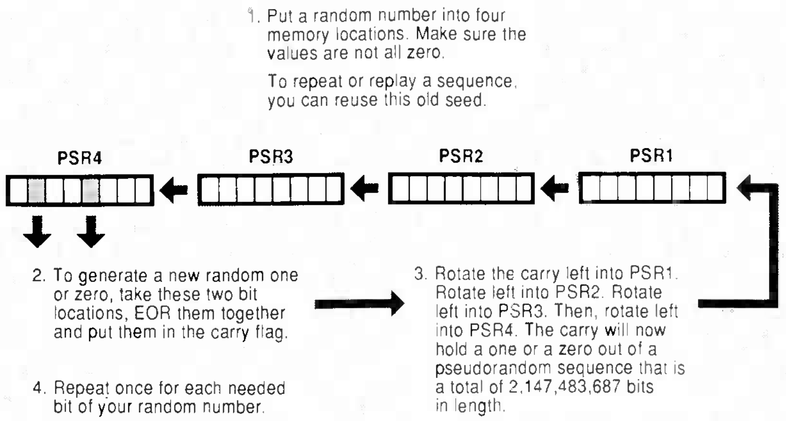


FIG. 3—A THIRTY-ONE STAGE PSEUDORANDOM sequence generator done in software produces a "random" string of 2,147,483,687 ones or zeros before it will start to exactly repeat. Typical execution time is under 40 microseconds.

(1) On an Apple II+, IIc, IIe, or IIgs, get into **BASIC.SYSTEM** and do a **CALL -151** to get into the monitor.

(2) Then, enter the following code:

```
0300:  4C 07 03 27 0C A1 C9 AD   <cr>
0308:  06 03 0A 0A 0A 4D 06 03   <cr>
0310:  0A 0A 90 03 2C 30 C0 2E   <cr>
0318:  03 03 2E 04 03 2E 05 03   <cr>
0320:  2E 06 03 4C 07 03 11 11   <cr>
```

(3) Finally, do a **BSAVE KFC.VIRUS, A$0300, L$28, D2**

(4) To test, use, or abuse your code, do a **BRUN KFC.VIRUS**

FIG. 4—THIS WHITE-NOISE GENERATOR makes an Apple computer sound as if it is frying itself in its own grease. A 31-stage pseudorandom generator is used. Except for stress-induced medical effects on the system owner, the code is more or less harmless.

NAMES AND NUMBERS

Allied Electronics
PO Box 1544
Fort Worth, TX 76101
(800) 433-5700

Amperex
230 Duffy Avenue
Hicksvile, NY 11802
(516) 931-6200

Ark-Plas Products
Hwy 178 North
Flippin, AK 72634
(501) 453-2343

Computer Shopper
Box F
Titusville, FL 32781
(407) 269-3211

Devtronix Organs
6101 Warehouse Way
Sacramennto, CA 95826
(916) 381-6203

Fotocut
Box 120
Erieville, NY 13061

Hewlett-Packard Journal
3200 Hillview Avenue
Palo Alto, CA 94304
(415) 857-1501

International Rectifier
233 Kansas Street
El Segundo, CA 90245
(213) 772-2000

Model Railroader
1027 North 7th Street
Milwaukee, WI 53233
(414) 272-2060

Pace
34 Foley Drive
Sodus, NY 14551
(315) 483-9122

Statek
512 N. Main Street
Orange, CA 92668
(714) 639-7810

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

tals and on all the roots of the digital synthesis revolution, while Craig Anderton's *Electronic Musician* offers "hands on" coverage of the very latest and the very best.

Let me know if there is anything else that you think should be added. So far, we have done resource collections on handicapped aids and electronic music. Which others would you like to see?

Top-octave generators

If you wanted to design your own home, theater, or a church organ from the ground up today, far and away the simplest and the cheapest way to get the highest possible quality results would be to model what you are after on the *Ensoniq* synthesizer inside an *Apple IIgs* and later on tack on a MIDI card or two.

Nonetheless, I get an amazing number of calls from all you **Radio-Electronics** readers who want to do things the "old way," using those rather obsolete and horribly limiting top-octave generators and keyer chips.

I suspect that is mostly the "Gee dad, its a Wurlitzer" folks trying to distance themselves from all the "Heavy Metal" punk rockers. Like it or not, all those punk rockers have dumped many millions of dollars and hundreds of thousands of man hours into developing very simple, ultra cheap, and highly effective all-digital synthesizers that can now easily duplicate any known or any imagined musical instrument with stunning accuracy and clarity.

Well, if it is top-octave generators you want, then top-octave generators are what you are going to get. Figure 5 shows you how one single-input reference square wave and a top-octave generator can generate thirteen of the highest needed keyboard notes. A second keyer chip can then divide those notes down and turn them on and off in an organ-like manner.

Roy DeVault of *Devtronix* has lots of top-octave generators and keyer chips and boards available, and is more than glad to sell them to you at low cost in very small quantities. Roy provides everything from single chips up through new and used complete organs, besides being one incredible information source. He welcomes your calls.

If you do decide to build a top-octave generator for use as a pitch reference or a tuning instrument, just be sure to take into account these two big gotchas: Your output tones absolutely must be filtered to produce ultra-pure sine

continued on page 86

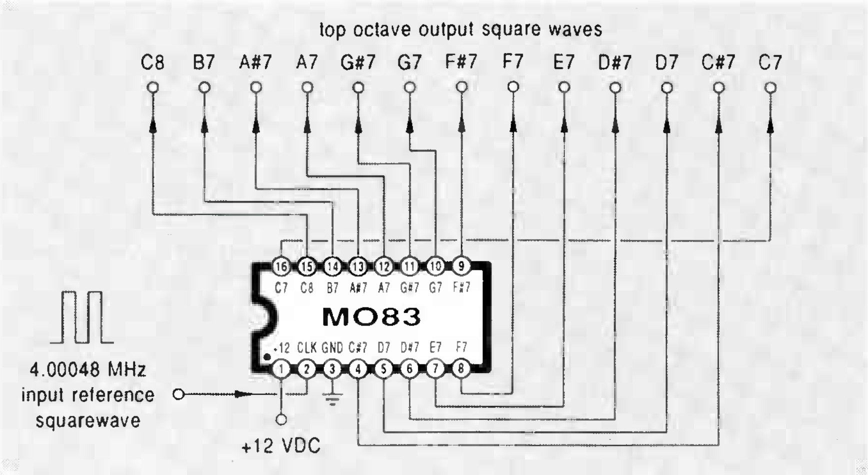


FIG. 5—A TOP-OCTAVE GENERATOR integrated circuit takes an input reference square wave and divides it down to approximate the thirteen uppermost notes on an electronic organ. Further binary division of each output can generate all the needed lower notes. This SGS part replaces the Mostek MK5083.

MASTER THE NEW ELECTRONICS WITH McGRAW-HILL'S

Contemporary Electronics Series

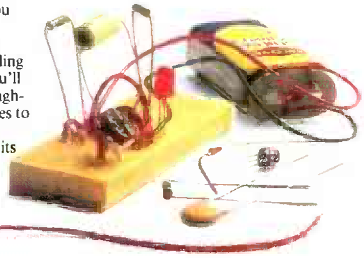
The fast, easy and low cost way to meet the challenges of today's electronic innovations. A unique learning series that's as innovative as the circuitry it explains, as fascinating as the experiments you build and explore.

From digital logic to the latest 32-bit microprocessor, the McGraw-Hill Contemporary Electronics Series puts you into the electronic picture one easy step at a time. Fifteen unique Concept Modules, sent to you one every 4–6 weeks, give you a handle on subjects like optoelectronics, robotics, integrated circuits, lasers, fiber optics and more.

Each Concept Module goes right to the heart of the matter. You waste no time on extraneous material or outdated history. It's a fast, efficient, and lively learning experience...a non-traditional approach to the most modern of subject matter.

Unique Interactive Instruction

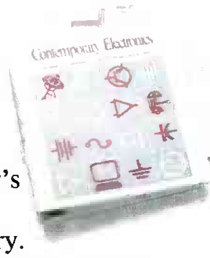
With each module, you receive a McGraw-Hill Action Audio Cassette. Each tape is a dynamic discussion that drives home the key facts about the subject. Your learning experience is reinforced through interaction with vividly illustrated text, audio cassettes, and actual electronic experiments. Indexed binders preserve backup material, notes, and tapes for convenient referral.



With your first module, you get this solderless breadboarding system. You'll use it throughout the series to build electronic circuits and bring concepts to life.

Perform Experiments in Contemporary Electronics

Throughout your series, laboratory experiments reinforce every significant point. This essential experience ...dynamic, hands-on demonstrations of theory in practice... will help you master principles that apply all the way up to tomorrow's latest VLSI (Very Large Scale Integrated) circuitry.



In your very first module, you'll use integrated circuits to build a digital oscillator, verifying its operation with a light emitting diode (LED). You'll learn to identify passive and active components, understand concepts common to all electronic circuits.

For Anyone Interested in Electronics

The Contemporary Electronics Series is designed for anyone from hobbyist to professional. It's for you if you're looking for new fields of interest...if you're a teacher who wants an update in contemporary circuits...a manager or supervisor in an electronics plant...a doctor, an engineer, a chemist who finds electronics playing an increasingly important role in your work. It's even for electronics engineers or technicians who feel their training needs freshening up. It's the quickest, most convenient, probably least expensive way to do it. And the only one that gives you hands-on experience.

15-Day No-Risk Trial

To order your first module without risk, send the card today. Examine it for 15 days under the terms of the order form and see how the Contemporary Electronics Series gets you into today's electronics. If card has been used, write us for ordering information.

McGraw-Hill
Continuing Education Center
3939 Wisconsin Ave.
Washington, D.C. 20016

HARDWARE HACKER

continued from page 82

waves that can be used for tuning purposes; and you have to be able to vary your pitch by as much as 30 percent when tuning a piano. Because of the enharmonic lateral stiffness of piano strings, a piano keyboard has to be "stretched," rather than tuned to textbook frequencies. Otherwise it will sound awful.

New tech lit

Free samples of some low-cost connectors for pneumatic robotics are available from *Ark-Plas Products*, while one good and cheap source for custom photochemical etching of thin materials is *Fotocut*. Many thanks to *Model Railroader* magazine for that hard-to-find item. Besides absolutely outstanding tech writing, you might want to check out that magazine for very unusual tools, ideas, and materials.

By the way, if you ever do run across a model railroader, just tell him you are scratch-building an 0-2-0 articulated Camelsback, and watch his eyes light up.

International Rectifier now has a free *Microelectronic Relay Designer Manual*, mostly on their *ChipSwitch* solid-state interfaces.

Allied Electronics has a new free *#889* Catalog. Allied is one of the oldest of those "old line" electronics distributors and are at long last back to offering lots of products stocked in depth at tolerable prices.

The free *Hewlett-Packard Journal* is certainly worth a subscription to. The October 1988 issue has good stuff in it on SCSI interface fundamentals and on some cheap optical encoders. On the other hand, I simply cannot conceive of anyone ever actually buying one of those diskless workstations they're highly touting in the same issue.

Even when spelled correctly, I do feel that diskless workstations are both fascist and on the stupid side of dumb.

One good and low-cost source of miniature low-frequency crystals is *Statek*, who have a number of data sheets, price lists, and apnotes on hand. Ask for their literature list.

Two sources of low-cost infrared "people detectors" that operate using new pyro-electric sensors include *Amperex* and *Pace*. They both have several very detailed application notes and data sheets available.

Turning to my own products: Yes, we now have complete bound sets of reprints to all of the *Hardware Hacker* columns that you've seen here to date, along with volumes I and II of my sister *Ask the Guru* column that you'll find in *Computer Shopper*. And, of course, my classic *TTL Cookbook* and *CMOS Cookbook* remain available to those of you wanting to pick up the basics of digital integrated circuits.

As always, this is your column and you can get tech help and off-the-wall networking per the end box. You'll find two *Names and Numbers* lists this month, one for music stuff and one for everything else. Let's hear from you. **R-E**

SHORTWAVE RADIO

STANLEY LEINWOLL,
CONTRIBUTING EDITOR

Sunrise and sunset affect frequency propagation.

DURING THE WINTER MONTHS (JANUARY and February, 1989) propagation conditions change drastically around sunrise and sunset, local time. Those sharp "transition periods" occur because the sun is closer to Earth than at any other time of the year and, consequently, solar radiation is at its most intense levels. It's the sun's radiation that affects the ionization density of the ionosphere, which directly affects the range of useful frequencies.

For example, at sunset—when solar energy is abruptly removed—the range of frequencies that the ionosphere will support plunges rapidly. That effect is especially noticeable during the long winter nights in the northern hemisphere, when the ionosphere is weakened. The opposite effect takes place during the hours around sunrise. At that time, the sudden intense illumination of a weak ionosphere causes a rapid increase in the range of useful frequencies. And lastly, during the daylight hours, the range of useful frequencies is higher than at other times.

Radio conditions over long circuits are at their worst when part of the path is in daylight and part in darkness, because the frequencies that are optimum over part of the path are radically different from those over the remainder of the path. On circuits to the east, for example, conditions will be poor several hours before sunset; on circuits to the west, conditions will be at their worst several hours after sunset. That phenomenon, often referred to as following the gray line, will be discussed later.

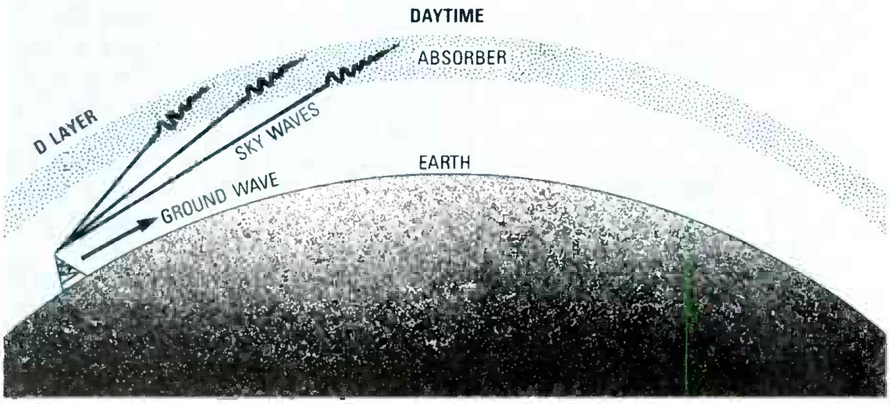


FIG. 1

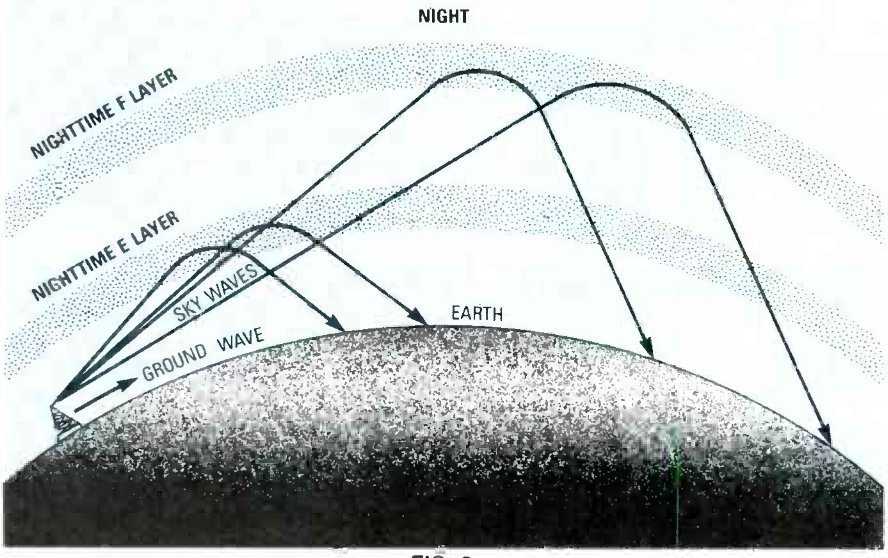


FIG. 2

General Conditions

Daytime conditions will be good to excellent throughout the forecast period, with DX openings possible from 15 to 28 MHz. The 10- and 11-meter bands will remain open for amateurs and CB DX-ers, and the seldom-used 26-MHz broadcast band will be open from early morning to around midday, local time in the eastern United States. The BBC (*B*ritish *B*roadcasting *C*orporation) and the Voice of America are the principal users of that band.

Nighttime DX conditions will be possible from 6 MHz up to 15 MHz over paths from the southern hemisphere. In general, the best DX will be in the 6- to 11-MHz bands.

Broadcast-band DX will be good to very good at night. During periods when the transmitter and receiver are both in darkness, openings from Europe will occur regularly

Chit-Chat

RFE (*R*adio *F*ree *E*urope) and RL (*R*adio *L*iberty) were founded in 1949 and 1951, respectively, as independent broadcasting stations. They originally received most of their financing from the CIA (*C*entral *I*ntelligence *A*gency). However, in 1971, all connections to the CIA were severed and the stations were temporarily financed by the U.S. State Department. By 1973, the BIB (*B*oard for *I*nternational *B*roadcasting) was established to ensure the continuity of RFE/RL. The BIB acts as the conduit and auditor of funds appropriated by Congress for the operation of RFE/RL, and is responsible for the general oversight of its operations. In 1985, a third station, RFA (*R*adio *F*ree *A*fghanistan) joined RFE and RL with broadcasts in Dari and Pashto.

In all, RFE, RL, and RFA broadcast in 23 languages of the USSR and Eastern Europe. Collectively, their 48 short-wave transmitters are located in Spain, Portugal, and the Federal Republic of Germany. Total power is approximately 7,500 kilowatts and they use about 85 different short-wave frequencies during a season.

Verification (QSL) cards are sent by those stations, and anyone wanting a complete schedule should write to the following address: RFE/RL Engineering, 1775 Broadway, New York, NY 10019.

Mail Box

A number of readers have written asking why it is that during the daylight hours only local medium-wave (broadcast band) stations are audible, whereas at night many distant United States and international stations can be heard by tuning across your AM-radio dial. Although the answer is not technically related to short wave, it is connected to the ionosphere so that interesting phenomenon will be treated here.

Those of you who have been reading this column regularly will remember that the ionosphere actually consists of several distinct layers, including the D, E, and F layers. The D layer is the lowest of the layers, and it exists only during the daylight hours. Although ionization in the D layer is not generally sufficient to absorb short-wave radio signals, its ionization is high enough to absorb medium-wave signals completely.

Figure 1 shows that during the day the broadcast band is absorbed by the D layer, while that part of the broadcast signal that travels along Earth's surface (the ground wave) contributes to the reception of the signal. Therefore, during the day, you get nothing but local stations.

However, at night the story is entirely different. As Fig. 2 shows, the D layer disappears because it's totally dependent upon solar radiation for its existence. And with that absorbing layer out of the way, the sky-wave signal travels to the E layer, which is present in residual amounts at night, and to the F layer, which is always present. Both the nighttime E layer as well as the F layer are capable of propagating medium-wave signals.

In general, the E layer will reflect signals at the lower end of the AM broadcast band (up to about 1000 kHz), whereas the F layer will reflect signals above 1 MHz (1000 kHz).

The maximum distance E-layer-reflected signals will propagate is about 1000 miles, whereas F-layer-reflected signals can cover twice that distance on the first hop. DX from more distant stations involves multiple-hop reflections between the ionosphere and Earth. Such multi-hop propagation can take place from a single layer, or from a combination of both E and F layers.

Those near the east coast of the United States will find that local sunset to several hours after are the best times to try for European medium-wave stations. During those hours it's dark across the Atlantic and still light to the west, minimizing the chances of interference from American stations. On the west coast, the hours immediately before sunrise to a little after are best because American stations are being absorbed in daylight while it is still dark across the Pacific Ocean.

If you are DX-ing European, African, or Asiatic stations, remember that the medium-wave bands in those regions are different from those in this hemisphere. The AM band in those areas extends from 531 kHz to 1602 kHz, and the separation between stations is 9 kHz, not 10 kHz as it is here. There are therefore 119 channels you can try for. **R-E**

AUDIO UPDATE

The question of reliability

LARRY KLEIN,
AUDIO EDITOR

FIG. 1

QUESTIONS ABOUT THE RELIABILITY OF audio components turn up regularly in the reader mail at the major hi-fi magazines. And I'm sure that the salespersons at the audio showrooms are occasionally quizzed about the durability of the models or brands under consideration. Test labs are also taken to task for not commenting in their reports on a unit's construction and potential longevity. In general, the writers and editors probably seem unresponsive to such concerns and suggestions, and I'd like to explain why. (By way of citing my credentials for what is to come: I worked as a lab technician/troubleshooter in a audio/test equipment factory for five years, did free-lance hi-fi service work for several years, and for about 20 years I served as the Technical Director of a major hi-fi magazine where I supervised the work of the test laboratory.)

Component longevity

Readers old enough to remember the days when all audio equipment had tubes are no doubt aware of the far greater reliability of today's transistor equipment. Vacuum tubes wear out through normal use; either their filaments blow out or their cathodes run out of electrons. In contrast, transistors have no inherent internal-wear mechanism, and can theoretically go on forever. In addition, one of the major causes of parts deterioration is heat; tube amplifiers run very hot, transistors amplifiers run merely warm.

Although transistors themselves may have a theoretically unlimited life span, we all know that transistor equipment does not. What determines whether an audio component will break down prematurely? One factor is the know-how of the designer. Example: Perhaps 10 years ago I received a press release (with schematic diagram) in my morning mail that announced the first amplifier product of a well-known loudspeaker-system manufacturer. Coincidentally, a friend who was the chief designer of a leading U.S. amplifier company chanced to drop in, spotted the diagram on my desk, and asked to see it. After a brief perusal of the schematic, my friend suggested that the amplifier was going to blow up in large numbers once it got into retail channels. His prediction proved accurate, and the product was subsequently withdrawn from production. Apparently the amplifier's designers hadn't included protection circuits to cope with some of the practical stress situations encountered in the "field." By the time they determined what was wrong, the amplifier's reputation was shot—along with dozens of output transistors.

But even knowledgeable designers occasionally find themselves in trouble. One best-selling power amplifier had a good reliability record for a year or so, then large numbers began to fail after a month or so of operation. I checked with the company's chief engineer, who told me this sad story: The source of the failure was a small-signal transistor at the input circuit of the amplifier. It seems that after X-number of hours of use, the transistor would develop enough leakage to upset the amplifier's direct-coupled circuit sufficiently to blow fuses. Although the same transistor type had been used without problems in similar circuits for years, there was something wrong with a recent batch supplied by the semiconductor manufacturer. Unfortunately, the defective batch (which passed incoming quality-control tests) had been mixed in with the other similar transistors and the manufacturer had no way of telling which of his finished amplifiers were OK and which had the built-in time bombs. A recall of the entire production run would have been inappropriate because less than 10 percent of the units had the potential problem. I don't know how the manufacturer and his dealers handled the problem but the model remained in the line and in the long run sold very well.

Incidentally, I've been told that the particular "timed" self-destruct problem resulted from manufacturing fault that causes a sort of electroplating process within the transistor. There is a slow transfer of material from one internal element to another until the transistor no longer operates. Capacitors, for different reasons, can also become timed destruct mechanisms. It's not uncommon for a specific brand and value of capacitor to have 75- to 100-percent failure rate, but only after months or even years of use.

Infantile mortality

Wouldn't the finished-product test procedures used by all reputable manufacturers have revealed those defective transistors? Unfortunately, no. In the absence of a special test, that kind of transistor problem only shows up after prolonged use. No manufacturer is going to tie up newly built equipment on the heat rack for hundreds of hours when his dealers are clamoring for shipment.

Luckily, most product failures take place during their first 24 hours of operation. Quality-control engineers refer to that as "infantile mortality." Obviously, any reasonable manufacturer would rather have a newly built component fail on his heat rack, than in the customer's home. The better heat racks enable amplifiers to be hooked up with appropriate line voltages, loads, and input signals, which are then automatically cycled to significantly stress the am-

continued on page 111

ANTIQUE RADIOS

Loudspeakers and things.

RICHARD D. FITCH,
CONTRIBUTING EDITOR

IN MOST INSTANCES, YOU WON'T BE able (or permitted) to plug in or make any tests on a set that you might want to purchase, so your decision must be based entirely on your visual inspection. Actually, being able to plug in a set isn't really that important—there have been only two sets that I was able to listen to before buying. If the set has a worn line cord, as practically all do, you wouldn't plug it in anyway. Suppose you plug in a prospective set and it doesn't light up at all. Would you reject it? If you did, you might be making a big mistake. I always prefer to repair a radio or TV that's "dead,"rather than one with distorted or intermittent sound, or a wavy picture.

FIG. 1

Restoration

I've got a Philco Model 650, from about 1936. Over 50 years old, the set shows its age. Having a collection of antique radios, I bought the set (the left one in Fig. 1) just to get a part for another set (the right one in Fig. 1). I don't think that $20.00–$25.00 is too much to pay for a parts set to get a major component. What should we do with what's left over? Well, let's restore it! Sometime in the future, I'll bet that this derelict will be the antique radio of the month.

The cabinet has a lot of damage, especially to the veneer, but we won't get into any woodwork this month. We'll concentrate on getting it working.

Not only is the veneer damaged, but the frame is coming apart also. The grille cloth is worn and torn, there is a knob problem, and the escutcheon is missing. There's nothing I hate more than finding an antique radio with the escutcheon missing. It's like taking its identity away—and I won't be able to make one as easily as I have for some other radios.

Besides the multi-band dial, there's also the Philco shadow-meter tuner—that is going to be a tough escutcheon to make. I'll have to get a photo of the same model to copy it. As you can see, this Philco has every defect that an antique radio can have. It would take a true antique radioer to see any possibilities in that mess.

Dynamic loudspeakers

The Philco Model 650 has a component problem: the loudspeaker, or the lack of one. The set was purchased for the sole purpose of getting the electro-dynamic loudspeaker for another radio of mine in which the speaker had a damaged voice coil and cone, but the field coil was still intact. Since the field coil (or a substitute) must remain in the circuit (for the Philco 650, but not all antique radios), I think I'll put the damaged speaker in the bottom of the cabinet, so that I can at least connect the field coil.

The purpose of the field coil is primarily to create an electro magnet. On sets where the field coil gets its DC voltage from a separate source, or from a battery, as in most auto radios, it can be disconnected when replacing with a permanent-magnet loudspeaker. However, in most antique radios, the field voltage is taken right from the set's power supply, so the field coil is actually shown schematically as part of the power supply—removing it would disable the power supply.

In a way, using the field coil in that manner was an economy move by the early radio manufactures. For us antique radioers, we would rather see a separate choke coil installed. Then we could replace the electro-dynamic loudspeaker with a permanent-magnet type by just disconnecting the field leads. The field coil could then be discarded, even though it was rarely the cause of trouble.

The last time I made that statement about the durability of field coils, it drew considerable reader response from radiomen who were not in complete agreement. I thank all who took time to correspond, even just to disagree. Many of the readers' comments were very educational. However, looking at my collection of antique radios, there's not an open or shorted field coil in the lot.

Yes, an open can occur in the winding of the field coil; a resin block, corrosion, overloading, or even a faulty speaker plug can give that indication. If the field coil is part of the B supply, it will completely disable the receiver.

Often the field-coil winding gets its voltage from a separate source or rectifier. In that case, there may be a weak signal from the loudspeaker, even though there is an apparent open associated with the loudspeaker field-coil winding. The slight residual magnetism is the cause. So, when you make a cold continuity test on a suspected open field coil, be sure to include all of the connecting wires and plugs. Also, be sure to set your ohm meter to the proper range; some field coils have resistances up to 2000 ohms.

If an open is found, and it is definitely in the field winding, remove some of the insulation where the leads enter the coil. That is a vulnerable spot, and often the trouble is there. You can then make the necessary repairs and replace the insulation.

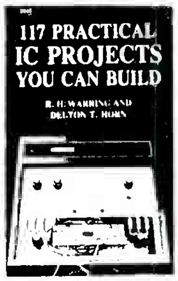
Now, if you can't repair the field coil, or if the cone or voice coil are beyond repair, a replacement loudspeaker must be found. You may have to buy a whole receiver just to get the proper electro-dynamic loudspeaker. All electro-dynamic loudspeakers are not interchangeable, so be sure to compare them before making substitutions. If you can't find a suitable substitute, you'll have to go with a permanent-magnet type.

On most units where the field coil is part of the B supply, you will be able to install a choke coil as a substitute. To do that, you will have to know the resistance of the field coil you are replacing. Then obtain a choke coil with about the same DC resistance. Usually a choke coil having an inductance of anywhere from 3–8 henrys will be suitable; even one that is slightly more or less might be OK. When a substitute choke coil has less resistance than the field coil, the operating voltages throughout the receiver may increase over what they normally were.

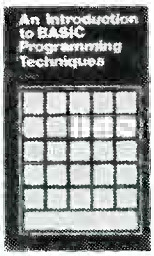
Besides the two aforementioned field-coil uses, they sometimes had another use. An extra wire from the field coil could be used to supply negative C bias voltage for the receiver. So you can see that there is no easy way to just remove an electro-dynamic loudspeaker and install a permanent-magnet unit. Each receiver will have to be studied to determine what will safely replace a unit that can't be repaired.

Going back to the Philco 650, that console was directed toward those who wanted all that was available in a radio at that time. Besides being a superhetrodyne, the set included the Philco shadow tuning. Also, there were provisions for short wave and tone control. That is a lot of radio. Everything appears to be in place and in fair condition. The multi-band superhetrodyne with eight tubes and push-pull output should have an excellent tone and provide some fine listening. How much will it be worth when restored? I'd say about $200.00. **R-E**

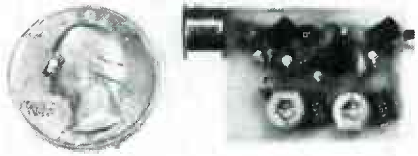
Radio-Electronics mini-ADS



2645T—117 PRACTICAL IC PROJECTS YOU CAN BUILD.....$10.95. Dozens of fully-tested, ready-to-build circuits you can put together from readily-available, low cost IC's! There are a total of 117 IC circuits ranging from an audio mixer and a signal splitter to a tape-deck amplifier and a top-octave generator organ! From TAB Books. **To order your copy send $10.95 plus $2.75 shipping to Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240**

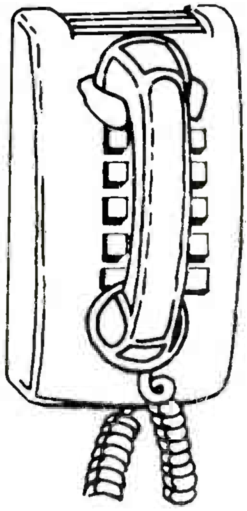


AN INTRODUCTION TO BASIC PROGRAMMING TECHNIQUES. This book is based on the author's own experience in learning BASIC and also in helping others, mostly beginners to programming, to understand the language. Included is a program library of programs that the author has actually written and run. Order your copy today. **Send $5.00 plus $1.25 for shipping** in the U.S. to **Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.**



SIMPLY SNAP THE WAT-50 MINIATURE FM TRANSMITTER on top of a 9v battery and hear every sound in an entire house up to 1 mile away! Adjustable from 70-130 MHZ. Use with any FM radio. Complete kit **$29.95** + **$1.50** S + H. Free shipping on 2 or more! COD add **$4.** Call or send VISA, MC, MO. **DECO INDUSTRIES, Box 607, Bedford Hills, NY 10507. (914) 232-3878.**

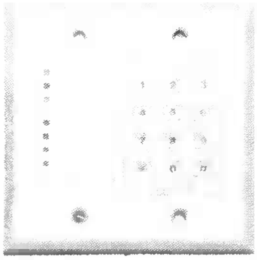
CIRCLE 127 ON FREE INFORMATION CARD



CALL NOW AND
RESERVE YOUR SPACE

- 6 × rate $890.00 per each insertion.
- Fast reader service cycle.
- Short lead time for the placement of ads.
- We typeset and layout the ad at no additional charge.

Call 516-293-3000 to reserve space. Ask for Arline Fishman. Limited number of pages available. Mail materials to: mini-ADS, RADIO-ELECTRONICS, 500-B Bi-County Blvd., Farmingdale, NY 11735.

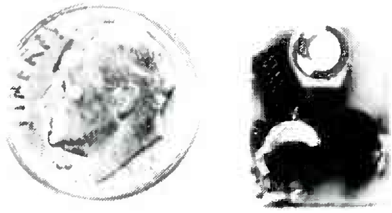


BECOME A WHOLESALE DEALER FOR all types of security electronic equipment and more. Controls, motion detectors, switches, sirens, CCTV, etc. Buy wholesale and make extra money reselling or installing alarm and surveillance systems. System examples and installation tips. Also built-in sound systems, intercome, vacuum systems. Call toll-free for catalog or write to: **ACS SUPPLY CO. INC., 2531 Jefferson NE, Albuquerque, NM 87110. 1-800-545-6286. $9.95, + 3.00 Postage and handling if COD.**

CIRCLE 176 ON FREE INFORMATION CARD

THE CHALLENGER 100 SERIES of digital panel meters are new high quality, low cost 3½ digit meters and come in LCD and LED versions. They are direct replacements for Modutec's "Big Little"™ 100 series. The Model 130 includes a bezel. High linearity analog-digital converters provide 35 PPM reference stability. Linearity is ± ½ count across the entire range. Price: **$39.50–49.50** (depending on model). VISA, M/C welcome. **DIGIMETER, INC., 512 Valley Way, Milpitas, CA 95035. (408) 946-9090, ext. 730, FAX: (408) 946-9190.**

CIRCLE 187 ON FREE INFORMATION CARD



THE MODEL WTT-20 IS ONLY THE SIZE OF A DIME, yet transmits both sides of a telephone conversation to any FM radio with crystal clarity. Telephone line powered - never needs a battery! Up to ¼ mile range. Adjustable from 70-130 MHZ. Complete kit **$29.95** + **$1.50** S + H. Free Shipping on 2 or more! COD add **$4.** Call or send VISA, MC, MO. **DECO INDUSTRIES, Box 607, Bedford Hills, NY 10507. (914) 232-3878.**

CIRCLE 127 ON FREE INFORMATION CARD

PANASONIC CABLE CONVERTERS DIST., Wholesale and Retail Scientific Atlanta and Panasonic model 140N 68 channel converter **$79.95,** Panasonic Amplified Video Control Switch Model VCS-1 **$49.95.** Scientific Atlanta Brand new Model #8528 550MHZ 80 Channels Converter **$89.95.** Video Corrector (MACRO, COPYGUARD, DIGITAL) ENHANCER **$49.95.** We ship to Puerto Rico, Caribbean countries, & So. Amer. Write or call **BLUE STAR IND., 4712 AVE. N, Dept 105, Brooklyn, NY 11234. Phone (718) 258-9495.**

CIRCLE 85 ON FREE INFORMATION CARD

CARRIER CURRENT

continued from page 64

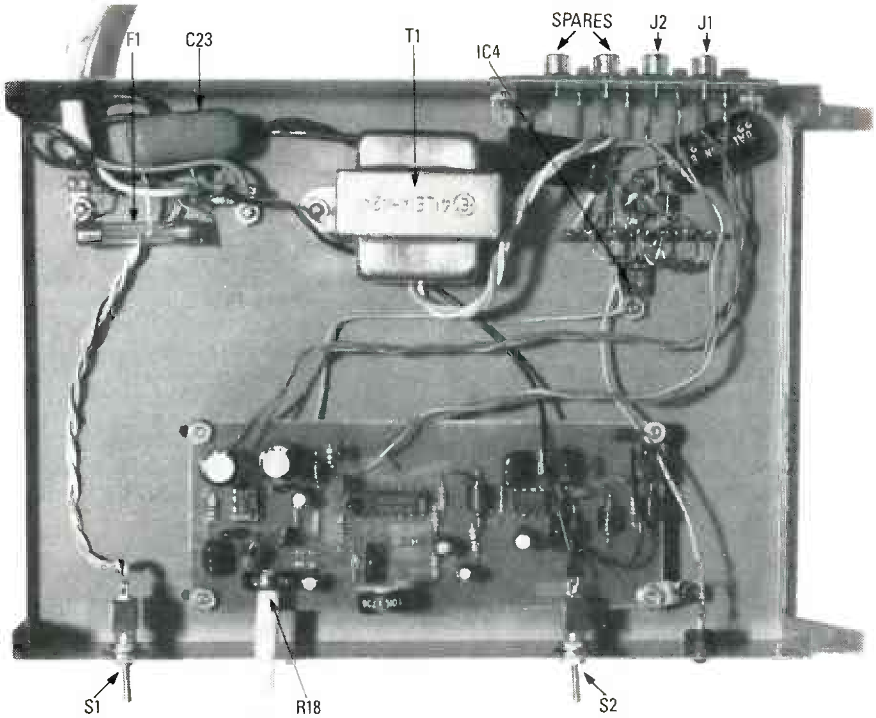


FIG. 6—THE PC BOARD for the FM receiver is installed as shown. Notice how the voltage regulator is mounted to the bottom of the cabinet; the cabinet serves as a heat sink.

- IC1 pins 1, 2, 4–6, and 8 to ground, and IC2 pins 2–10 to ground: no shorts (more than 500 ohms).

Set all potentiometers at halfway, apply DC power, and check for:

- Across C25: 16 volts (exact voltage depends on T1).
- IC3 pin 6: 12 volts.
- IC3 pin 5: 6 volts.
- Q2 collector: 7 volts.
- Q1 emitter: 9–10 volts.
- IC2 pin 7: 10–11 volts.
- IC2 pin 8: 10.5 volts.
- IC2 pins 2 and 3: 4 volts.
- IC1 pins 1 and 2: 11 volts.
- IC1 pin 5: 4 volts.

If everything's OK, connect a speaker to the output of either receiver. Apply power and continue:

AM receiver—Set R10 at about ⅔ open (to get between 6 and 7 volts across C15). Apply a 1-millivolt, 30% amplitude-modulated signal at 280 kHz between C1 and ground. If no signal generator is available, connect a long (25 feet or so) piece of wire to that point and try to pick up some noise from an appliance, etc. peak C2 and C4 for maximum audio output. Adjust R5 so that the audio output stays relatively constant over a range of inputs between 1 millivolt and 1 volt. R5 will affect the receiver's gain, so don't set it too high. Terminate the detector output terminals with a 1K resistor for that test.

FM receiver—Set R9 at midpoint and apply a 1-millivolt modulated signal with 40-kHz deviation, and then adjust R9 for minimum distortion. If no generator is available, set R9 at midpoint; you should hear a hiss in the speaker with no input signal. If possible, verify the frequency response of the input network by connecting a scope to pin 8 of IC1 and applying a CW signal (unmodulated) to the junction of C1 and C2. The signal should be low enough so that no more than 0.5 volts peak-to-peak appears at that pin, and also so that D1 and D2 do not conduct. Vary the signal frequency between 200 and 350 kHz, and plot the response (keep the input level constant). You should get ±1dB flatness or better between 240 and 330 kHz. If not, try adjusting the value of C3, C4, and C5 as required.

The boards are mounted as shown in Figs. 5 and 6. Another alternative is to install the receiver board and power supply inside an old speaker cabinet and use the existing speaker. Sometimes a speaker can be purchased for less than it might cost for just a project case alone. R-E

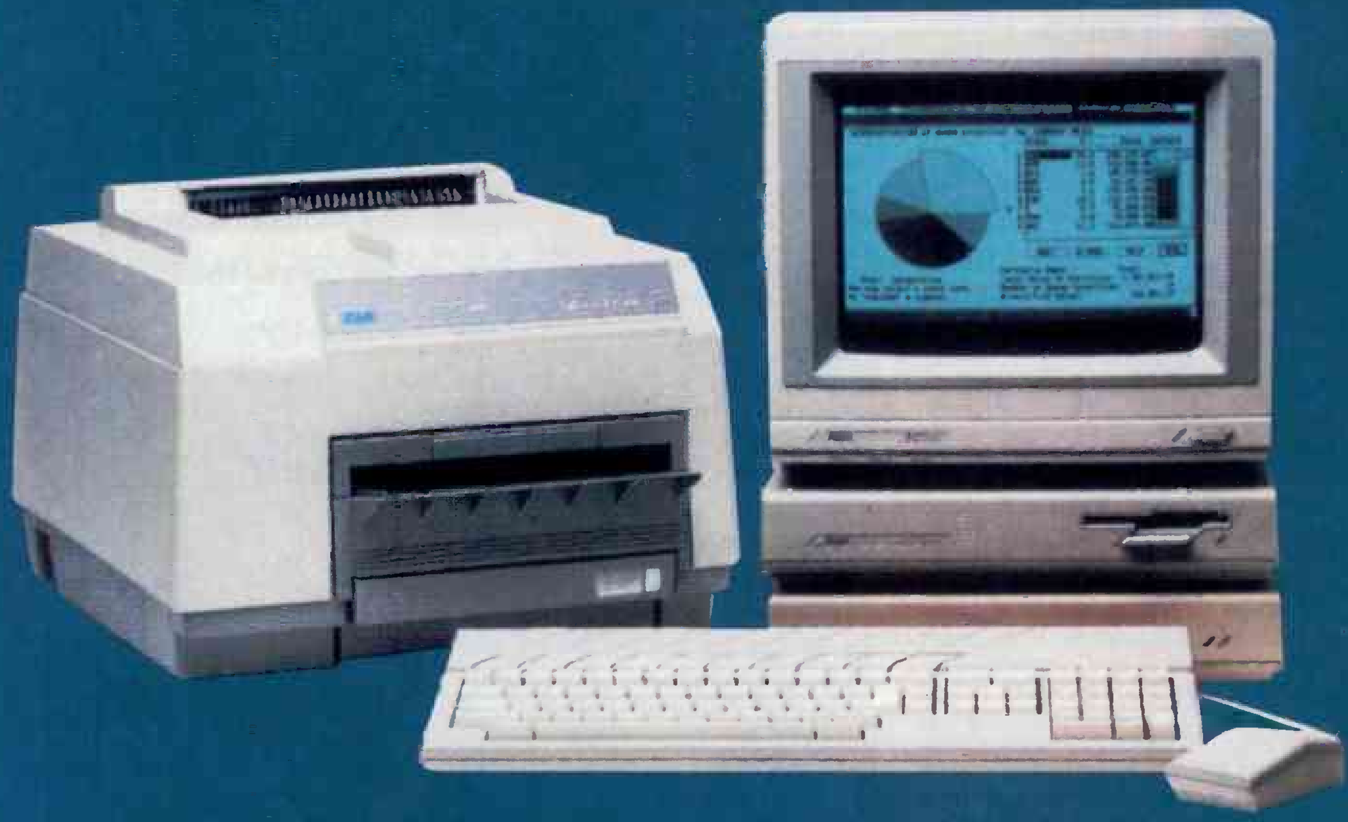
VOL. 6 NO. 2 FEB. 1989

ComputerDigest

A NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

THE ATARI ST

Who needs an IBM PC

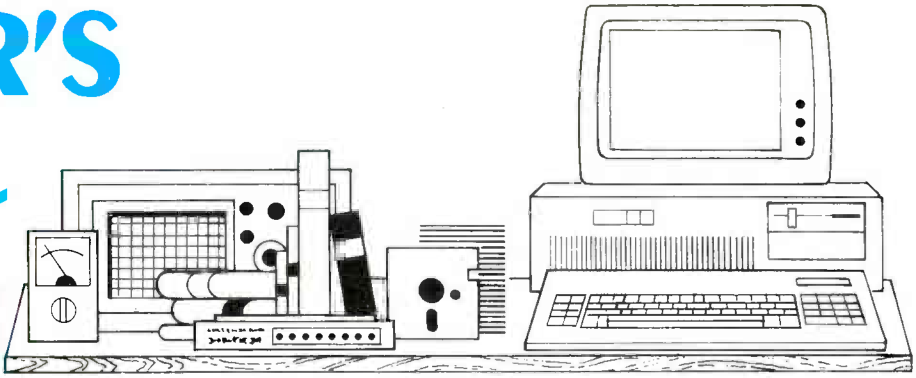


INTEL's 80386

Digging deeper

A GERNSBACK PUBLICATION

EDITOR'S WORK-BENCH



On-The-Go Computing

Z80 computing is not dead! British inventor Sir Clive Sinclair has introduced a new laptop to U.S. computer users. Sir Clive's Z88 features a CMOS Z80, 32K RAM, eight-line by 106-character supertwist LCD display, operation from four AA cells, a built-in serial port, and three slots for memory expansion.

The machine also contains 128K of ROM-based software, including several desktop accessories (clock, calendar, alarm, diary, etc.), and a combination spreadsheet/word processor called PipeDream.

Because of its extensive software, capacity for memory expansion, and wide screen, the Z88 is somewhat more powerful than the original laptop, Radio Shack's Model 100. However, the Z88 is incompatible with MS-DOS software, and has nowhere the storage capacity or expandability of typical DOS laptops.

Even so, the Z88 goes for a great price: just under $600 for the basic unit with 32K of RAM (only 20K of that is usable, however). Not coincidentally, that's Radio Shack's current price for the 32K Model 102 (a cosmetically upgraded Model 100).

For purposes of comparison, we examined a Z88, a Model 100, and a Toshiba T1000. The latter is an MS-DOS machine. Major features of the three are shown in Table 1.

The Z88

The Z88 has a rubberized keyboard that provides a surprisingly good feel. Using a setup utility, you can enable a keyclick that lets you know when you've pressed a key far enough. You can also vary the keyboard's repeat rate. However, the screen cannot keep up with the faster rates; the Z88 simply ignores keystrokes it can't process immediately. Also, the keyboard has no function keys, but it does have an embedded numeric pad. The Z88 also has several unique keys that allow you to use the software efficiently.

One key is labeled with a diamond; it is located in the spot traditionally reserved for the Control key (left of *A*), and functions with other keys as a Control key.

TABLE 1—FEATURES COMPARED

	Z88	T1000	Model 102
Hardware			
CPU	Z80 (CMOS)	80C88	80C85
Clock speed (MHz)	N/A	4.77	2.4
RAM (standard)	32K	512K	32K
RAM (maximum)	416K	1280K	32K
ROM	128K	(DOS 2.1)	32K
Keyboard keys	64	82	56
Display matrix size	8 × 106	25 × 80	8 × 40
Display area (sq in)	10.9	27.8	16.2
Tiltable display	No	Yes	No
RGB video port	No	Yes	No
Composite video port	No	Yes	No
Internal modem	No	Option	300 baud
Expansion slots	3	1	1
Disk drive	No	720K	Option
Weight (lb)	2	6.4	3
Battery life (hr)	20	5*	20
Low-power warning	Yes	Yes	Yes
Auto power off	Yes	No	Yes
Rechargeable	No	Yes	No
Serial port	Yes	Yes	Yes
Parallel port	No	Yes	Yes
Disk drive port	No	Yes	No
Software			
Word Processor	Yes	Yes**	Yes
Spreadsheet	Yes	No	No
Telecom	No	No	Yes
Clock, calendar, etc.	Yes	Yes**	Yes
DOS	No	Yes***	No
BASIC	Yes	No***	Yes

Notes:
*Without modem and memory card
**Borland's SideKick 1.5
***MS-DOS 2.11 in ROM. GW-BASIC not included

Another key is labeled Index; you can press it at any time to bring up a menu of the currently installed applications programs, along with a list of which applications are currently open. Installed applications include both those in the machine's built-in ROM and those in optional memory cartridges.

You open an application by navigating the Index list with the cursor keys and pressing Enter. Several programs can be open at once; in fact, several instances of the same application can be open at once. For example, you could have a spreadsheet open in one instance of PipeDream, and a business letter in another.

A third special key is labeled Menu; within a given application, pressing it brings up a menu of commands. For example, the PipeDream menu lists the following items: Blocks, Cursor, Edit, Files, Layout, Options, and Print.

Each time you press the Menu key, a new item is highlighted, and a sub-menu of available commands appears beside the menu. As with the Index list, you traverse the command list with the cursor keys, and select the desired item by pressing Enter.

A Help key brings up a brief context-sensitive help message in many situations, and a key marked with a square provides a quick way of switching between applications. For example, []-S brings up the Setup screen; []-P brings up PipeDream; etc. If more than one instance of a program is running, repeatedly pressing the box-key combination will switch among those instances.

The software provides some unusual features. For example, although PipeDream is basically a spreadsheet, it also functions fairly well as a word processor. One neat trick is to set up several columns with narrow margins; text typed in each column will wrap within its margins. In that way you can create multi-column documents with ease. 72 columns of text are shown in the middle of the screen; along the left side is the command menu; on the right is a miniature preview map of the current page, in which each pixel corresponds to a single character on the page.

PipeDream can read and write text files in WordStar format; it can also read and write Lotus 1-2-3 files, although a number of features are not implemented (macros and graphics, among others).

You can also use PipeDream as a miniature database; a sort command allows you to sort by column. Search and Replace commands are included.

The software also includes a simple calculator, a calendar display that can work with a diary to schedule appointments, and a flexible alarm that can alert you to single and repetitive events. (The Z88 has a battery-backed clock/calendar.) Another "pop-down" shows the current time and date. In addition, a file manager lets you manage files in the various memory banks.

A version of BASIC called BBC BASIC is also included. It's fairly powerful, but if you're used to any version of Microsoft (or Borland) BASIC, it'll take some getting used to, and you'll definitely have to work to convert programs to run on the Z88.

A dumb-terminal emulator lets you hook up to an external modem and access on-line services. To upload and download files, however, you'll need the special modem, to be discussed shortly. There is a way to send and receive files using just the built-in software, but it's kludgy.

You can print files on an Epson or compatible printer with no problem. The Z88 also includes a special editor for entering codes to activate various features in other types of printers.

Memory management

One inconvenience is that you must treat each bank of memory as a separate unit. For example, you refer to the built-in 32K bank of RAM as RAM.0. You can add 32K ($48) and 128K ($113) expansion modules; a RAM module in the first expansion slot is known as RAM.1, the second as RAM.2, etc. Three 128K modules could be added, provided a maximum of $32K + 3 \times 128K = 416K$.

Surprisingly, you can organize files into a hierarchical directory structure, as used by MS-DOS and UNIX. So, for example, you might refer to a file in the second expansion slot like this:

```
:RAM.2/FINANCE/1989/FEBRUARY/
BUDGET
```

Two ROM modules are currently available. One (PC Link II, $78) contains a program for trading files with an IBM-compatible PC. The program comes with a special cable and a disk containing a program you run on the PC. The other ROM module ($264) contains a telecommunications program and comes with a miniature 1200-baud Hayes-compatible modem.

Several user-programmable EPROM modules are also available with capacities of 32K ($48) and 128K ($113). The Z88 contains a built-in EPROM programmer; using the Filer program, you can save data files to the EPROM. However, you can't access them from there directly; instead, you must copy a desired file from EPROM to RAM to use it.

With only three slots available, you must analyze your needs carefully to get the right combination of features and enough RAM.

The Tandy Model 100

Because for all practical purposes the Model 100 and the Model 102 are identical, we'll refer to both simply as the Model 100. This venerable machine includes an 8 × 40 line LCD screen, 300-baud modem, and five programs: BASIC, Text (editor), Telcom (communications), Addrss (address book), and Schedl (appointment scheduler). The first three provide the machine's real power.

The screen has fairly low contrast by today's standards, but its large characters are easier to read than those of the other machines discussed here. The editor is primitive, but functional. However, to print files, you must send them to another machine, write your own BASIC program, or obtain a commercial or public- domain program.

Because of the Model 100's longevity, there are numerous third-party expansion options, both hardware and software. There is also a wealth of public-domain software, especially on CompuServe. Several books have been written discussing its workings in minute detail, and several magazines devoted to the Model 100 have been published off and on.

Third-party expansion options include RAM and ROM switching systems that allow you to add as much as a megabyte of memory to the machine. Floppy-disk drives that operate off the serial port are available from Radio Shack and others.

The Model 100 is not as glitzy as the Z88, but it's a solid, bug-free product that is well supported. Many Model 100 users (including yours truly) refuse to upgrade to an expensive MS-DOS machine, even though they could easily justify doing so.

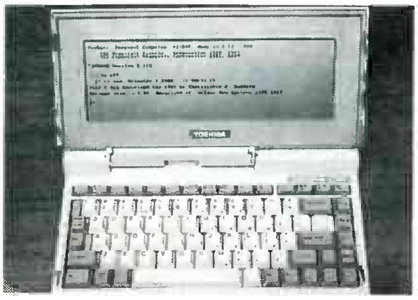
The Toshiba T1000

Based on list prices, this machine is not competitive with the others discussed here. At $1250, the T1000 costs twice what the others cost. However, it's regularly sold in big city computer stores and by mail order for about $750. That's 25% more than the Model 100 and the Z88, but you get more than 25% more computing power for your money.

For one, you get a full 25 × 80 screen. And no matter how much you love your Model 100, you lust for a bigger screen.

You also get 512K of contiguous memory. The other machines can't even count that high. However, that 512K is volatile—when you turn the machine off, the RAM contents are lost. (But there is a fix—we'll talk about that shortly.)

The T1000 also comes with a 720K floppy-disk drive. Although external drives are available for the Model 100, they are slow and buggy. Cambridge Direct advertises the Z88 saying: "No disks. No DOS." However, the user's manual mentions "disc" storage, suggesting that an upgrade may be available at some point. But it would have to run off the serial port also. And external drives are a pain to deal with when traveling.



No modem is included with the T1000, but there is an internal slot for one.

There is another slot for a 768K memory card. (List price = $399; street price = $270.) The memory card bridges the gap between typical MS-DOS portables, and the Model 100/Z88 crowd. The reason is that the memory on the card is not volatile, and may be used as a RAM disk (or as EMS 3.2 memory).

It's probably most useful as a RAM disk, because you can load your favorite DOS applications on the RAM disk, thereby providing the equivalent of the ROM-based software in the other machines.

The T1000 normally boots from DOS version 2.11, which is contained in ROM. If you need a later version, you can boot from floppy, or you can format the RAM disk with the DOS version of your choice, and boot from it.

Other than DOS, the only software that comes with the T1000 is SideKick. Most people think of SideKick as a utility program, but it has a fairly good text editor, and better desktop accessories (address book, scheduler, etc.) than either the Model 100 or the Z88. To provide a complete range of full-powered applications, you could install Microsoft Works or PFS: First Choice for about $100.

The choice

As a long-time Model 100 owner, I find choosing among the three excruciating. The Z88's screen provides many more characters per line than the Model 100, but it has only about 67% of the surface area. Consequently, characters are small. The T1000 provides a standard 25 × 80 work area, and the largest overall screen size. Even so, the Model 100's screen is easier to read.

The Z88 has much more built-in software than the Model 100. For example, even though the Model 100 has a built-in text editor, it provides no way to print files. And a spreadsheet costs an extra $150. The T1000 includes a copy of SideKick, whose features exceed those of the corresponding programs in the other machines, but SideKick has neither a spreadsheet nor a communications program.

The Model 100 has a built-in telecommunications program that works with both its built-in modem and its built-in serial port. There is no excuse for not providing a built-in communications program in the Z88. The T1000 is also weakened by that omission.

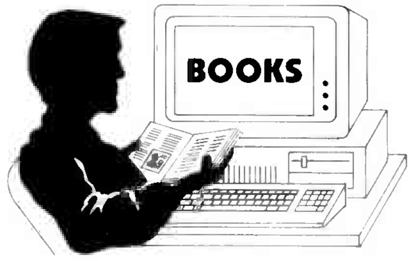
The big question is whether DOS compatibility is important. If it is, the T1000 is the best buy on the market. It's not as powerful as the 286 and 386 machines, but it costs one third as much.

Disadvantages of the T1000 include limited battery life (about four hours with the RAM card), about 50% more weight, and about 67% more volume.

If you can get by without a DOS machine, it's a tough decision. The Z88 includes more software, and has more usable screen space, but the Model 100's screen is more legible. The base Model 100 has more memory (a full 32K vs. 20K in the Z88), and built-in telecomm software. Upgrading the Z88 for 32K of RAM and the modem/software combo costs more than $300; in that price range, you may as well go for a T1000.

Another point to consider is third-party support. Only time will tell whether the Z88 will generate the kind of support that the Model 100 has.

If I were in the market now, I'd probably go for the T1000 with RAM card, and put up with the squashed screen. But as a Model 100 owner, neither the Z88 nor the T1000 represents a significant enough improvement in design and utility to retire my old machine. ◆CD◆



The New Norton

In any field less than ten years old, it's hard to refer to any printed work as a classic. But Peter Norton's *Programmer's Guide To The IBM PC* comes as close as anything can. The venerable guide to PC hardware and software has been reissued and renamed the *Programmer's Guide To The IBM PC and PS/2*.

As you can guess from the title, the update includes much information on hardware and software introduced with and since the PS/2: DOS (3.3 and 4.0), new hardware (VGA, enhanced keyboards, the PS/2 mouse interface), and new BIOS functions. To make room for all the new information, the update drops some information about the PCjr, the PC Convertible, and the XT/286.

The book is both a good read and a good reference. If you're new to the PC world and curious about what's going on inside the box, several introductory chapters give the proper background quickly. If you're an old hand, the multitude of reference charts can help you locate necessary information quickly.

The book isn't perfect; for example, the discussion of keyboards fails to mention that late-model IBM XT's have BIOS support for the enhanced keyboard. And although it provides a good discussion of scan codes, etc., no mention is made of the dedicated keyboard controller used in AT's. So for the most complete information, you'll want to examine IBM's Technical Reference manuals.

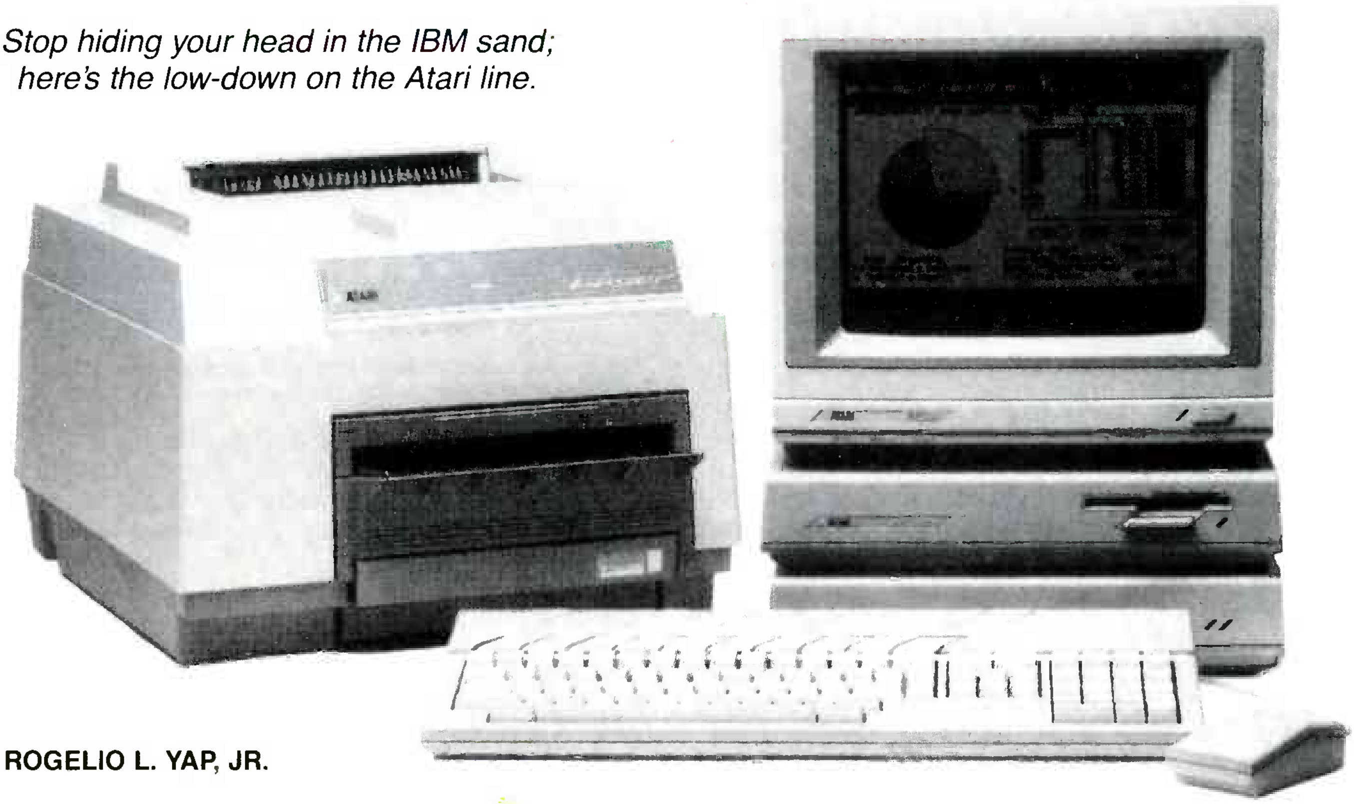
The book's co-author, Richard Wilton, is also author of the excellent *Programmer's Guide To PC And PS/2 Video Systems*. Both books have found permanent places in my reference library. ◆CD◆

PRODUCTS REVIEWED

- Z88 ($599), Cambridge Direct, 1419 Lake Cook Rd., Suite 300, Deerfield, IL 60015. (800) 435-7729. (312) 940-1554.
CIRCLE 45 ON FREE INFORMATION CARD
- Toshiba T1000 ($1249), Toshiba America, Inc., Information Systems Division, 9740 Irvine Blvd., Irvine, CA 92718. (714) 583-3000.
CIRCLE 46 ON FREE INFORMATION CARD
- Model 100 ($599), Radio Shack.
CIRCLE 47 ON FREE INFORMATION CARD
- *Programmer's Guide To The IBM PC and PS/2* ($22.95), *Programmer's Guide To PC And PS/2 Video Systems* ($24.95), Microsoft Press, 16011 NE 36th Way, Box 97017, Redmond, WA 98073-9717. (206) 882-8080.
CIRCLE 48 ON FREE INFORMATION CARD

THE ATARI ST

Stop hiding your head in the IBM sand; here's the low-down on the Atari line.



ROGELIO L. YAP, JR.

In the July 1988 issue, we published a letter that berated us for our lack of coverage of machines outside the MS-DOS family. (See page 16 of that issue.) Actually, in Computer Digest, 50% of the articles published in the past year dealt with a 68000 system; much of the other 50% consisted of articles that had no machine-specific orientation.

Anyway, the author of that letter sang the praises of the Atari line. So we decided to take a look. What follows is an introduction to the Atari family and several of the more interesting hardware and software products available for it.—Editor

Atari's ST was formally introduced at the Winter 1985 Consumer Electronic Show. With 512K of RAM, a 512-color video system, an 8-MHz 68000, and an under-$1000 price tag, the 520 ST caused quite a stir.

Other standard features include a graphical user interface, support for both monochrome and RGB color monitors, a full-function keyboard with function keys and numeric keypad, a two-button mouse, serial and parallel interfaces, a 360K/720K 3.5" disk format, second-drive port, and ROM-cartridge port. The ST also includes a blazingly fast (10 MHz) DMA port, and a built-in MIDI (Musical Instrument Digital Interface) port for attaching electronic musical instruments.

The ST line includes four models: the 520 ST, the 1040 ST, the Mega 2, and the Mega 4 of those models. Features are summarized in Table 1.

The four models are highly compatible with one another; in fact, they're nearly identical, with the exception of memory. However, all ST's are upgradable to 4 megabytes of directly addressable RAM.

The major differences between the 520 and the 1040 on one hand, and the Mega machines on the other is that the Mega machines offer detached keyboards, an expansion bus that allows direct access to the 68000 CPU, and a graphics processor (named the "blitter") that provides lightning-fast text and graphics screen updates.

User interface

The ST comes with a graphical operating environment called GEM (Graphic Environment Manager); GEM was written by Digital Research, the company that designed the CP/M operating system a decade ago. GEM is also available for IBM machines.

If you have used Windows or a Macintosh, you'll find working with GEM familiar. Drop-down menus, movable and re-sizable windows, icons, and desk accessories are found on the GEM desktop.

The Mac and the ST handle desktop accessories in slightly different manners. On the ST, all desk accessories are loaded into RAM when you boot, so the system disk is no longer required. By contrast, the Mac must load an accessory from disk each time it is needed.

TABLE 1—SYSTEM CONFIGURATIONS

Model	Standard Memory	Monochrome System	Color System
520	512K	$799	$999
1040	1024K	$999	$1199
Mega 2	2048K	$1699	$1899
Mega 4	4096K	$2399	$2599

GEM does not support multitasking, but "switching" programs are available that allow you to load as many as eight programs in RAM simultaneously. And several telecommunications programs are available that allow you to perform file transfers by modem while using other software. If you need real multitasking, versions of OS/9 and Idris (a UNIX look-alike) are available.

GEM, along with the BIOS and GEMDOS (the ST's disk operating system), are contained entirely in 192K of ROM. Because the entire operating system is contained in ROM, booting an Atari takes only about five seconds.

GEMDOS is quite similar to MS-DOS. In fact, if you hate graphical interfaces, you'll be glad to know that an MS-DOS style command-line interface is available for the ST. Batch files, I/O redirection, etc., are all available through various software packages.

The Atari ST can read and write IBM-format 720K 3.5" diskettes, as well as 360K and 720K 5.25" diskettes using an optional external 5.25" drive. If you don't need IBM file compatibility, you can squeeze even more data on a disk: 400K and 800K 10-sector/track formatting programs are available commercially and in the public domain. As on IBM systems, floppy-disk drives have a 250 kilobit/second data-transfer rate.

Printed output

An external part of the ST's operating system is GDOS, a virtual device interface designed to provide high-quality output on a variety of printers. In use, GDOS can, for example, map a desktop-publishing layout on a 32K by 32K grid. The image is then scaled down to a form that is suitable for either Atari's laser printer, or an inexpensive 9- or 24-pin dot-matrix printer. Figure 1 shows a sample output from a 9-pin Panasonic KX-P1091i printer. The image was created using Timeworks Desktop Publisher.

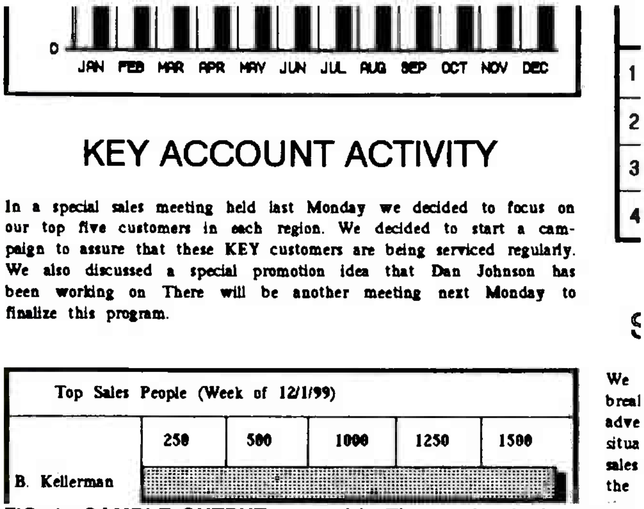


FIG. 1—SAMPLE OUTPUT created in Timeworks desktop publisher and printed on an inexpensive Panasonic dot-matrix printer.

The Atari laser printer provides high-quality 300 DPI output at low cost ($1899 list). The SLM804, shown in Fig. 2, was the first "dumb" laser printer, a concept subsequently imitated by Apple.

Most laser printers have built-in intelligence, and are usually built around 68000 or 68020 microprocessors and a big chunk of RAM. In order to keep costs down, Atari let the RAM and the CPU in the computer do the "thinking" for

FIG. 2—THE SLM804 LASER PRINTER costs less than $2000 and provides a resolution of 300 dots per inch.

the printer too. That keeps the cost down.

One reason for the SLM804's high speed is that it connects to the computer via the DMA port, rather than an RS-232 port. That increases speed by about a factor of ten.

Connecting up

The ST's cartridge port provides an interface for a wide variety of accessories, including sound and video digitizers, ROM-based desktop accessories, hardware RAM disks, scanners, etc.

One exciting use for the cartridge port is to turn an ST into a Macintosh. The secret is to use a device called the Magic Sac, which lists for $149.00. (A set of Apple ROM's is also required.)

The Magic Sac consists of a standard ST cartridge with two empty sockets for the Mac's 64K operating system in ROM. You can buy the ROM's at your local Atari dealer for $40–$60 (or $80–$120 from an Apple dealer). A new version of the Sac should be released by the time you read this; the new version will allow use of the new 128K ROMS, thereby making it possible to run HyperCard on the ST! The Magic Sac works by disabling the ST's operating system and replacing it with the Macintosh operating system contained in the ROM's.

Getting the Magic Sac up and running is as simple as plugging the cartridge in and running the ST software that activates it. The difficult part is transforming Macintosh software to the ST disk format. To help solve that problem, the Magic Sac includes a null modem cable and file-transfer software for both the Mac and the ST. The software allows you to transfer any unprotected Mac disk onto a custom-format (called "Magic format") ST disk. Of course, to transfer files by that means, you must have a real Mac physically present (but see below). A "Magic" disk can only be recognized by the Atari when the Sac cartridge is activated.

The Mac is extremely picky about when you can remove a disk from a drive; in fact, you must explicitly ask the machine to eject a disk, or you risk irrecoverable damage to the data on the disk.

The ST does not have the ejection hardware, so the Magic Sac software informs you when it is safe to remove a disk by flashing a large *A* or *B*, depending on which drive the disk is to be ejected from.

It took more than a year to develop the Magic Sac software, and the software has been revised numerous times. The software is so well done that the ST can now run programs that will not work on the $5000 Mac II! In fact, some Macintosh developers test their programs on Magic Sac equipped ST's as a test of compatibility! Overall, the Magic Sac is approximately 90% compatible with a Mac SE.

The Magic Sac has several advantages over a real Mac. For one, the ST's 640 × 400 screen provides almost 50% more resolution than the Mac's 512 × 342. The difference is noticeable in MacWrite, for example, where the on-screen ruler is visible only up to the 6" mark on a real Mac, but goes past 8" on the ST.

FIG. 3—ATARI'S MEGA 4 includes four megabytes of RAM, an 8-MHz 68000, 3.5" floppy-disk drive, and the GEM operating system.

Another advantage is the ST's increased speed, which makes mouse movement and scrolling faster.

Use of available memory is another improvement. A four-megabyte Mega 4, shown in Fig. 3, will function effectively as a 3.8-megabyte Mac. In addition, the Mac's modem port is fully supported and properly written telecommunications programs (Red Ryder, for example) will run normally.

As mentioned earlier, the ST cannot read or write Macintosh-format disks. However, in addition to the Magic Sac, Data Pacific markets a product called The Translator that allows the ST to read Mac disks via an external disk drive. The biggest advantage of the Translator is that a Mac need not be physically present to transfer software.

The problem with reading Mac disks in an ST is that Macintoshes have variable-speed disk drives, whereas the ST uses constant-speed drives. So rather than vary the speed of the drive, the Translator varies the rate at which bits of data are sent to the drive. The variable data-transfer rate even allows you to run copy-protected programs on an ST. The Translator is completely invisible to the ST when turned off, and it won't interfere with any ST software. The Translator is rather expensive at $279.95 list, but it's still cheaper than buying a Mac.

The Macintosh simply won't work with non-Apple printers. Another Data Pacific product called Epstart ($45) allows you to use an Epson (or compatible) printer to print Macintosh text and graphics. Epstart is a Macintosh desk accessory that can be installed and forgotten. Epstart works by fooling the Mac into thinking that an Imagewriter is present; the program intercepts and correctly formats all printer output, including screen dumps, graphics, and text. In fact, I think my Panasonic printer produces output superior to the Apple printer, which costs more than twice as much. As for compatibility, programs including MacPaint, MacDraft, Microsoft Word, and PageMaker produce good, clean output without problem.

The Atari in Europe

Because of Atari's past connection with game machines, the company has concentrated (and continues to concentrate) on the European market. Those efforts have been so successful that the Atari ST is a top-selling computer in West Germany, and is consistently in the top three in England, France, and the Scandinavian countries.

In all of those places, the ST is viewed as a professional system; it enjoys widespread use in businesses and universities. In fact, the number of ST computers sold in West Germany (roughly 400,000) outnumbers American sales significantly. But the company is now starting to focus on the American market.

IBM emulation

Using an $89 product called PC Ditto, the ST can also run IBM software. PC Ditto turns the ST into a 99% compatible IBM clone that can run Lotus 1-2-3, Flight Simulator, DESQview, the Norton Utilities, GW-BASIC, and most other programs. Mouse drivers are included to let the ST mouse emulate a Microsoft mouse.

Because the PC and the ST are based on microprocessors from totally different families, PC Ditto is a software emulator. Every 8088 machine instruction must be translated into an equivalent 68000 instruction or series of instructions. Because of that translation, PC Ditto generally runs at about 80% of the speed of an XT. For that reason, PC Ditto works best with non-graphics software. Figure 4 shows PC ditto running Lotus 1-2-3 and SideKick.

At least two companies are working on hardware emulators based on 8088-compatible microprocessors; these emulators have expansion slots that can accept IBM cards.

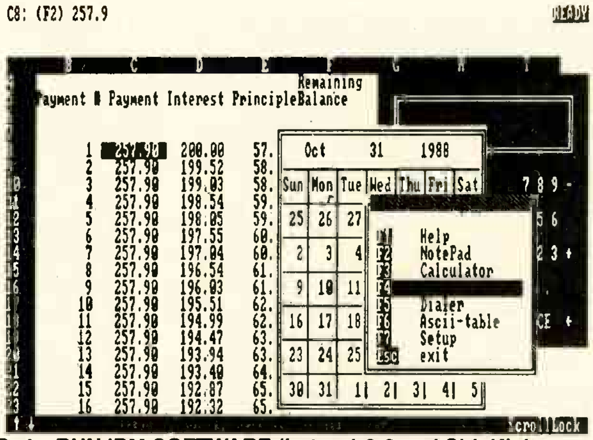


FIG. 4—RUN IBM SOFTWARE (Lotus 1-2-3 and SideKick, among others) on an Atari using PC Ditto.

Software outlook

If you're concerned about the so-called lack of business software for the ST, file-compatible Lotus and dBase III+ clones are available; the clones also provide full support for mice and windows.

On the desktop publishing front, several powerful programs are available that can drive PostScript and HP LaserJet laser printers.

Of course, a multitude of games is available, and entertainment software for the ST meets or beats that found in the arcade. The ST has a joystick port in addition to the mouse port, but for two-player games, the mouse port can also be used as a joystick port. Many of the recent games that have become available use the ST's large RAM size to store digitized graphics and sound to provide a new level of sophistication.

Musical applications

One of the ST's strongest areas is music. Popular rock groups (The Pointer Sisters and Fleetwood Mac, among others) use Atari computers; the computer's low price make computerized musical editing and creation available to budget-conscious hobbyists as well.

The ST's musical abilities come about through its MIDI port, which allows as many as sixteen different instruments to be controlled. That includes synthesizers, drum machines, special effects generators, and digital samplers.

For example, Atari and Yamaha Music teamed up to produce a home electronic music system consisting of an Atari 520ST, a Yamaha keyboard, and software that allows composing, tapeless multi-track recording and playback. The system lists for under $1000.

To get up to speed in music theory, you may want to check out Alfred Publishing's Practical Theory and Music Achievement Series. It runs on the 1040ST.

Conclusion

In this article, we have tried to indicate why the Atari line of personal computers should be taken seriously by serious computerists. The ST combines high quality, low price, and extensive third-party support. Add-on products allow it to run software from the IBM and Macintosh families.

Vendors

Atari Computer Corporation
1196 Borregas Avenue
Sunnyvale, CA 94086
(408) 745-2000

Yamaha Music Corporation, USA
Consumer Products Division
6600 Orangethorpe Avenue
Buena Park, CA 90620
(714) 522-9240

Alfred Publishing Co., Inc.
16380 Roscoe Blvd.
Van Nuys, CA 91410
(818) 891-5999

Timeworks Inc.
444 Lake Cook Road
Deerfield, Illinois 60015
(TimeWorks Desktop Publisher, $129.95)

Data Pacific Inc.
609 Speer Blvd
Denver, Colorado 80203
(Magic Sac, $149)
(Translator, $279)
(Epstart, $45)

Avante Garde Systems
381 Pablo Point Drive
Jacksonville, Florida 32225
(PC Ditto, $89.95)

Word Perfect Corp.
288 West Center ST.
Orem, UT 84057
(Word Perfect 4.1, $395)

Antic Software
524 Second St.
San Francisco, CA 94107
(CADD 3-D 2.0, $89.95)

INSIDE INTEL's 80386

How the 80386 supports operating systems.

NEAL MARGULIS, INTEL CORP.

An operating system is like the foundation of a house: it provides a base on which the entire structure rests. In a house, several sub-systems (plumbing, electrical, heating and cooling) interact to provide an environment for living. When we flip a switch to turn on a light, for example, we don't need to understand or even know about the electrical circuits involved.

Likewise, an operating system has both visible and invisible components. For example, when you copy a file from a hard disk to a floppy disk, a complex system of software functions provide low-level (raw serial data), mid-level (track and sector), and high-level (file) access to data on the disk.

More visible, but no less important, is an operating system's user interface. It translates your COPY command into something the underlying components can understand, so that you don't have to keep track of the tracks and sectors that comprise a file yourself. Thus, copying a file is like flipping a switch.

In this article we'll show how architectural features of the 80386 microprocessor make efficient multi-tasking operating systems possible.—Editor

Time slicing is a technique by which a number of tasks appear to execute on a computer simultaneously. In a simple time-slicing system, each of several tasks is allowed to execute sequentially for a specific amount of time—a time slice. If the time slices are of the proper duration, all tasks appear to execute simultaneously.

Time-slicing has been used, on mainframes and minicomputers, since the 1960's. It is only recently, however, that microprocessors became powerful enough to make time-slicing multi-tasking operating systems practical.

Depending on the operating system, the tasks themselves may be parts of a single program, different programs run by the same user, or different programs run by different users. It is up to the operating system to provide each task with the illusion that it can use any and all resources of the machine throughout the duration of its time slice.

The size of each slice (i.e., the frequency at which tasks are switched) has a great affect on system performance. If you switch tasks too often, system overhead becomes so great that the tasks don't have enough time to do any useful work. But if you don't switch often enough, the responsiveness of a system suffers. For example, if you switched tasks every 10 seconds, typing in a word processor would be frustrating, to say the least!

For the duration of each time slice, the operating system assigns the real processor to a "virtual processor." Each virtual processor has a complete environment consisting of a set of microprocessor registers and information describing that task's use of memory. That information is specified in a *Task State Segment* (TSS).

Task state segments

A TSS is shown in Fig. 1. It is one of several data tables defined by the 80386. The data tables are sometimes referred to as task control blocks. The purpose of the TSS is to save the state of a task's virtual processor while it is not actually running on the microprocessor.

The task control block consists of two parts. The lower part holds the values contained in the virtual microprocessor's registers. The upper part is defined by the operating system, and holds task-related information, including I/O privilege level (discussed shortly), and other information.

To create a new task, the operating system creates a TSS and initializes each slot in the table to the values the task should have when it begins execution.

The processor keeps a selector for the current task's TSS in an on-chip *Task Register* (TR). The TR has a visible 16-bit selector and an invisible selector cache. The selector cache is loaded automatically when the selector is changed. We described selector-cache loading in Part 1 of this article (last month).

To switch tasks, the operating system executes a JMP or CALL instruction; the target of the instruction is a selector for the new task. For example, the processor executes the Jump TSS instruction by storing its registers in the current TSS and then loading the TR with the selector specified in the instruction. The microprocessor can now determine

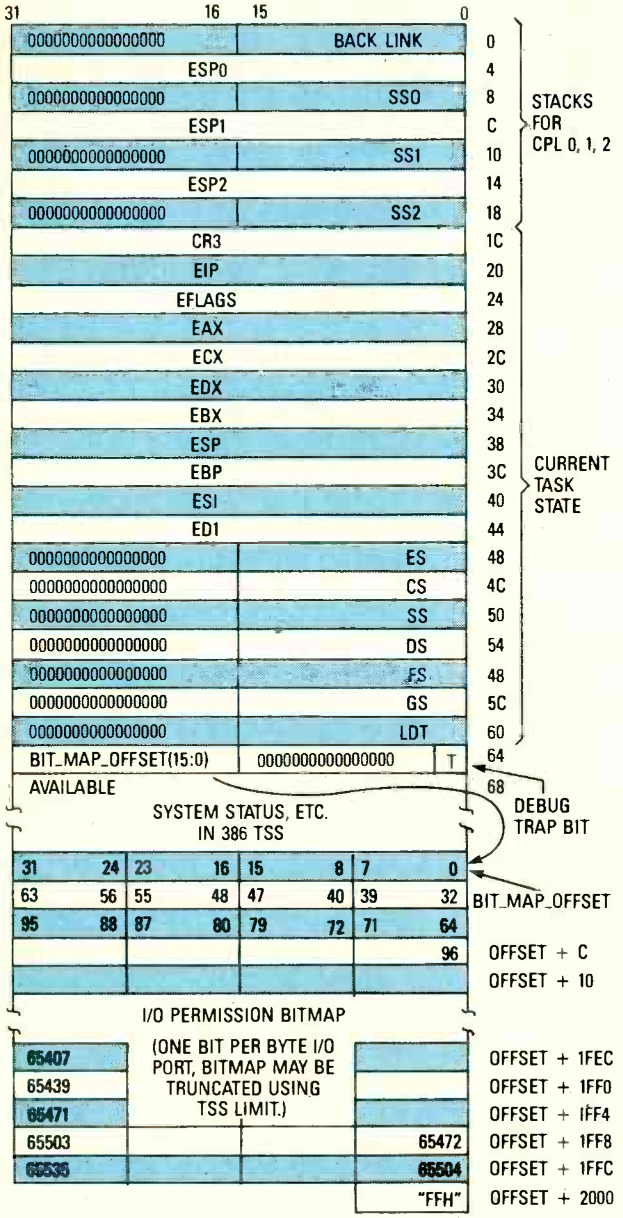


FIG. 1—A TSS IS ONE OF SEVERAL data tables defined by the 80386. The purpose of the TSS is to save the state of a task's virtual processor while it is not actually running on the microprocessor.

the actual memory address of the new TSS, because that address is part of the TR descriptor.

The processor then loads its memory registers with the values in the new TSS. Execution continues with the instruction that is pointed to by the new task's instruction pointer. The old task, including the pointer to the next instruction to be executed in that task, have been stored in that task's TSS. Execution of the old task can resume in the same manner; it is done by issuing a JMP to that task's TSS selector.

In addition to the jump method of loading descriptors described above, two instructions are available for loading and storing the Task Register directly: LTR and STR, respectively. LTR is used to load the TR with a pointer to the TSS data area prior to the first use of JUMP TSS. That ensures that the execution of JUMP TSS stores the current processor state in a valid area of memory.

Memory management

The physical address space of most computers is organized as a simple array of bytes. However, with the development of *M*emory *M*anagement *U*nits (MMU's), computer architectures began to distinguish between the physical address space implemented in hardware, and the logical address space seen by a programmer. It is the MMU's job to translate the logical addresses seen by programs into physical bus addresses. (The 376 embedded processor does not need virtual-memory management so some MMU features are not included.)

The address space of the 386 Microprocessors can be viewed in several ways: flat, segmented, paged, and paged segments.

Flat: The address space is an array of bytes with no additional structure. The logical address is equal to the physical address, so no MMU translation occurs.

Segmented: The logical address space consists of a number of segments, each of which can vary in size. Each segment is specified by a selector and a descriptor, as discussed in Part 1 of this article.

Paged: The logical address space consists of many relatively small fixed-size pages.

Paged segments: The logical address space consists of a segment and an offset. The logical address specifies a linear address; however, each linear address is translated into a page and an offset into that page.

Each type of address space is suitable for a different type of task. A one-to-one correspondence between physical and logical addresses requires the least operating system overhead. A paged-segmented structure is more complicated, but more flexible.

The 386 and 386SX microprocessors can support any of the four models, but the 376 supports only the flat and the segmented models.

Segments

A task's logical address space consists of one or more segments. The 80286 allowed segments with a maximum length of 64K bytes, but the 80386 allows four-gigabyte segments.

Each segment is defined by a descriptor. Descriptors are stored in the shared *G*lobal *D*escriptor *T*able (GDT), which all tasks can access, and in a *L*ocal *D*escriptor *T*able (LDT), where they are more private.

Swapping is a method of sharing memory, when there is more code, data, or both, than physical memory. An operating system that employs swapping keeps track of how often each segment is used. When there is a memory shortage, the least-used segments are stored on disk; the freed-up space can then be used by the current task. OS/2, for example, currently uses segment swapping as the basis for its virtual memory management.

Because 80286 segments are limited to 64K, it is possible to perform memory management by swapping segments. With the 386, however, segments can be extremely large, so swapping on a segment basis is not feasible. That is the origin of paging.

Paging

In the 386 family, there are three kinds of address space: logical, linear, and physical. Depending on which mode the microprocessor is operating in, all three may be identical, two of the three may be identical, or all three may differ. As discussed above and in Part 1, the logical address space is what the programmer sees; in protected mode, selectors in the microprocessor's segment registers refer to the logical address space by way of descriptors, special tables in RAM.

When paging is not enabled, the linear and physical addresses are identical. When paging is enabled, any given 4K chunk of linear memory may correspond to any 4K chunk of physical memory.

The 4K page size is convenient. The reason is that the small page size prevents a common memory-management problem: memory fragmentation that occurs when variable-sized segments are used for memory allocation. When a segment-based operating system needs to make room for a large segment, and only small areas of free memory are available, the operating system must rearrange the programs and data currently in memory to provide one contiguous chunk for the desired segment. Doing so takes time that degrades system performance.

Another complication that a segment-based operating system must contend with is whether to place a new segment into the first memory area the operating system finds, or into an area that is close in size to the new segment. Those strategies are known as first-fit and best-fit management, respectively. With a paging system, memory contents don't actually have to be moved; rather, tables that indicate the linear-to-physical mapping are updated—a much quicker process.

An 80386 operating system enables paging by setting the PG bit in control register CR0. When paging is enabled, the processor translates a linear address to a physical address with the aid of page tables. As on mainframes, page tables are arranged in a two-level hierarchy, as shown in Fig. 2.

Control register CR3 is also known as the Page Table Directory Base; it points to the first entry in a Page Table Directory. A Page Table Directory is one page (4K) long and contains entries for 1024 page tables. Each page table is one page long; each page table describes 1024 pages. Referring back to Fig. 1, you'll notice that CR3 is stored in the TSS. Therefore, each task may optionally have its own page table directory.

Figure 3 shows the complete mechanism that the 80386 uses to translate a linear address into a physical address when paging is enabled. The processor uses the upper ten bits of the linear address as an index into the directory. The selected directory entry contains the address of a page table. The processor adds the next ten bits of the linear address to the page table address. That is then used to select the entry in the page table corresponding to the desired address. Last, the lower twelve bits of the linear address select the desired location in the 4K page.

Note that all of that paging information is stored in memory. If the microprocessor had to access the page tables every time it needed to access memory, performance would suffer greatly. So to reduce the overhead of the page-table lookups, the processor automatically caches mapping information for the 32 most recently used pages in an on-chip *T*ranslation *L*ookaside *B*uffer (TLB), shown in Fig. 3. Only when it does not find the mapping information for a page in the TLB does the processor perform a page table lookup from information stored in memory. Fortunately, 98–99% of all address references are TLB hits (i.e., are found in the TLB). When a TLB miss does occur, the processor replaces an older TLB

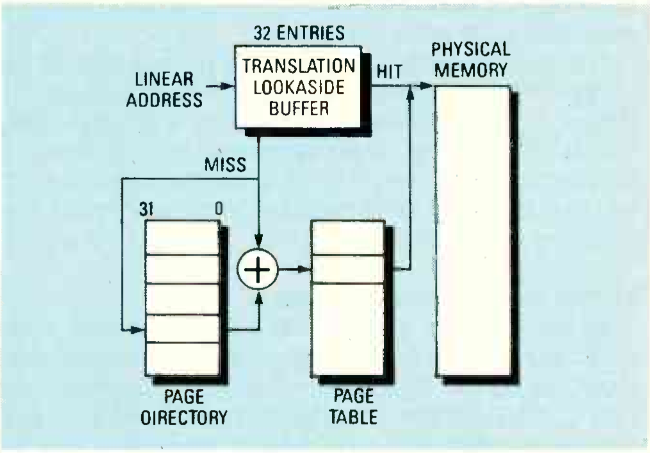


FIG. 3—HERE IS THE COMPLETE MECHANISM that the 80386 uses to translate a linear address into a physical address when paging is enabled.

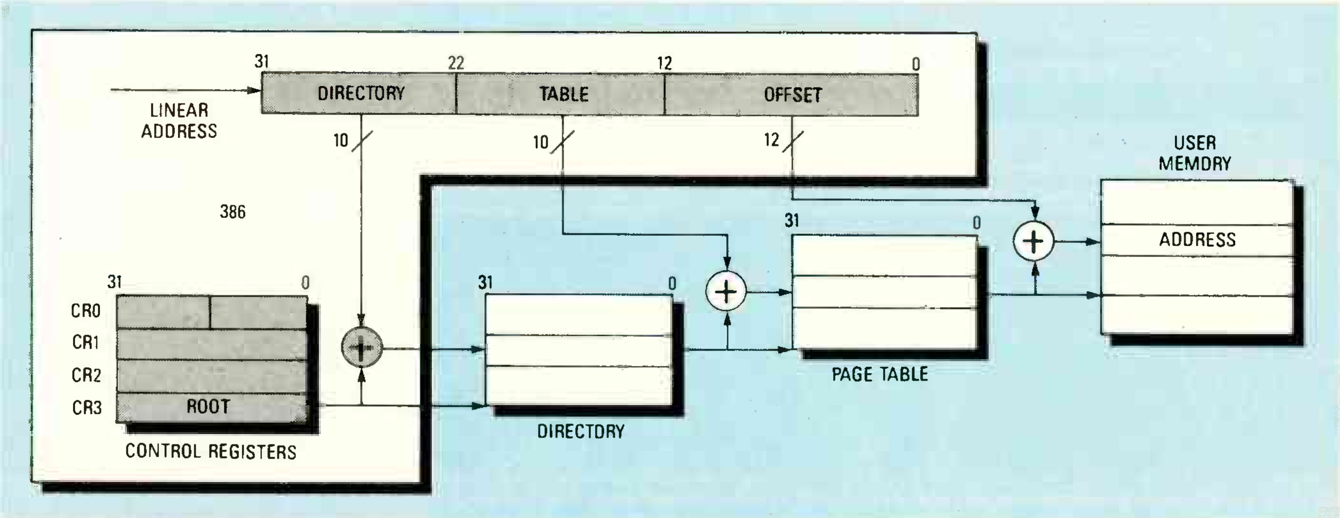


FIG. 2—WHEN PAGING IS ENABLED, the processor translates a linear address to a physical address with the aid of page tables, which are arranged in a two-level hierarchy.

entry with the new entry, which is likely to be used by the microprocessor again soon.

The on-chip page table lookups do not add to the address translation time. However, due to occasional TLB misses, paging does cause execution time to vary slightly. In a real-time system, where varied execution time would be unacceptable, paging is not used. The 376 processor, which is designed for embedded and real-time applications, has no paging mechanism.

Virtual memory management

Virtual memory allows a very large program to be executed as if the entire program was in memory, even though a portion of it is still on disk. For example, with proper management, a computer could run a 2MB program in a system with only 1.5MB of memory.

The page directory and page table entries provide the mechanism. As shown in Fig. 4, the lower twelve bits of each type of entry indicate which pages are in memory, which pages are still on disk, information for deciding which page should be swapped out in favor of a new page, and whether the swapped page needs to be written back to disk or merely overwritten.

The P (present) bit, if set to 1, indicates that the entry is present in memory. If the P bit is 0, then any attempt to access the page will cause a page fault. When a page fault occurs, the microprocessor passes control to a special handler via interrupt fourteen. The interrupt-fourteen handler must read the needed page into memory and return execution to the program. To accomplish that, the handler first determines which page caused the fault. Doing so is easy, because the processor stores that information in CR2.

But what happens if there is no room in physical memory to load another page? Then the handler must decide which page of those presently in memory may be discarded. The handler can't know whether a given page will be needed later on, so it makes an educated guess, based on which page was used least recently.

The A (accessed) bit and the bits available for OS use determine which pages have not been recently used. The A bit is automatically set whenever the processor accesses any location on a page; the A bit is only cleared by software. By periodically clearing A bits, the operating system can keep track of which pages are used often, and which aren't.

After the operating system determines which page will be discarded, it must decide whether it must be written back to disk. It does that via the D (dirty) bit, which is set each time the page is written to. So when a page is to be discarded, if the D bit is set, the operating system knows that that page must be written back to disk. If the D bit is not set, then the contents of the page in memory and the page on disk are the same, so the memory image needn't be written to disk.

That method of swapping pages in and out of memory when needed is called demand paging. Demand paging is used, for example, by UNIX System V for the 80386. And Phar Lap software offers a set of tools for developing large applications that rely on demand paging.

Paging is useful in applications other than virtual-memory management. For example, paging can be used to remap memory. Remapping can be used to fill in gaps in physical memory, or to emulate one type of memory with another.

For example, a program called 386MAX allows you to fill out 512K motherboards to the 640K MS-DOS limit by using paging. The program also allows you to emulate LIM EMS 4.0 memory using extended (physically linear) memory. Similar programs are available from a number of vendors, including Compaq, Quarterdeck Office Systems, and others.

Protection and privilege

The 80386 provides several mechanisms that an operating system can use to protect tasks from one another. We've already discussed one form of protection; that is, the separation of address spaces by segment descriptor tables.

Other protection facilities are based on the notion of privilege hierarchy. At any instant, a task's privilege level is equal to the privilege level of the code segment in which it is executing. A two-bit protection field found in each

31 ... 12	11 10 9	8	7	6	5	4	3	2	1	0
PAGE FRAME ADDRESS 31..12	OS RESERVED	0	0	D	A	0	0	U/S	R/W	P

Page Table Entry (Points to Page)

31 ... 12	11 10 9	8	7	6	5	4	3	2	1	0
PAGE FRAME ADDRESS 31..12	OS RESERVED	0	0	D	A	0	0	U/S	R/W	P

Page Directory Entry (Points to Page Table)

P — PRESENT
R/W — READ/WRITE
U/S — USER/SUPERVISOR
A — ACCESSED
D — DIRTY
AVAIL — AVAILABLE FOR SYSTEMS PROGRAMMER USE

NOTE: 0 INDICATES INTEL RESERVED. DO NOT DEFINE.

FIG. 4—THE PAGE DIRECTORY AND PAGE TABLE ENTRIES. The lower twelve bits of each type of entry indicate which pages are in memory, which pages are still on disk, information for deciding which page should be swapped out in favor of a new page, and whether the swapped page needs to be written back to disk or merely overwritten.

descriptor and selector specifies four privilege levels. Level 0 is most privileged; level 3 is least privileged. Level 0 is for the operating system; level 3 is for user code. The middle levels can be used for other types of code. For example, OS/2 uses level 2 for device drivers. Figure 5 shows how the different privilege levels can be used to form "rings" of protection.

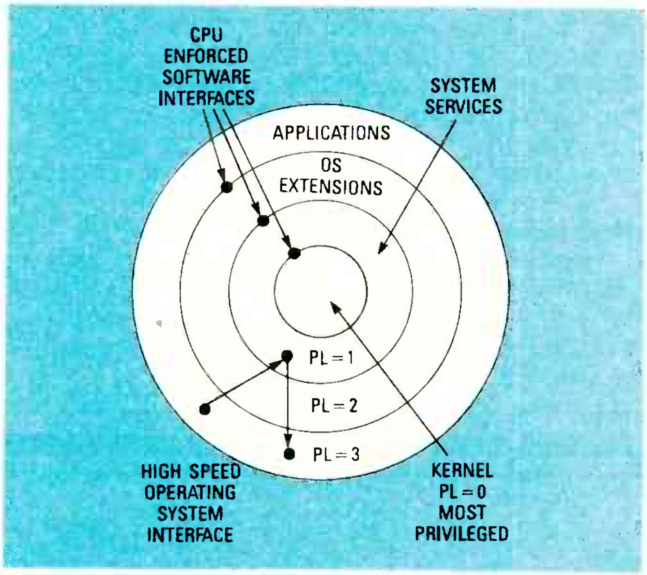


FIG. 5—DIFFERENT PRIVILEGE LEVELS can be used to form "rings" of protection.

When paging is enabled, there is a separate mechanism for protecting user and operating-system memory. That mechanism is governed by the U/S (User/Supervisor) and R/W (Read/Write) bits, which are found in each page directory and page table entry. Those bits control access to individual pages; the operating system manipulates those bits to allow a user program read and write, read only, or no access at all to a given page. That type of control is especially useful for systems that do not use segmentation.

I/O has its own privilege-control mechanism. The flags register contains a field called *I/O Privilege Level* (IOPL), which defines the minimum privilege level at which the currently running task can execute I/O instructions. Because the IOPL is updated during task switches, different tasks can have different IOPLs.

In addition, each task has an I/O Permission Bitmap for controlling access to each port address. That RAM-based table consists of a variable number of bytes, each bit of which corresponds to one of the 64K I/O ports available on the 80386.

Virtual 8086 environment

The 386 microprocessor can execute 8086 applications in two modes: real mode and virtual 86 mode. In real mode, the 80386 functions just like an 8086: the data bus is accessed sixteen bits at a time, as are the microprocessor's registers; memory is limited to one megabyte; and the 80386 paging and protection mechanisms are unavailable.

Virtual mode combines the best of real and protected modes; a simulated real-mode environment that enjoys the full benefits of paging and protection. When the processor is executing in virtual mode, the segment registers are used as in real mode. The contents of the segment register are shifted left four bits and added to the offset to form a linear segment address.

However, by using paging in virtual mode, 8086 ap-

WHAT IS AN OPERATING SYSTEM?

When it comes to operating systems, what you see is not the operating system. The user interface and the functions it performs—formatting disks, for example—is not the operating system. The user interface is really just another program that runs on the operating system. Many companies that sell operating systems include a user interface. Other companies sell just the operating system and include an interface specification so that programmers can write their own user interfaces. The user interface in MS-DOS is contained in COMMAND.COM.

An operating system is not a language or a compiler. Although an operating system must be written in some language, the language is not the operating system. Nor is the compiler, although one is often included with an operating system.

Utilities (FORMAT.COM and DEBUG.COM, for example) and commands (DIR and COPY, for example) are also not the operating system.

Then what is an operating system? An operating system is a program that provides orderly access to computer hardware by applications programs: word processors, spreadsheets, databases, etc. Without an operating system, every application would have to define its own disk-file structure and write its own code to access that structure. Different applications would undoubtedly have different file structures, so they would be unable to coexist on the same disks. Chaos would result if users had to use a different disk for every application.

Likewise, the operating system provides orderly access to the other resources: keyboard, video display, serial and parallel ports, etc.

Operating systems vary greatly in the services they provide. A single-tasking operating system (MS-DOS, for example) provides capabilities for loading and executing programs, reading and writing disk files, etc. A multitasking operating system is more complex because it must allow multiple tasks to share a machine simultaneously, prevent them from corrupting one another, and prevent them from trying to access the hardware simultaneously.

An operating system is the most complex program a programmer can write. Because of that complexity, typical operating systems are designed in layers. The services needed to implement a given layer are found in the layer below. The lowest level of an operating system is the one that interacts with the hardware directly.

Multitasking operating systems were developed in the 1960's to allow multiple users to share a central computer. This is called time sharing. In time sharing, relatively inexpensive terminals connect each user to an expensive central computer. From his terminal, each user seems to have the central computer all to himself, but as the number of users increases, performance decreases.

Many of the advantages of time-shared central computers are disappearing. Personal computers and workstations offer much less expensive processing power than mainframes. And advances in networking allow users to share information with inexpensive network file servers.

Although the popularity of time-shared computers is decreasing, the number of multitasking computer systems is increasing. Multitasking is showing up in both real-time control systems and in personal workstations.

plications can be executed anywhere in physical memory, not just the lower one megabyte. As discussed above, the paging hardware allows the 20-bit linear address produced by a virtual-mode program to be divided into 256 4K pages. Each page can be located anywhere in physical memory.

All virtual-mode programs execute at privilege level 3, the lowest level. If a virtual-mode task attempts to execute a privileged instruction, a microprocessor exception will occur. IN and OUT instructions are not sensitive to I/O privilege level when executed in virtual 8086 mode. Instead, I/O port access is controlled using the I/O permission bit map.

A virtual-machine monitor program such as Windows 386 can provide a virtual-8086 environment that is totally transparent to normal applications programs. The main requirement is that operating-system calls and I/O instructions are intercepted and emulated by the virtual-machine monitor.

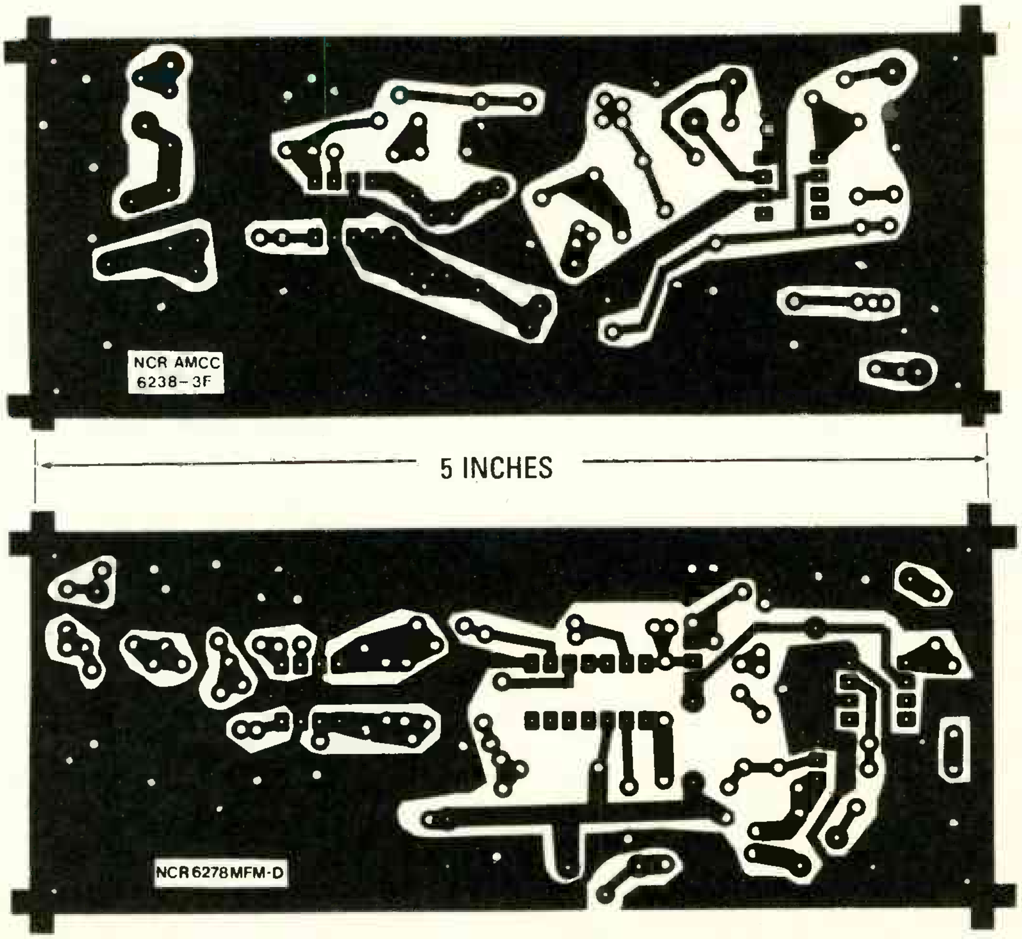
One of the biggest advantages of virtual mode is the ability to run several MS-DOS programs simultaneously. OS/2 cannot multitask DOS applications because OS/2 was designed specifically for the 80286, which does not provide a virtual 86 mode. On the other hand, Windows/386, OmniView, VM/386, and other programs use virtual mode to run several DOS programs simultaneously.

Other products use virtual mode to run DOS applications under UNIX. DOS uses interrupt 21h to provide operating-system functions: opening and closing disk files, etc. When a program issues an interrupt 21h, the operating system examines the VM bit in the image of the EFLAGS register that is stored on the stack. If that bit is set, the task was a virtual 8086 task. It is then up to the operating system either to emulate the call using its own resource, or to send the call on to an actual copy of DOS.

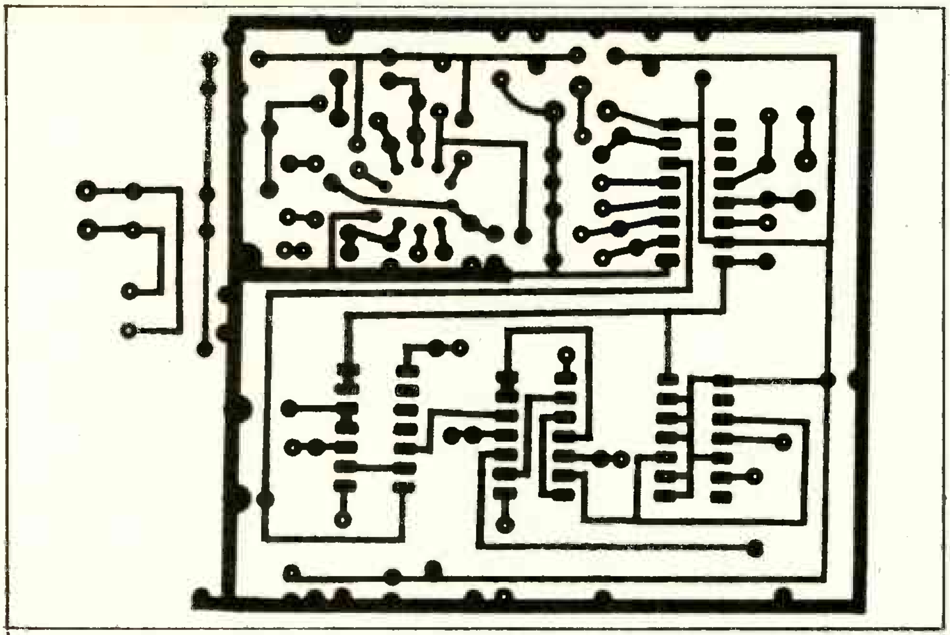
Next month

In the final part of this series, we'll look at hardware design issues, including memory interfacing, I/O interfacing, and interfacing with other system components, including the 80387 math co-processor and the 82386 cache controller.

PC SERVICE

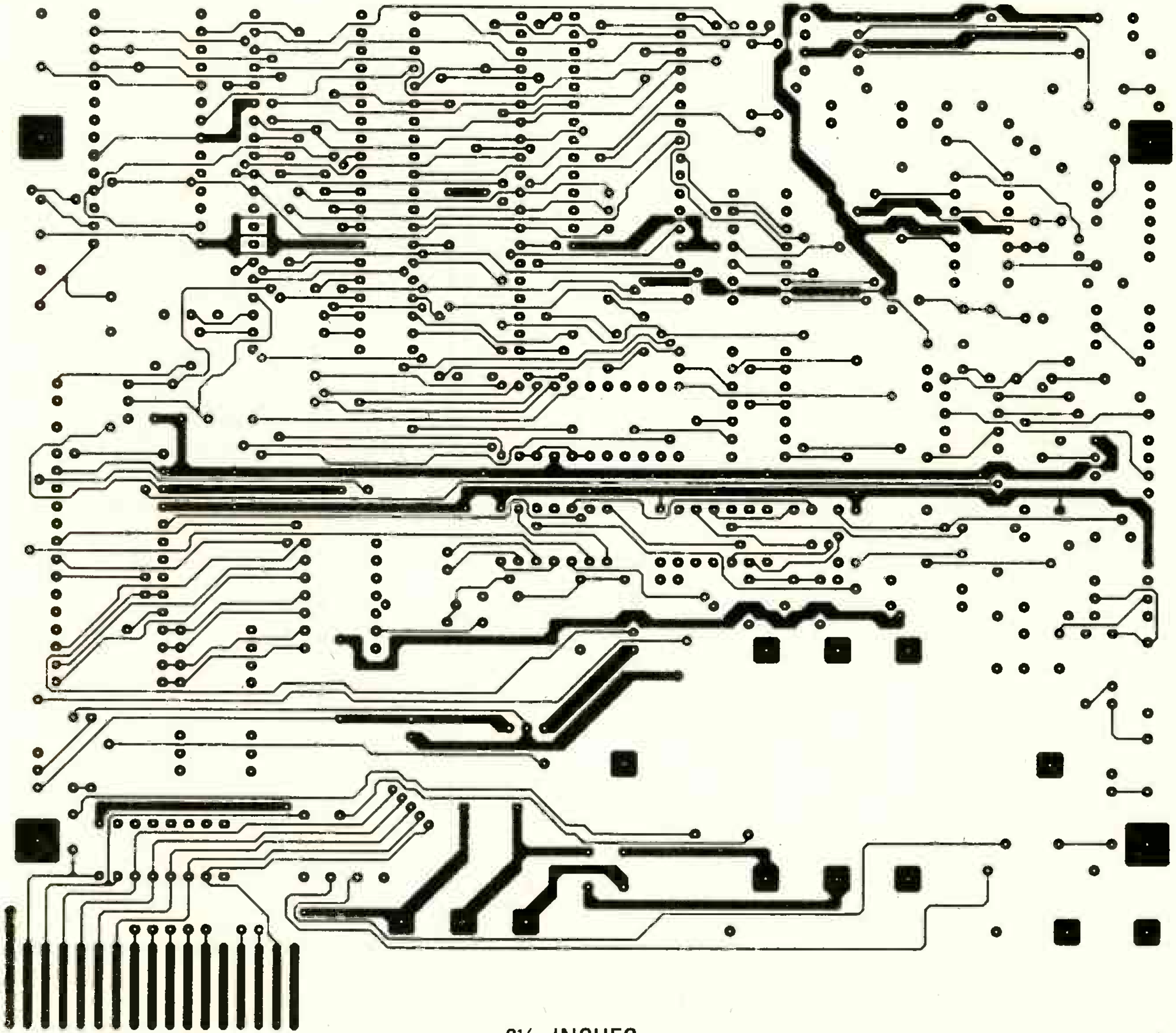


THE FOIL PATTERNS for the AM (top) and FM (bottom) carrier-current receivers.



4 7/8 INCHES

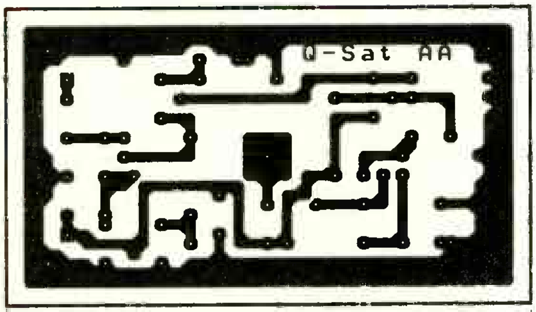
THE 10-MHz FREQUENCY STANDARD can be assembled on this PC board.



6 1/16 INCHES

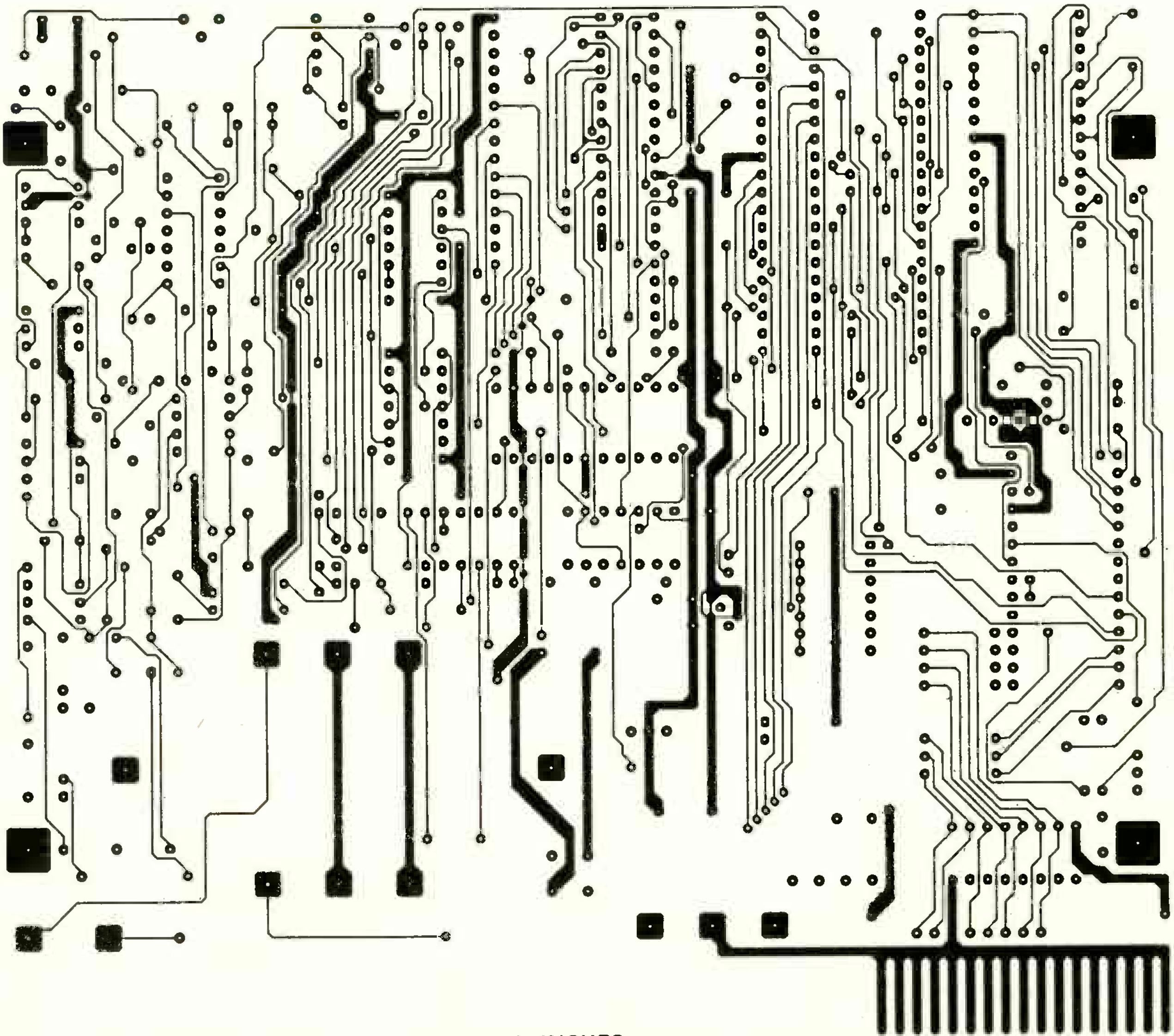
COMPONENT SIDE of Phonlink II.

PC SERVICE



2¾ INCHES

ACTIVE ANTENNA foil pattern.



6¹⁄₁₆ INCHES

SOLDER SIDE of Phonlink II.

HDTV

continued from page 43

those of us who travel to Europe and watch TV there. It is planned that future displays would be refreshed from the frame storage memory at a 75- or 100-Hz rate.

The HDTV system that seems to be favored for North America has a more complex relationship to NTSC. The line ratio would be 15:7. A down-conversion from HDTV to broadcast NTSC would require either a digital interpolation of 15:7 or the cropping of 69 lines at top or bottom or both to give 966 active TV lines, so that a simple 2:1 digital interpolation could yield 483 active lines per the NTSC standard (the remaining lines of the so-called 525 line NTSC system are not visible on screen, but are in the vertical blanking interval). Many of the HDTV systems that are currently under consideration are known as MAC systems, which is an acronym that stands for Time *M*ultiplexed *A*nalog *C*omponents. MAC systems, it should be noted, are inherently free of the color artifacts that have always plagued both NTSC and PAL broadcast pictures.

In Europe, the consensus seems to be that the HDTV production standard used in studios will be fully compatible with a version of MAC called D-2 MAC which is intended to be used shortly as the *D*irect *B*roadcast *S*atellite (DBS) transmission signal of the *E*uropean *B*roadcast *U*nion (EBU). The emphasis there is on compatibility with D-2 MAC, and not necessarily with PAL or SECAM. Some see the eventual use of D-2 MAC for terrestrial transmission with the eventual replacement of the existing PAL and SECAM.

B-MAC, a system developed by Scientific Atlanta, while not a true HDTV system in that it transmits an interlaced 525-line picture and is therefore limited in vertical resolution, might more properly be called an Enhanced Definition System. NHK, the Japanese government-sponsored broadcast authority, has taken a totally different approach to the transmission of HDTV pictures. Since their 1125-line picture is not designed to be compatible with any existing broadcast standards, they have developed a special form of MAC for HDTV transmission. It's called MUSE, which is an acronym for *MU*ltiple *S*ub-Nyquist *E*ncoding." MUSE sub-samples the 1125-line picture, transmitting every other pixel of every other line in a first field. The missing samples of the line are transmitted next, followed by alternate samples of the missing lines and, finally, the samples previously omitted. MUSE has two resolution specifications. One resolution is for static pictures where the full information content of the 1125-line system is delivered via one 8.1-MHz baseband video signal. The other is the resolution that is provided when the picture contains motion; that is the resolution of current NTSC pictures. All forms of MAC, including MUSE, employ various amounts of pre-emphasis for the video signals, as shown in Fig. 9. In MAC systems, the 0-dB crossover frequency for the emphasis curve is much higher than for NTSC, and the low-frequency gain reduction is only about 3 dB for the B-MAC and D-2 MAC systems. MUSE employs a very elegant form of pre-emphasis that provides substantial improvement in signal-to-noise ratios. The MUSE pre-emphasis characteristic applies a large high-frequency gain boost for small-amplitude high-frequency components, and much less emphasis for large high-frequency components. That is possible only with a signal format that has no color subcarrier mixed in with it.

There are other variations on the MAC HDTV idea, but by now it should be clear that the path towards a standard is going to be a long and tortuous one. There seems to be an increasing tendency, in this country at least, to favor some sort of NTSC compatible approach to enhanced definition TV, so that millions of TV's don't become obsolete. It is entirely possible that the first delivery of HDTV may not be via broadcasting or cable TV at all. It could well be that we will see first examples of HDTV delivered to us in the form of software (new laser optical-disc formats or even new VCR formats based upon Super VHS or ED-Beta technology). Of course, such software will require new video monitor/receivers and other new hardware. Still, you should hold on to those NTSC receivers for the moment, since the current multiplicity of HDTV systems could well delay over-the-air HDTV for many years to come. **R-E**

AUDIO UPDATE

continued from page 90

plifier. If an amplifier survives 24 hours of such rough treatment, then the statistical probability is that it is not likely to break down in a customer's home in the foreseeable future. (See Onkyo's product-life test facilities in Fig. 1.)

Physical examinations

How much will a physical examination reveal about an electronic component's reliability? Unfortunately, not much. In the past, some very expensive audiophile components sporting ½-inch thick front panels, beautifully laid out wiring on military glass-epoxy circuit boards, computer-grade parts, etc., have had a far higher breakdown rate than some other unpretentious and far less expensive mass-produced products. That is not to say that pushing the state of the art results in unreliable products, but rather that some designers in their pursuit of the will-of-the-wisp of ultimate fidelity seem to neglect (or have never understood) some essential ground rules of amplifier design. For example, at one point many of the high-end limited-production amplifiers seemed to suffer from instability and to be unable to withstand standard slew-factor testing without blowing fuses.

I don't mean to imply that cheaper is better. An overzealous pursuit of lower manufacturing costs will almost always have negative consequences. Reducing the size and thickness of the front panel won't affect longevity, but cutting back on the heat sinks might. It appears, however, that when the economies of large production runs are possible, the manufacturer gains very little in the way of cost by scrimping on parts quality—particularly considering the ill will engendered by premature failures.

As someone who grew up with audio during the unlamented mono tube days, I continue to be impressed with the extended longevity—and sound—of today's audio equipment. Of course, failures still occur, but they are rarer than ever before. **R-E**

MARKET CENTER

FOR SALE

TUBES. new, unused. Send self-addressed, stamped envelope for list. **FALA ELECTRONICS,** Box 1376-2, Milwaukee, WI 53201.

PHOTOFACT folders, under #1400 $4.00. Others $6.00. Postpaid. **LOEB,** 414 Chestnut Lane, East Meadow, NY 11554.

TUBES: "Oldest," "latest." Parts and schematics. SASE for list. **STEINMETZ,** 7519 Maplewood Ave., R.E. Hammond, IN 46324.

GREAT buys! Surplus prices, ICs, linears, transformers, PS, stepping motors, vacuum pump, phototransistor, meters, lsase, **FERTIK'S,** 5400 Ella, Phila., PA 19120.

TWO-WAY-RADIO, PC COMPUTERS, UNIDEN SERVICE. General Radiotelephone licensed technician. Catalog-**RAYS,** 2025 Moline, Ft. Worth, TX 76117 (817) 831-7717.

Quality Microwave TV Antennas

Multi-Channel 1.9 to 2.7 GHz. 40dB Gain
30-Channel System complete $149.95
12-Channel System complete $104.95
2-Channel System complete $79.95

Phillips-Tech Electronics
P.O. Box 8533 • Scottsdale, AZ 85252
(602) 947-7700 ($3.00 Credit all phone orders!)
LIFETIME WARRANTY
MasterCard • Visa • COD's Quantity Pricing

RESTRICTED technical information: Electronic surveillance, schematics, locksmithing, covert sciences, hacking, etc. **Huge selection. Free brochures. MENTOR-Z,** Drawer 1549, Asbury Park, NJ 07712.

DESCRAMBLERS. All brands. Special combo Jerrold 400 and SB3 $165. Complete cable descrambler kit $39. Complete satellite descrambler kit $45.00. Free catalog. **MJM INDUSTRY,** Box 531, Bronx, NY 10461-0531.

TRS-80 color computer software. Low prices! Huge selection! Free catalog. **T&D,** P.O. Box 1256, Holland, MI 49422.

SOLAR electric systems. Discount prices. **SUN POWER-TEXAS,** Dept. 01C, P.O.B. 2788A, Freeport, TX 77541. 1 (409) 233-8350.

BANDSTOP Filters–Remove interfering signals on Cable T.V. Channels 2, 3, 4, 14, 15, 16, 17, 18, 19, 20, 21 or 22. $20 each - Money Back Guarantee, **dB ELECTRONICS,** P.O.Box 8644, Pembroke Pines, FL 33084.

CB RADIO OWNERS!

We specialize in a wide variety of technical information, parts and services for CB radios. 10-Meter and FM conversion kits, repair books, plans, high-performance accessories. Over 12 years of satisfied customers! Catalog $2.

CBC INTERNATIONAL
P.O. BOX 31500RE, PHOENIX, AZ 85046

MONITOR room and/or telephone conversation. Range unlimited. $88.00. Catalog, $3.00. **LISTEN** 603 Elgin, Muskogee, OK 74401. 1 (800) 633-8277.

T.V. Tunable notch filters. Free Brochure. **D.K. VIDEO,** Box 63/6025, Margate, FL 33063. 1 (305) 752-9202.

OPENING Special. Super Duper Kits. Send $1.00 U.S.$ for booklet to **3C TECHNOLOGY** Box 306, S. Lafleche, St. Hubert, Quebec, J4T-3J6.

OEM QUALITY AUDIO TUBES, wholesale prices, dealers invited. Restoration supplies, tubes, capacitors, resistors, sockets, needles, cartridges, for tube equipment. Catalog $1. **TRIODE ELECTRONICS,** 2010 W. Roscoe, Chicago, IL. (312) 871-7459. **FAX** (312) 871-7938.

TUBES, name brands, new, 80% off list. **KIRBY,** 298 West Carmel Drive, Carmel, IN 46032.

IS it true...Jeeps for $44 through the government? Call for facts! **1 (312) 742-1142,** ext. 4673.

CLASSIFIED AD ORDER FORM

To run your own classified ad, put one word on each of the lines below and send this form along with your check to:

Radio-Electronics Classified Ads, 500-B Bi-County Boulevard, Farmingdale, NY 11735

PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of **$25.00.**

( ) Plans/Kits ( ) Business Opportunities ( ) For Sale
( ) Education/Instruction ( ) Wanted ( ) Satellite Television
( ) ________________________________

Special Category: $25.00

PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.
(No refunds or credits for typesetting errors can be made unless you clearly print or type your copy.) Rates indicated are for standard style classified ads only. See below for additional charges for special ads. **Minimum: 15 words.**

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15 ($46.50)
16 ($49.60)	17 ($52.70)	18 ($55.80)	19 ($58.90)	20 ($62.00)
21 ($65.10)	22 ($68.20)	23 ($71.30)	24 ($74.40)	25 ($77.50)
26 ($80.60)	27 ($83.70)	28 ($86.80)	29 ($89.90)	30 ($93.00)
31 ($96.10)	32 ($99.20)	33 ($102.30)	34 ($105.40)	35 ($108.50)

We accept MasterCard and Visa for payment of orders. If you wish to use your credit card to pay for your ad fill in the following additional information (Sorry, no telephone orders can be accepted.):

Card Number ________ Expiration Date ________

Please Print Name ________ / Signature ________

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.

CLASSIFIED COMMERCIAL RATE: (for firms or individuals offering commercial products or services) $3.10 per word prepaid (no charge for zip code)...**MINIMUM 15 WORDS.** 5% discount for same ad in 6 issues; 10% discount for same ad in 12 issues within one year; if prepaid. **NON-COMMERCIAL RATE:** (for individuals who want to buy or sell a personal item) $2.50 per word, prepaid....no minimum. **ONLY FIRST WORD AND NAME** set in bold caps at no extra charge. Additional bold face (not available as all caps) **55¢ per word additional.** Entire ad in boldface, $3.70 per word. **TINT SCREEN BEHIND ENTIRE AD: $3.85 per word. TINT SCREEN BEHIND ENTIRE AD PLUS ALL BOLD FACE AD:** $4.50 per word. **EXPANDED TYPE AD: $4.70 per word prepaid.** Entire ad in boldface, $5.60 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD:** $5.90 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD PLUS ALL BOLD FACE AD:** $6.80 per word. **DISPLAY ADS:** 1" × 2¼"—$385.00; 2" × 2¼"—$770.00; 3" × 2¼"—$1155.00. **General Information:** Frequency rates and prepayment discounts are available. **ALL COPY SUBJECT TO PUBLISHERS APPROVAL. ADVERTISEMENTS USING P.O. BOX ADDRESS WILL NOT BE ACCEPTED UNTIL ADVERTISER SUPPLIES PUBLISHER WITH PERMANENT ADDRESS AND PHONE NUMBER.** Copy to be in our hands on the 12th of the third month preceding the date of the issue. (i.e., Aug. issue copy must be received by May 12th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding working day. Send for the classified brochure. Circle Number 49 on the Free Information Card.

★★★★★PRESENTING★★★★★
CABLE TV DESCRAMBLERS
★★★★★ STARRING ★★★★★
JERROLD, HAMLIN, OAK
AND OTHER FAMOUS MANUFACTURERS

- FINEST WARRANTY PROGRAM AVAILABLE
- LOWEST RETAIL/WHOLESALE PRICES IN U.S.
- ORDERS SHIPPED FROM STOCK WITHIN 24 HOURS

FOR FREE CATALOG ONLY **1-800-345-8927**
FOR ALL INFORMATION 1-818-716-5914

PACIFIC CABLE CO. INC.
7325½ RESEDA BLVD., DEPT. RE1/89
RESEDA, CA 91335

VISA

SENIOR PROM- For all your Eprom needs! Duplication, Programming, Supplies. Great Prices! Write for details. **SENIOR PROM,** 11 Manor Ridge Drive, Princeton Junction, NJ. 08550.

DESCRAMBLERS All remote at wholesale prices, Z-Tac $199.95, Jerrold 400, $139.95, Tocom $205.95, Oak RTC 56 $199.95, Add ons, SB3-2 $69.95, SA3-2 $89.95, Hamlin $59.95, TRI-BI $89.95. All types Converters, Call, C.O.D. OK, **G.D. ELECTRONICS,** (602) 829-9441.

TOCOMS and more TOCOMS. Outstanding Zenith units. Quality cable products at discount prices. **(714)-974-5688.**

CABLE TV CONVERTERS and DESCRAMBLERS. We sell only the best. Low prices, SB-3 $79.00. We ship COD. free catalog. ACE PRODUCTS. PO Box 582 Dept E. Saco, ME 04072. (207) 967-0726.

ENGINEERING software. IBM/compatibles. CompDes Circuit Design. Basic electricity through circuit designs. CompMath—General mathematics through statistics. CompView—Digital Analysis, waveforms and filters. $49. (614) 491-0832. **BSOFT SOFTWARE**, 444 Colton Road, Columbus, OH 43207.

NUTS & VOLTS MAGAZINE
P.O. Box 1111-E
Placentia, CA 92670
714-632-7721

GIVE YOURSELF A BREAK — A PRICE BREAK! NUTS & VOLTS WILL *Save* YOU MONEY ON ELECTRONIC PARTS & EQUIPMENT *Plus* SHOW YOU WHERE TO FIND UNIQUE, UNUSUAL AND HARD-TO-FIND ITEMS.

SUBSCRIBE TODAY!

Subscription Rates
U.S. FUNDS REQUIRED
3rd Class Mail - USA
One Year $12.00
Two Years $21.00
Lifetime $60.00
1st Class Mail
One Year USA $20.00
Canada Mexico $22.00
Air Mail
Foreign 1 Yr $55.00

A National Publication For The Buying And Selling Of Electronic Equipment

LOW Prices - ICs, Transistors, Capacitors, Switches. Special 27128 - $3.00, 2716- $1.25. Flyer - SASE **SANTECH** 11 Revere Place, Tappan, NY. 10983. (914) 359-1130.

Crystal Oscillator Board and Instructions. 27 MHZ Range. Send $3.00 **PD & F,** P.O.Box 10281, Killeen, TX. 76542.

SURVEILLANCE Electronics, Debugging, Kits. Latest High-Tech. Catalog $5.00 **TECHNOLOGY SERVICES,** 829 Ginette Street, Gretna, LA. 70056.

RADIO Amateur (HAM) Education. Learn at home or in your car. VHS Video or Audio Cassettes. Easy to obtain License. Free information. **AMATEUR RADIO SCHOOL** 2350 Rosalia Drive, Fullerton, CA. 92635.

AIRBAND Converter. Uses your CB $29.00 Complete. SASE for info **MICRO TEK PRODUCTS,** Box 563, Romeo, MI. 48065. (313) 752-3978.

DESCRAMBLERS, Zenith Z-Tac that really work, remote controlled, Tocom all in one combo, remote controlled, $199.95. Full Warranty. S.A.C. (702)-647-3799.

DESCRAMBLERS, Jerrold 400-450, SB3-2, TRI BI, Oak TC 35 - RTC 56, Hamlin MLD1200, SA3-2, Remote converters, Tocom, Zenith. All at wholesale prices and carry a Full Warranty, C.O.D. OK. S.A.C. (702) 647-3799.

Cable TV Descramblers liquidation. Zenith Z-Tac w/ remote $165; Tocom VIP w/remote $235; Oak M35B $60; Jerrold 450 Dic $150; other units available unmodified units at wholesale prices: **DEALERS** Wanted. Call (702) 887-3894.

Software, Schematic Fonts, Electronics Programs, Electronics Dictionary. For C64 or C128 with GEOS (tm). Send $19.95 or write for Info. **THOMAS SOFTWARE,** 1375 Beasley Rd., Jackson, MS. 39206.

ALUMINUM image transfer process, your artwork to aluminum. Write: **J & E ENTERPRISES,** 2457 N. Marmora, Chicago, IL. 60639.

PLANS AND KITS

BUILD this five-digit panel meter and square-wave generator including an ohms, capacitance and frequency meter. Detailed instructions $2.50. **BAGNALL ELECTRONICS,** 179 May, Fairfield, CT 06430.

CATALOG: Hobby/broadcasting/HAM/CB: Cable TV, transmitters, amplifiers, bugging devices, computers, **more! PANAXIS,** Box 130-F2 Paradise, CA 95967

TOP quality imported, domestic kits, surplus, discount electronics, **computers** components. **Free catalog. TEKTRASONIX,** 1120 Avenue of the Americas, 1/fl Suite 4038, New York, NY 10036.

MICRO-LINK FM STEREO AUDIO TRANSMITTER. One chip does it all! Transmit your CD/VCR/ Walkman in stereo to any FM radio. Free schematic and info. Send a self addressed/stamped envelope to: **DJ INC.,** 217 E. 85th St., Suite 108, New York, NY 10028.

ALL SALES SUBJECT TO THE TERMS OF OUR 90 DAY LIMITED WARRANTY. FREE COPY UPON REQUEST.

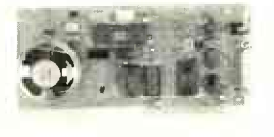
CALL FOR FREE CATALOG

TEXT TO SPEECH BOARD!

PC/XT COMPATIBLE. MAKE YOUR COMPUTER TALK!

A VERY POWERFUL AND AMAZING SPEECH CARD. USES THE NEW GENERAL INSTRUMENTS SPO256-AL2 SPEECH CHIP AND THE CTS256A-AL2 TEXT TO SPEECH CONVERTER.

THIS BOARD USES ONE SLOT ON THE MOTHERBOARD AND REQUIRES A COM SERIAL PORT. BOARD MAY ALSO BE USED IN A STAND ALONE ENVIRONMENT WITH ALMOST ANY COMPUTER THAT HAS A RS232 SERIAL PORT. FEATURES ON BOARD AUDIO AMP OR MAY BE USED WITH EXTERNAL AMPS. DEMONSTRATION SOFTWARE AND A LIBRARY BUILDING PROGRAM ARE INCLUDED ON A 5¼ INCH PC/XT DISKETTE. FULL DOCUMENTATION AND SCHEMATICS ARE ALSO INCLUDED.

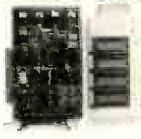


NEW! PRICE CUT! **$69.95** ASSEMBLED & TESTED

NEW! IC TESTER! $149.00

SIMILAR TO BELOW EPROM PROGRAMMER. PLUGS IN TO YOUR PC OR XT. TESTS ALMOST ALL 14, 16, AND 20 PIN 74XX SERIES. INCLUDES STANDARD POWER, "S" AND "LS" DEVICES. ALSO TESTS CD4000 SERIES CMOS. SOFTWARE INCLUDED CAN EVEN DETERMINE PART NUMBERS OF MOST UNMARKED AND HOUSE NUMBERED DEVICES WITH SIMPLE MOD. THIS UNIT CAN ALSO TEST 6.4K AND 256K DRAMS! WITH MANUAL AND SOFTWARE: $149. PERFECT FOR SCHOOLS.

PC/XT EPROM PROGRAMMER $169



ASK ABOUT OUR NEW PAL PROGRAMMER!

★ LATEST DESIGN ★ PROGRAMS UP TO 4 DEVICES AT ONE TIME ★ FEATURES EASY TO USE MENU DRIVEN SOFTWARE THAT RUNS UNDER PC OR MS-DOS. ★ USES AN INTELLIGENT PROGRAMMING ALGORITHM FOR SUPER FAST (8X) EPROM BURNING. ★ THIS PLUG-IN BOARD ATTACHES TO AN EXTERNAL MINI CHASSIS CONTAINING 4 TEXTOOL Z.I.F. SOCKETS. ★ NO PERSONALITY MODULES REQUIRED ★ AUTOMATIC VPP SELECTION: 12.5V, 21V, OR 25V. ★ EPROM DATA CAN ALSO BE LOADED FROM OR SAVED TO A DISKETTE. ★ PROGRAMMING SOFTWARE SUPPORTS: 2716, 2732, 2732A, 2764, 2764A, 27128, 27128A, 27256, 27256A, 27512, AND 27512A. ★ ASSEMBLED AND TESTED, BURNED. IN WITH MANUAL. $169 WITH SOFTWARE.

JUST RECEIVED. SAME AS ABOVE PROGRAMMER, BUT PROGRAMS 8 UNITS AT ONE TIME - $299.

Digital Research Computers

P.O. BOX 381450 • DUNCANVILLE, TX 75138 • (214) 225-2309

TERMS: Add $3.00 postage. We pay balance. Orders under $15 add 75¢ handling. No C.O.D. We accept Visa and MasterCard. Texas Res. add 6-1/4% Tax. Foreign orders (except Canada) add 20% P & H. Orders over $50 add 85¢ for insurance.

Scientific Atlanta & Pioneer Cable Descramblers in Stock
AC/DC — *The New Leader in Low Prices*
• We will match or beat anyone's advertised price •

ITEM	ONE UNIT	10+UNITS
PIONEER ADD ON PD-2 DECODER FOR ALL PIONEER SYSTEMS	250.00	200.00
PANASONIC WIRELESS CONVERTER 1403N	79.95	69.00
JERROLD JSX3-DIC 36 CHANNEL CONVERTER	84.95	65.00
JERROLD 400 WITH REMOTE (MANUAL FINE TUNING)	64.95	55.00
JERROLD 400 COMBO W/ REMOTE (DRX3DIC)	134.95	100.00
JERROLD 450 COMBO W/ REMOTE (DRZ3DIC)	169.95	125.00
JERROLD 400 OR 450 REMOTE HAND UNIT	24.95	15.00
JERROLD SB ADD ON	74.95	55.00
JERROLD SB ADD ON WITH TRI-BI	95.00	75.00
OAK M-35 COMBO	94.95	65.00
OAK MINICODE (N-12)	84.95	59.00
OAK ECONOCODE (E-13)	64.95	40.00
HAMLIN MLD-1200	64.95	55.00
EAGLE PD-3	99.95	60.00
ZENITH SSAVI CABLE READY	149.95	100.00
SCIENTIFIC ATLANTA SA-3 ADD ON	109.95	80.00
INTERFERENCE FILTER (CHANNEL 3 OR 6)	24.95	14.00
VIDEO TAPE COPY STABILIZER	69.95	45.00
PANASONIC CONVERTOR W/ VOLUME CONTROL (170 3PB)	109.95	95.00
SCIENTIFIC ATLANTA 8580	299.95	249.00
SCIENTIFIC ATLANTA 83 CHANNEL CONVERTER	94.95	79.00
SCIENTIFIC ATLANTA 8535	210.00	175.00
PIONEER CONVERTOR (4535)	89.95	75.00

QUANTITY	ITEM	OUTPUT CHANNEL	PRICE EACH	TOTAL PRICE
			SUBTOTAL	
			Shipping Add $3.00 per Unit	
			COD: Add 5%	
			TOTAL	

It is not the intent of AC-DC to defraud any pay television operator and we will not assist any company or individual in doing so.

PLEASE PRINT: ☐ Cashier's Check ☐ Money Order ☐ COD

Name ______
Address ______
City / State / Zip ______
Signature ______ Phone Number ( ) ______

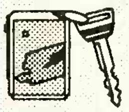
WAIVER. Since I, the undersigned, fully understand that the ownership of a cable decoder does not give the owner of the decoder the right to decode or view premium cable channels without proper authorization from their local cable company, hereby declare under penalty of perjury that all products purchased, at any time, will only be used on cable TV systems with proper authorization from local officials or cable company officers in accordance with all applicable federal and state laws. Federal and various state laws provide for substantial criminal and civil penalties for unauthorized use.

Dated: ______ Signed: ______

ATLANTIC CABLE DISTRIBUTING CENTER INC.
366 N. BROADWAY, SUITE 310, JERICHO, NY 11759.
516 - 625-3550 IMPORTANT: Have make and model # of the equipment used in your area. 516 - 625-3532

CIRCLE 191 ON FREE INFORMATION CARD

REMOTE CONTROL KEYCHAIN



Complete w/mini-transmitter and +5 vdc RF receiver. Fully assembled including plans to build your own auto alarm. Quantity discounts available.

$19.95 Check, Visa or M/C 30 days refund

VISITECT INC. (415) 872-0128
PO BOX 5442, SO. SAN FRAN., CA 94080

DESCRAMBLING, new secret manual. Build your own descramblers for **cable and subscription TV**. Instructions, schematics, for SSAVI, gated sync, sinewave, Jerrold, Hamlin, Oak, Zenith, (HBO, Cinemax, Showtime, UHF, Adult) $8.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20814.

FM transmitter 88 to 108 MHZ kit $12.95 **SIERRA ELECTRONICS.** Box 709, Elfers, FL 34680-0709

ELECTRONIC Kits! Transmitters! Recorders! Phone Devices! Surveillance items! More! Catalog $1.00: **XANDI ELECTRONICS,** Box 25647, 60K, Tempe, AZ 85285–5647.

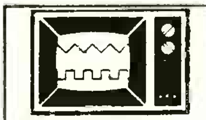
PROJECTION TV Convert your TV to project 7 foot picture...Easy... Results comparable to $2,500 projectors..**Plans and 8" Lens** $24.95.. Professional Systems available...Illustrated Catalog FREE... **MACROMA** 15GF Main Street, Washington Crossing, PA 18977. Creditcard orders 24 Hrs. (215) 736-3979.

PCB Design, Artwork layouts. S/D Sided Boards, low prices. No minimum charge. **VENUS VENDING,** Box 113, Kew Gardens, NY 11415. (718) 739-7809.

110 VAC power from any car...change 12VDC to 125VAC 60 Hz 100 watts, completely assembled or kit. For schematic parts list send $5.00 SASE to **JAMES TYLER** 107-51 139 Street, Jamaica, NY 11435.

SUPER Strobe Circuit. Convert Neon, Fluorescent tubes into bright strobe lights. Excellent for DJ's light shows. Plans $10.00. **COSMOS** 205 White Plains Rd., Trumbull, CT 06611.

"CB Trick of the Trade book" learn CB repair tricks and tuning tricks. Send $19.95 to **MEDICINE MAN,** CB P.O. Box 37, Clarksville, AR 72830.



DETAILED PLANS: $4.95

TV-SCOPE

PENN RESEARCH, Box 3543 Williamsport, PA 17701

FINALLY!

An interesting and worth-while project. This **EASY-TO-BUILD** circuit lets you use any regular TV set as a simple **OSCILLOSCOPE.** Build for less than $10. **NO MODIFICATIONS TO TV!** Single or dual trace. Send for **FREE CATALOG** of other plans and kits.

RADIO ASTRONOMY! Monthly magazine, books, components. $3.00 brings sample package. **BOB'S ELECTRONIC SERVICE,** 7605 Deland, Ft. Pierce, FL 34951.

ROBOTICS! Engines! Inventions! Shape Memory Metals contract like muscles when electrically stimulated. Send SASE for catalog. **MONDO-TRONICS,** 1014 Morse Ave., Suite 11-R, Sunnyvale, CA 94089.

PRO2004 Turbo Scan, 30CPS. 400 Channels. Kit $35.00. **LESTER JERNIGAN,** Box 2406, Orange Park, FL 32067-2406.

Free Microprocessors, Free Electronic Magazines, Free Education in Computers. For info write **MICRO-SAT CORPORATION.** 2401 N.E. Cornell, Hillsboro, OR 97124.

$50 PACKET for Commodore 64. For info send SASE to: **A & A ENGINEERING,** 2521 W. LaPalma, #K, Anaheim, CA 92801.

SINGERS!
REMOVE VOCALS FROM RECORDS AND CDs!

SING WITH THE WORLD'S BEST BANDS!

An Unlimited supply of Backgrounds from standard stereo records! Record with your voice or perform live with the backgrounds. Used in Professional Performance yet connects easily to a home component stereo. This unique product is manufactured and sold Exclusively by LT Sound - Not sold through dealers. Call or write for a Free Brochure and Demo Record.

LT Sound, Dept. R L-3, 7980 LT Parkway
Lithonia, GA 30058 (404) 482-4724
Manufactured and Sold Exclusively by LT Sound
24 HOUR PHONE DEMO LINE: (404)482-2485

SATELLITE TV

CABLE TV Secrets—the outlaw publication the cable companies tried to ban. HBO, Movie Channel, Showtime, descramblers, converters, etc. Supplier's list included $8.95. **CABLE FACTS,** Box 711-R, Pataskala, OH 43062.

SATELLITE TV receiver kits! Instruction manual, boards, semiconductor parts! 59° LNA's! LNB's! Ku-Band LNB's! Catalog $1.00 **XANDI ELECTRONICS,** Box 25647, Dept. 21PP, Tempe, AZ 85285–5647.

CATALOG OR INFORMATION:(213)888-8988
TOLL FREE 1-800-423-3483 OR
1-800-521-MARK(IN CAL)FOR ORDERS
PAID BY VISA MasterCard AMERICAN EXPRESS **ONLY**
ORDER BY FAX (213) 888-6868

MARK V ELECTRONICS, INC.
8019, E. SLAUSON AVE.
MONTEBELLO, CA 90640

SHOWROOM HOURS: (PACIFIC TIME)
MON.—FRI. 9:30 to 5:00 SAT. 10:00—5:00

FREE CATALOG

VIDEO/AUDIO SURROUND SOUND PROCESSOR
SM—333 ΔΔ

It's a must for every modern family!

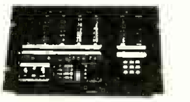
It creates high quality simulated stereo Surround "Music Field" for most video types CD LD, Surround Sound Encoding Disks, tapes, & etc.
This processor employs the most updated IC at its heart. It is also equipped with a "DNR", DYNAMIC NOISE REDUCTION SYSTEM IC made by NATIONAL SEMICONDUCTOR to particularly filter out the annoying noise that is commonly found on tapes or CD disk. In addition, there is six LOW NOISE OP-AMPS and all in one board design, no other external connections connect to the main board.

Other features include:
• Continuous Variable Audio Time Delay • Surround Effect & Level Control • Dynamic Noise Reduction System • High output signal (6.6V MAX) can match with any kind of Main-Power Amp • All metal construction for reliability & durability!

SPECIFICATIONS:
Frequency Response: 20Hz 20KHz (± 5dB) • Total Harmonic Distortion 0.05% 20Hz–20KHz (front channel) < 0.25% (surround channel) • Input Signal Voltage: 0.1V 3.5V • Output Voltage: 0.1V–3.5V (front channel), 6.6V Max. (surround channel) • Delay Time: 5ms–50ms • Input Impedance: 47K Ohms Power AC 110V 60Hz • Dimensions 4 3/16in (W) X 4 13/16in (D) X 2 1/16in (H) •
KIT/ASSM. AND TESTED $62/83

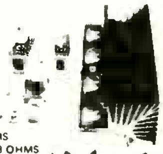
SUPER SALE

PROFESSIONAL COLOR LIGHT CONTROLLER
SM—328



FEATURES
1. FOUR GROUPS OF INDEPENDENT OUTPUT SYSTEM 1000W/CH MAX. 4680W (100-117V) 2. PROFESSIONAL COLOR CONTROL SYSTEM (KEYBOARD TYPE) 3. INDEPENDENT INPUT SIGNAL ADJUSTMENT 4. FOUR GROUPS OF INDEPENDENT DIMMER CONTROL 5. SPEED CONTROL CHASER 6. AUTOMATIC CHASING CONTROL SYSTEM 7. FOUR KINDS OF SPECIAL CHASING PROGRAM 8. COMBINATION OF PROGRAM AND MUSIC CHASING EFFECT 9. FORWARD/ BACKWARD CHASING CONTROL
SM-328 color light controller is specialized for ballroom, night club disco and advertisement lighting. It consorts with several color control characteristics, which employ professional color control system and keyboard program selection. Therefore, it is capable of producing lighting effects by using chasing program and fluctuating music signal. There are two kinds of lighting effects. The first type is controlled by 'music' signal. In order to adjust the brightness of four groups of lightings, each music signal will be separated into high, medium low A, and low B frequency range. Furthermore, each group of lightings is incorporated with an independent signal adjustment. The second kind is composed of electrical circuits and this is the main part for creating a special lighting effect. It has four chasing programme.
Dimensions 14 5/16" x 8 15/16" x 3 3/16"
Ass AND tested .... $150.00 ONLY

300W HQ HI-FI POWER AMPLIFIER (MONO)
TA-3600 ΔΔΔ



QUASI-COMPLEMENTARY-SYMMETRY WITH PARALLEL HIGH OUTPUT TRANSISTORS
SPECIFICATIONS
*POWER OUTPUT: 300W (RMS) INTO 8 OHMS
2450W (P.M.P.O.) INTO 8 OHMS
540W (MUSIC POWER) INTO 8 OHMS
*LOAD IMPEDANCE: 4 OHMS OR 8 OHMS
*FREQUENCY RESPONSE: 10Hz-200,000Hz
*TOTAL HARMONIC DISTORTION LESS THAN 0.05%
*INPUT SENSITIVITY AND IMPEDANCE AT 1KHz 1V-1.4V 47K OHMS
*SUPPLY VOLTAGE DC ± 75V OR AC 53V x 2.8A
KIT/ASSM AND TESTED $86/110
X' FORMER/10,000 μF 80V E. CAP $38/20

NEW with 4 pcs THOMSON HUGE 250 W POWER TR!

STATE OF ARTS HQ FET ST. PRE—AMP
TA-377A ΔΔΔ

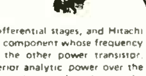
0.007% THD

- This Pre-emplifier employs 18 pairs of HIGH QUALITY N channel and P channel FET and 1% metal film resistor to form a state of arts full complementary symmetric mirror circuit.
- It uses "CR" RIAA EQ pre-amplifier to minimize TIM distortion and to obtain high fidelity.
- The power supply is based on by pass coupling DC stabilizer which uses class A design to obtain low internal impedance at high frequency and to greatly reduce transient distortion.
- Professional relay delay circuit prevents noise which may occur during power on and off.
- All FETs were tested and paired in the factory so no problem is likely to occured during building.
- It can be directly connected to any power amplifier. The best partner is TA-477 120W MOS FET power amplifier & TA 3600

KIT/ASS AND TESTED $69.95/75
METAL CABINET $20.16

120W MOSFET POWER AMPLIFIER
TA-477 ΔΔ

BUILD A PROFESSIONAL AMP BY YOURSELF



This amplifier consists of three super low TIM differential stages, and Hitachi 2SJ49/2SK 134 match pair "MOSFET" as output component whose frequency response and transient response is superior to the other power transistor. Therefore this amplifier has high-fidelity and superior analytic power over the entire Audio Spectrum. It is suitable for reproducing classic and modern music. Heavy Duty Heat Sink with 28 radial fins is included!
Kit $68.00
Metal Cabinet/X'Former (Optional) $33.00/24.00

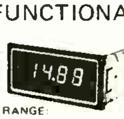
FREE CATALOG

4½ HI-PRECISION D.P.M.
SM-48A ΔΔΔ

SPECIFICATIONS
*4½ digit 14mm red large display with overload flash
*Multi-functions including BCD, BUSY, STROBL output, very suitable for micro computer.
*MEMORY STYSTEM CAN HOLD the input reading for comparison and monitor.
*Range DC voltage DC ± 1mV - ± 2000A
DC current DC ± 1uA - ± 20A
*Accuracy DC ± 0.025% ± 2 digit
*Power DC5-6V at 200mA
DIMENSIONS 3 3/4" (W) x 1 7/8" (H) x 4 1/16" (D)
(MEET WITH DIN STANDARD OF W. GERMANY.)
KIT/ASSM AND TESTED & CAL. .... $36/48 SALE

MULTIFUNCTIONAL LED D.P.M. ΔΔ

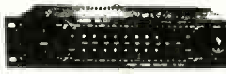
LARGE 3½ DIGIT 0.6" LED DISPLAY



FREE GOLD-PLATED EDGE CONNECTOR

MEASUREMENT RANGE:
D.C VOLTAGE: 1mV – 1000V
A.C. VOLTAGE: 1mV – 1000V
DIGITAL THERMOMETER: 0°C – 100°C
D.C. CURRENT: 1 uA – 2A
CAPACITOR METER: 1 pF – 2 uF
DIMENSIONS 3 3/4" x 1 7/8" x 4 1/16"
SM-43 Kit $32
ASSM AND TESTED & CAL. .... $43 SALE

120W VERSATILE STEREO POWER BOOSTER ΔΔ
TA—302



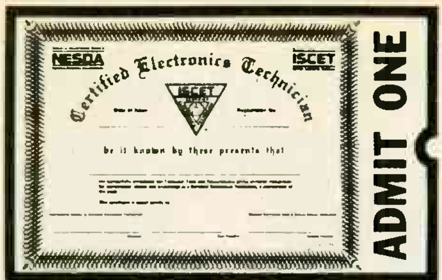
MATCH WITH OUR SURROUND SOUND PROCESSOR

- OTL full transistorize and low distortion of SEPP circuit design, high output power and sound fidelity
- With high and low input inpendence for selection, so it can match with all preamplifiers, low power of portable sound equipment, and all types of stereo recorder deck to use. It can boost 'walkman' type of radio and tape player, too.
- With 10 band colour LED power meter, output power can be easily defined. TA—302 is a versatile amplifier for both visual and listening enjoyment 60W x 2 P.M.P.O

KIT/ASSM AND TESTED .... $50/70 SUPER VALUE

TERMS: $10 min order • $20 min charge card order • Check, money order or phone order accepted • We ship UPS Ground • Add 10% of total order (min $2.5) for shipping, outside USA add 20% (min $5.00) • Transit Insurance: add 5% of total (outside USA only) • CA residents add sales tax • All merchandise subject to prior sale • Prices are subject to change without notice • Any goods proved to be defective MUST BE RETURNED IN ORIGINAL FORM WITH A COPY OF YOUR INVOICE WITHIN 30 DAYS FOR REPLACEMENT.

CIRCLE 93 ON FREE INFORMATION CARD



Your Ticket To SUCCESS

Over 25,000 technicians have gained admittance worldwide as certified professionals. **Let your ticket start opening doors for you.**

ISCET offers Journeyman certification in Consumer Electronics, Industrial, Medical, Communications, MATV, Radar, Computer, and Video. For more information, contact **the International Society of Certified Electronics Technicians, 2708 West Berry St., Fort Worth, TX 76109 • (817) 921-9101.**

Name ____________

Address ____________

City ____________

State ____________ Zip ____________

____ Send material about ISCET and becoming certified.

____ Send one "Study Guide for the Associate Level **CET** Test." Enclosed is $5 (+ $1 postage).

VIDEOCIPHER II Manuals. Volume 1 - hardware, Volume 2 - software. Either $32.45. Both $54.95. **NEW! Volume 3**-Projects/software - $42.45. All for $89.95. CODs - 1 (602) 782-2316. Catalog - $3.00 **TELECODE** Box 6426-R, Yuma, AZ 85366-6426.

DESCRAMBLERS for movies, networks, $175. video only $450 complete. Visa, MC accepted. Catalog $4 **SKYWATCH,** 238 Davenport Road, Toronto, Ontario, Canada, M5R-1J6.

VIDEOCYPHER II descrambling manual, schematics, video and audio DES, cloning, muskateering, EPROM codes. (HBO, Cinemax, Showtime, adult channels.) $13.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20814.

Pay TV and Satellite Descrambling Vol. 2
"Scrambling News"

Vol. 2 is even better than vol. 1. $12.95 Vol. 1 $14.95 Experiments with Videocipher. Cloning, musketeering $14.95. Cable TV Security, design $12.95. MDS/MMDS Handbook. Microwave hacking $9.95. Build Satellite Systems Under $600. $12.95. Any 3/$27 or 6/$40. Scrambling News. Monthly $24.95/yr. New Z-TAC and VC series. Sample $3 (refundable). New enlarged Fall product catalog $1.

Scrambling News, 15552A Hertel Ave. Buffalo, NY 14216 COD's 716-874-2088

FREE catalog systems, **Upgrades,** Houston, Uniden, Chaparral, etc. **Save,** $$$$ **SKYVISION,** 2009 Collegeway, Fergus Falls, MN 56537, (218) 739-5231.

SEND Stamp For Catalog. **COMMUNICATIONS ENGINEERING,** 76 Boulevard, Hudson Falls, NY 12839.

FREE catalog 36 pages. Major brands. Nobody undersells **WEST,** since 1977. Immediate shipping. Call for prices. 1741 Cedardale Road, Mt. Vernon, WA 98273. (800) 222–9064.

WANTED

INVENTORS! AIM WANTS—Ideas, Inventions, technology, improvements on existing products. We present ideas to manufacturers. **Confidentiality** guaranteed. Call toll-free in U.S. and Canada **1 (800) 225-5900.**

CABLE T.V. "BOXES"

Converters—Descramblers
Remote Controls—Accessories

★ Guaranteed Best Prices ★
★ 1 Year Warranty—C.O.D.'s ★
★ Immediate Shipping ★
★ FREE CATALOG ★

Call or Write
TRANS-WORLD CABLE CO.
12062 Southwest 117th Court, Suite 126
Miami, Florida 33186
800-442-9333

WANTED: Old, Western Electric, McIntosh, Marantz, Dynaco, Altec, JBL, Jensen, RCA; **TUBES** Speakers, amps (713) 728-4343. **MAURY,** 12325 Ashcroft, Houston, TX 77035.

WANTED: WRITERS Heath Company, the world's largest manufacturer of electronic kits and publisher of a new technical magazine, is looking for alert Electronic Hobbyists to add to our staff as contributing part-time or regular authors. SASE for information: **HEATH COMPANY** P.O.Box 217, Benton Harbor, MI 49022-0217.

TUBES - 2000 TYPES
DISCOUNT PRICES!

Early, hard-to-find, and modern tubes. Also transformers, capacitors and parts for tube equipment. *Send $2.00 for 24 page wholesale catalog.*

ANTIQUE ELECTRONIC SUPPLY
688 W. First St. • Tempe, AZ 85281 • 602/894-9503

THE ULTIMATE ELECTRONICS CATALOG.

Order your 260 page catalogue packed with over 10,000 money saving electronic parts and equipment. Send $3.00 check or money order, or call **1-800-543-3568** today and use your Mastercard or Visa.
Consolidated Electronics, Incorporated
705 Watervliet Ave., Dayton, Ohio 45420-2599

NAME

ADDRESS

CITY

STATE ZIP

CIRCLE 188 ON FREE INFORMATION CARD

OPPORTUNITY WITHOUT RISK.

The biggest improvement in 40 years has made U.S. Savings Bonds an ideal investment.

A variable interest rate lets you share in rates offered by today's securities market. No limit on how much you might earn.

What makes this improved Bond ideal is that you're protected by a guaranteed minimum. And if the Bond is held to maturity, you'll double your money.

Take another look at this opportunity without risk.

Take stock in America. UNITED STATES SAVINGS BONDS

Ad Council — A public service of this publication and The Advertising Council.

CABLE HOT LINE

PRICE & Product Best of 2 Worlds 1 (313) 548-0050. SSAVI/RKDM400/SB-3/DRX-3DIC-105/PD-3/M35B/DF-3... **BONDED CABLE** P.O. Box 340 Ferndale MI 48220-9998.

DIGITAL CAR DASHBOARDS

BUILD yourself a complete electronic dashboard. Free details, $1 P & H. **MODERN LABS,** 2900 Ruisseau, St.-Elizabeth, QC, JOK 2JO, Canada.

SCRAMBLE FACTS
718-343-0130

PHONE TODAY for 3 minutes of satellite TV industry news, technical tips, and new product information.

PRINTED CIRCUIT BOARDS & ARTWORK LAYOUTS

LOW priced single, double sided boards. Low setup fees. CAD artwork at discounted prices. (704) 464-1164; **WE-KAN,** RT-3, Box 662-H, Conover, NC 28613.

MODEMS

SMARTONE Internal Hayes compatible 1200bps Autoanswer/Autodial. FREE Bitcom Software. $15.00 FREE Compuserve. 2 year warranty. NO SHIPPING CHARGES. $65.95. **GTECH TECHNOLOGIES,** 11221 Interstate-10, New Orleans, LA 70128.

BIG PROFITS!

Learn VCR cleaning-Repair! Prior experience unnecessary. Need only small hand tools, average mechanical ability. **Big demand** performing VCR cleanings and repairs! Viejo's 400 page TRAINING MANUAL (over 500 photos and illustrations!) and companion **VIDEO TRAINING TAPE** contains hundreds of REAL-WORLD examples of VCR malfunctions and their repair solutions. Secrets revealed! Also: business tips for your new service business!

Free INFO: call (toll free) 1-800-537-0589
or write to: **Viejo Publications, Dept. R-E**
217 E. 86th St., STE 272, NY, NY, 10028

BUSINESS OPPORTUNITIES

YOUR own radio station! AM, FM, TV, cable. Licensed/unlicensed. **BROADCASTING,** Box 130-F2, Paradise, CA 95967.

MECHANICALLY inclined individuals desiring ownership of small electronics manufacturing business—without investment. Write: **BUSINESS,** 92.R, Brighton 11th, Brooklyn, NY 11235.

EARN thousands with your own part time electronics business. I do. Free proof, information. **INDUSTRY,** Box 531, Bronx, NY 10461-0531.

PROJECTION TV...Make $$$'s assembling Projectors. Easy!.. Results comparable to $2,500 projectors... **Plans, 8" Lens** & Dealers information $22..50... Professional Systems available... Illustrated catalog FREE **MACROCOMA** 15GFX Main Street, Washington Crossing, PA 18977... Creditcard Orders 24 HRS. (215) 736-2880.

BIG PROFITS

ELECTRONIC ASSEMBLY BUSINESS

Start home, spare time. Investment knowledge or experience unnecessary. BIG DEMAND assembling electronic devices. Sales handled by professionals. Unusual business opportunity.

FREE: Complete illustrated literature
BARTA, RE-O Box 248
Walnut Creek, Calif. 94597

Cable TV Converters
Why Pay A High Monthly Fee?

Jerrold Products include "New Jerrold Tri-Mode," SB-3, Hamlin, Oak VN-12, M-35-B, Zenith, Magnavox, Scientific Atlanta, and more. (Quantity discounts) 60 day warranty. For fast service C.O.D. orders accepted. Send SASE (60 cents postage) or call for info 1-800-648-3030. **MIDWEST ELECTRONICS, INC.,** 5143-R W. Diversey, Chicago, IL 60639. MC/Visa orders accepted. No Illinois orders accepted. Mon.-Fri. 8 A.M.-5 P.M. CST

DESCRAMBLER MODULE

LATEST technology alternative to Jerrold SB-3 or Radio-Electronics Feb. 1984 project. Featuring electronic tuning, AGC, auto-on/off, AD/DC power, mini-size, A&T, and more. For literature—**SOUTH-TECH DISTRIBUTING,** (813) 527-2190.

CABLE-TV AT IT'S BEST

SCIENTIFIC Atlanta models 8500—8550—8580 remote included... $275.00. **SB-3's**... $74.00. **TRI-Bl's**... $95.00. **SA-3's**... $99.00. **Zenith** (Z-Tac) descramblers... $169.00. **N-12** (Vari-sync)... $89.00. **M-35 B** (Vari-sync)... $99.00. **Hamlin MLD-1200's**... $89.00. **80-Channel converters**... $95.00. **Dealer discount** on (5) units. Call—**N.A.S. INTERNATIONAL,** (213) 631-3552.

BUY BONDS

AMAZING
SCIENTIFIC & ELECTRONIC PRODUCTS

PLANS
Build Yourself — All Parts Available in Stock

LC7— BURNING CUTTING CO_2 LASER	$20.00
RUB4— PORTABLE LASER RAY PISTOL	$20.00
TCC1— 3 SEPARATE TESLA COIL PLANS TO 1.5 MEV	$25.00
IOG1— ION RAY GUN	$10.00
GRA1— GRAVITY GENERATOR	$10.00
EML1— ELECTRO MAGNET COIL GUN/LAUNCHER	$8.00

KITS
With All Necessary Plans

MFT3K— FM VOICE TRANSMITTER 3 MI RANGE	$49.50
VWPM7K— TELEPHONE TRANSMITTER 3 MI RANGE	$39.50
BTC3K— 250,000 VOLT 10-14" SPARK TESLA COIL	$249.50
LHC2K— SIMULATED MULTICOLOR LASER	$44.50
BLS1K— 100,000 WATT BLASTER DEFENSE DEVICE	$69.50
ITM1K— 100,000 VOLT 20' AFFECTIVE RANGE INTIMIDATOR	$69.50
PSP4K— TIME VARIANT SHOCK WAVE PISTOL	$59.50
STA1K— ALL NEW SPACE AGE ACTIVE PLASMA SABER	$59.50
MVP1K— SEE IN DARK KIT	$199.50
PTG1K— SPECTACULAR PLASMA TORNADO GENERATOR	$149.50

ASSEMBLED
With All Necessary Instructions

BTC10— 50,000 VOLT-WORLD'S SMALLEST TESLA COIL	$54.50
LGU40— 1MW HeNe VISIBLE RED LASER GUN	$249.50
TAT30— AUTO TELEPHONE RECORDING DEVICE	$24.50
GVP10— SEE IN TOTAL DARKNESS IR VIEWER	$349.50
LIST10— SNOOPER PHONE INFINITY TRANSMITTER	$169.50
IPG70— INVISIBLE PAIN FIELD GENERATOR MUTLI MODE	$74.50

• **CATALOG** CONTAINING DESCRIPTIONS OF ABOVE PLUS HUNDREDS MORE AVAILABLE FOR $1.00 OR USE OUR PHONE FOR "ORDERS ONLY" 603-673-4730.

PLEASE INCLUDE $3.00 PH ON ALL KITS AND PRODUCTS PLANS ARE POSTAGE PAID. SEND CHECK, MO, VISA, MC IN US FUNDS.

INFORMATION UNLIMITED
P.O. BOX 716 DEPT. RE, AMHERST, NH 03031

CPU's & CHIPS

V20-8	14.95	8086	8.00
8080A	2.75	8088	7.50
Z80A CPU	1.75	8155-2	2.75
Z80B CPU	3.75	8202	9.00
Z80A CTC	1.95	8203	16.00
Z80A DART	5.25	8212	2.25
Z80A DMA	5.50	8214	3.75
Z80A P10	1.95	8216	1.50
Z80A S10	5.50	8224	2.25
Z80B S10	9.95	8226	1.60
82C43	2.75	8237-5	6.50
AMD2901	4.00	8238	3.95
6502	3.25	8250B	6.75
6522	3.50	8251-A	2.40
6800	1.75	8253	1.75
6802	4.50	8255-A-5	1.85
6803L	8.00	8257	2.40
6809	5.50	8259	2.40
6810	1.75	8272A	4.75
6821	1.75	8275	9.00
6845	4.50	8279-5	2.75
6850	1.75	8284	2.50
8031AH	3.75	8288	4.75
8035	1.75	8355	12.95
8048	5.00	TMS9927NL	9.95
8049	2.50	68000L8	8.50
8085A	2.75		
NS16450	12.95		
68000L-12	19.95		
68881	95.00		

RAM's

5M4C1000A-12	30.00
21L02-3	.70
2016	1.50
2101A-4	1.50
2111A	1.75
2112-1	1.95
2114-2	1.00
2118-4	1.75
2147-3	2.50
3242	6.00
TMS3409	1.75
MK4027-3	.90
TMS4050NL	1.75
MK4096-11	1.25
4108-3	1.60
4116-2	.70
4118-4	1.75
4164-15	3.40
MK4802	5.00
Z6104-4	2.50
6116-3	4.50
6264LP-15	9.80
8118-12	2.95
41256-12	
41256-15	

REGISTERS

MM1402	1.75
MM1403	1.75
MM1404	1.75
MM5013	2.50
MM5055	2.50
MM5056	2.50
MM5058	2.50
MM5060	2.50

INTERFACE

AY5-1013A	3.75
AY3-10150	4.75
1488	.40
1489	.40
TR1602B	3.95
BR1941L	5.50
AY5-3600PRO	9.95
CRT5037	18.95
MM5307	7.95
8830	2.50
8833	2.50
8834	2.00
8838	2.00
MPY112K	25.00
MM5369AA	1.95

ROM's

INS205-1	4.50
TPB18S42	3.50
82S123	1.50
82S126	1.95
82S129	1.95
82S130	1.95
82S131	1.50
TPB28S166	9.50
82S181	4.50
82S191	4.50
74S474	3.95
2708	3.75
2716 + 5V	3.75
2732-3	3.75
2764-25	4.00
27128-30	4.75
27256-25	8.00
3347	2.95
3628A-3	3.00
8256-5	1.25

DISC Controllers

D765C	4.50
1771	4.75
1791	9.50
1793	9.50
1795	12.00
1797	12.00
WD2010A	14.95
2797	7.95

CRYSTALS

2.000	6.144
3.000	8.000
3.12	10.000
3.579	17.32
4.000	18.000
5.000	20.000
6.000	34.550

1.75 ea.

LASER LD65 7W 1R LASER diode $14.95

NO. 30 WIRE WRAP WIRE SINGLE STRAND
100' $1.40

DIP SOCKETS

8 PIN	.10	22 PIN	.15
14 PIN	.11	24 PIN	.20
16 PIN	.12	28 PIN	.20
18 PIN	.15	40 PIN	.25
20 PIN	.18		

WIRE WRAP SOCKETS

14 PIN	.45
16 PIN	.50
18 PIN	.65
20 PIN	.90
24 PIN	1.10
28 PIN	1.25
40 PIN	1.80

DB CONNECTOR

DB9P	-$ .80
DB9S	-$ .95
HOODS	-$ .65
DB25P	-$1.25
DB25S	-$1.50

TRANSISTOR SPECIAL

TIP 31B NPN Si TO-220	$ .40
TIP 32B PNP Si TO-220	$ .40
TIP 34 PNP Si	$ .95
TIP 111	$ .50
TIP 122 NPN Si U84	$ .50
TIP 141 NPN Si U97	$1.00
TIP 145	$1.35
2N1307 PNP GE TO-5	$ .40
DPS2000—DUAL POWER DARL.	$3.95
2N2222 NPN Si TO-92	7/$1.00
2N2907 PNP Si TO-92	7/$1.00
TIP 2955 PNP Si	$ .70
2N3055 NPN Si TO-3	$ .60
MJE3055T	$ .60
2N3772 NPN Si TO-3	$1.25
2N3904 NPN Si TO-92	7/$1.00
2N3906 PNP Si TO-92	7/$1.00
2N4901 PNP Si TO-3	$1.00
2N5296 NPN Si TO-220	$ .50
2N6109 PNP Si TO-220	$ .55
MRF-8004 CM RF NPN	$ .75
MPSA42 300V NPN	5/$1.00

TTL IC SERIES

7400	.19	7480	.45	74170	1.50		
7401	.19	7483	.50	74173	.75		
7402	.19	7485	.55	74174	.85		
7403	.19	7486	.35	74175	.85		
7404	.19	7489	1.90	74176	.75		
7405	.25	7490	.39	74177	.65		
7406	.27	7491	.40	74180	.75		
7407	.27	7492	.50	74181	2.00		
7408	.24	7493	.35	74182	.75		
7409	.18	7494	.60	74184	1.50		
7410	.18	7495	.55	74190	.80		
7411	.25	7496	.50	74191	.80		
7412	.25	74107	.30	74192	.75		
7413	.35	74116	1.20	74193	.75		
7414	.45	74121	.30	74194	.80		
7416	.25	74122	.45	74195	.80		
7417	.25	74123	.45	74196	.75		
7420	.20	74125	.45	74197	.80		
7425	.27	74126	.45	74199	1.25		
7426	.30	74145	.60	74221	1.25		
7427	.27	74148	1.20	74273	1.00		
7430	.20	74150	1.35	74278	1.95		
7432	.27	74151	.55	74279	.70		
7437	.27	74153	.55	74298	.60		
7438	.29	74154	1.25	74365	.65		
7440	.20	74155	.75	74367	.65		
7442	.45	74156	.75	74390	.90		
7445	.65	74157	.55	75114	.90		
7447	1.00	74158	.60	75115	.90		
7450	.20	74160	.85	75150	.60		
7472	.29	74161	.65	75325	1.50		
7473	.35	74162	.65	75491	1.00		
7474	.32	74163	.85	9602	.90		
7475	.45	74164	.85	8T26	1.10		
7476	.50	74165	.85	8T28	1.10		
		74166	1.00	8T97	1.10		
				8T98	1.10		

SCR's

PRV	1.5A	6A	35A	75A
100	.35	.40	1.40	
200	.40	.50	1.80	
400	.60	.70	2.40	9.00
600	.80	1.00	3.60	12.00

TRIAC's

PRV	1A	10A
100	.35	.60
200	.50	.80
400	.70	1.00
600	1.00	1.20

LINEAR CIRCUITS

TL062C	.95	LM393	.40	MC1391	1.00
TL064CN	1.00	LF398A	3.00	1456	.80
TL072	1.00	LF411	1.25	1458	.50
LM79BCT	.60	AD506JH	2.50	LM1808	1.75
TL084	1.00	537	1.50	ULN2003A	.75
DG201BP	1.40	LM555	.29	AD2700LD	4.95
LM201	.75	LM556	.45	LM2901	.95
LM301	.35	558	1.10	CA3018	1.95
LM307	.45	AD561	3.00	CA3045	1.20
LM308	.65	564	1.75	CA3078AT	1.50
LM311	.45	565	.90	CA3089E	1.75
LM318	1.00	566	1.25	CA3094	1.30
LM319	1.10	567	.75	CA3130	.90
LM324	.35	NE570	2.50	CA3140	.75
LM339	.50	NE592	.95	SG3543	.70
LM348	.65	709CN	.80	SG3544	1.00
LF351	.45	711CH	.60	UNL3701E	1.75
LF353	.75	733	.95	LM3900	.50
LF355	.75	739	1.50	4136	.85
LF356	.85	741CV	.29	SD5000	1.75
LM358	.45	747	.50	N5534	.75
LM370	1.60	DAC0808	2.95	N5596A	1.50
LM380	.85	ADC0809		SD6000	1.00
LM384	1.60	CNN	8.95	8038	3.95
LM386	.85	MC1310	1.00	8700CJ	5.95
		MC1350	.90	LM13080	.95
		MC1355	1.25	76477	2.95

C/MOS

74C00	.25	74C915	1.10	4027	.35	4072	.20
74C04	.25	4001	.19	4028	.65	4076	.55
74C08	.25	4002	.25	4029	.65	4077	.28
74C10	.25	4006	.65	4030	.35	4081	.20
74C14	.55	4007	.20	4034	1.40	4082	.20
74C20	.25	4008	.75	4035	.65	4093	.45
74C32	.35	4009	.35	4040	.65	4099	1.40
74C42	1.10	4010	.35	4041	.75	4501	.95
74C74	.55	4011	.19	4042	.55	4503	.45
74C76	.60	4012	.25	4043	.85	4506	.75
74C85	1.25	4013	.35	4044	.65	4510	.65
74C86	.35	4014	.65	4045	.85	4511	.65
74C93	1.00	4015	.28	4046	.85	4512	.75
74C157	.95	4016	.28	4047	.65	4514	.95
74C161	.95	4017	.45	4049	.28	4515	1.60
74C174	.95	4018	.65	4050	.28	4516	.75
74C175	.95	4019	.35	4051	.65	4518	.85
74C193	1.25	4020	.55	4052	.65	4520	.75
74C245	1.75	4021	.65	4053	.65	4528	.75
74C901	.35	4022	.65	4060	.65	4529	1.40
74C902	.40	4023	.25	4066	.28	4538	.95
74C903	.80	4024	.48	4068	.35	4539	1.50
74C907	.75	4025	.25	4069	.19	45418	1.20
		4026	1.25	4070	.28	4553	1.75
				4071	.20	4583	.90
						4585	.75

PLEASE CALL FOR QUANTITY PRICING

74HC SERIES

74HC00	.35	74HC125	.50	74HC245	.80
74HC02	.35	74HC133	.50	74HC257	.55
74HC04	.35	74HC137	.75	74HC259	.60
74HC08	.35	74CH138	.70	74HC273	.80
74HC10	.35	74HC139	.45	74HC354	.95
74HC11	.40	74HC153	.55	74HC373	.80
74HC20	.35	74HC154	1.75	74HC374	.80
74HC30	.35	74HC157	.50	74HC533	1.35
74HC32	.35	74HC162	.55	74HC534	1.35
74HC50	.45	74HC163	.55	74HC573	2.50
74HC58	.60	74HC164	.80	74HC595	2.50
74HC74	.40	74HC174	.60	74HC640	2.00
74HC75	.40	74HC175	.80	74HC4002	.50
74HC85	.70	74HC194	.70	74HC4020	1.10
74HC86	.40	74HC221	.90	74HC4066	.60
74HC107	.35	74HC240	.75	74HC4514	3.20
74HC109	.40	74HC242	.75	74HC4538	1.40
74HC112	.40	74HC244	.80	74HC4543	1.40

74LS SERIES

74LS00	.17	74LS112	.29	74LS241	.65
74LS01	.17	74LS113	.33	74LS242	.65
74LS02	.17	74LS114	.33	74LS243	.65
74LS03	.17	74LS122	.70	74LS244	.65
74LS04	.17	74LS123	.45	74LS245	.75
74LS05	.17	74LS125	.35	74LS246	1.40
74LS08	.17	74LS126	.35	74LS247	.75
74LS09	.17	74LS132	.39	74LS243	.65
74LS10	.17	74LS136	.35	74LS251	.45
74LS11	.20	74LS137	.90	74LS253	.45
74LS12	.27	74LS138	.39	74LS257	.39
74LS13	.25	74LS139	.39	74LS258	.45
74LS14	.36	74LS145	.70	74LS259	1.20
74LS15	.25	74LS147	1.00	74LS260	.45
74LS20	.17	74LS148	.90	74LS266	.55
74LS21	.22	74LS151	.39	74LS273	.75
74LS22	22	74LS153	.39	74LS279	.39
74LS26	.23	74LS154	1.50	74LS280	1.70
74LS27	.23	74LS155	.55	74LS283	.55
74LS28	.25	74LS156	.45	74LS290	.80
74LS30	.17	74LS157	.35	74LS293	80
74LS32	.17	74LS158	.20	74LS298	.65
74LS37	.26	74LS160	.29	74LS299	1.25
74LS38	.26	74LS161	.49	74LS320	2.00
74LS40	.17	74LS162	.49	74LS322	3.00
74LS42	.35	74LS163	.49	74LS323	2.40
74LS48	.65	74LS164	45	74LS365	.39
74LS51	.17	74LS165	.65	74LS366	.39
74LS54	.22	74LS166	.95	74LS367	.39
74LS73	.25	74LS169	.90	74LS368	.39
74LS74	.24	74LS170	.80	74LS373	.75
74LS75	29	74LS173	.49	74LS374	.75
74LS76	.29	74LS174	.39	74LS377	.75
74LS83	.45	74LS175	.39	74LS386	.45
74LS85	.45	74LS181	1.40	74LS390	1.10
74LS86	.22	74LS190	.49	74LS393	.75
74LS90	39	74LS191	.49	74LS398	2.50
74LS92	.45	74LS192	65	74LS446	2.00
74LS93	.45	74LS193	.65	74LS541	1.40
74LS95	.48	74LS194	.65	74LS625	1.75
74LS96	.49	74LS195	65	74LS645	.95
81LS98	1.40	74LS196	.55	74LS668	1.45
74LS107	.35	74LS197	.55	74LS670	.95
74LS109	.35	74LS221	.55	25LS2521	1.95
		74LS240	.65		

RCA. HC 2500
60 WATTS $34.95
SOLID STATE HYBRID LINEAR AND AUDIO AMP
BAND WIDTH 30 KHz at 60 WATTS, 7 AMP OUTPUT

PAL's

TANTALUM CAPACITORS

.22UF 35V	5/$1.00	15UF 16V	3/$1.00
.47UF 35V	5/$1.00	22UF 10V	$ .30
.68UF 35V	5/$1.00	30UF 6V	5/$1.00
1UF 20V	5/$1.00	33UF 15V	$ .50
2.2UF 20V	5/$1.00	47UF 20V	$ .85
3.3UF 20V	4/$1.00	68UF 20V	$1.00
4.7UF 20V	4/$1.00	100UF 16V	$1.10
6.8UF 20V	4/$1.00	330UF 10V	$1.75
10UF 20V	$ .40		

DISC CAPACITORS

.1UF 16V	10/$1.00	100/$8.00
.01UF 35V	16/$1.00	100/$5.00

IN4148 (IN914) 15/1.00

REGULATORS

LAS39U	$5.95	323K (LA1405)	$2.95
78L05 or 12	$ .30	LM337	$2.75
78M05, 12 or 15	$ .40	LM338K	$3.75
LM305	$ .75	340T-5,6,8,12, 15,18 or 24V	$ .45
309K	$1.25	723	$ .45
LM317T	$ .90		
320T 5,12,15 or 24			$ .55

L1411-IR Detector	3/$1.00
FP 100 Photo Trans	$ .50
Red LED's .2"	10/$1.00
Yellow, Green, or Amber Lg LED's 2"	8/$1.00
Red-Green Bipolar LED	$ .90
Red-Yellow Bipolar LED	$ .90
MLED92 IR LED	$ .40
MRD148 Photo Darl. XTOR	$ .60
IL-5 Opto Isolators or MCT-2	$ .60
4N45 Opto Coupler	$ .60

TTL SIZE RELAYS

5V DPST	.95
12V DPST	.95

PRINTED CIRCUIT BOARD
4" x 6" DOUBLE SIDED EPOXY BOARDED 1/16" THICK
$.60 ea ..... 5/$2.60

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

DIP SWITCHES

CTS 206-4	4 Position	.75
CTS 206-7	7 Position	.95
CTS 206-8	8 Position	.95
CTS 206-10	10 Position	1.25

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.05	.14	.35	.90	6.00	7.00
200	.06	.17	.50	1.30	8.00	10.00
400	.09	.25	.65	1.50	10.00	12.00
600	.11	.30	.80	2.00	13.00	15.00
800	.13	.35	1.00	2.50	16.00	18.00
1000	.20	.45	1.25	3.00	20.00	26.00

MULTI TURN TRIM POTS
50 OHM
100 OHM
1000 OHM
5K 10K
20K 50K 100K
3/$2.00

POSTAGE RATES
ADD 10% FOR ORDERS UNDER $25.00
ADD 5% FOR ORDERS BETWEEN $25.00 AND $50.00
ADD 3% FOR ORDERS ABOVE $100.00

TERMS: FOB CAMBRIDGE, MASS. SEND CHECK OR MONEY ORDER. MINIMUM TELEPHONE, C.O.D. PURCHASE ORDER OR CHARGE $20.00. MINIMUM MAIL ORDER $5.00.

SEND $.25 FOR OUR CATALOG FEATURING TRANSISTORS & RECTIFIERS.
145 HAMPSHIRE ST., CAMBRIDGE, MASS. 02139

SOLID STATE SALES
P.O. BOX 74D - SOMERVILLE, MASS. 02143

TEL. (617) 547-7053
FAX 617-354-1417
TOLL FREE 1-800-343-5230
FOR ORDERS ONLY

WE SHIP OVER 95% OF OUR ORDERS WITHIN 24 HOURS OF RECEIPT

CIRCLE 74 ON FREE INFORMATION CARD

Be a TV/VCR Repair Specialist

Now you can train at home in spare time for a money-making career as a TV/VCR Repair Specialist. No previous experience necessary. No need to quit your job or school. Everything is explained in easy-to-understand language with plenty of drawings, diagrams and photos. We show you how to troubleshoot and repair video-cassette recorders and TV sets, how to handle house calls and shop repairs for almost any make of television or VCR. Tools are included with your course so you can get "hands-on" practice as you follow your lessons step by step. Send for free facts about the exciting opportunities in TV/VCR Repair and find out how you can start making money in this great career.

MAIL COUPON TODAY K03B

ICS SINCE 1891 SCHOOL OF TV/VCR REPAIR, Dept. DE019
Scranton, Pennsylvania 18515

Please send me full information and color brochure on how I can learn TV/VCR Repair at home in my spare time. I understand there is no obligation and no salesman will visit me.

Name ____ Age ____
Address ____ Apt. # ____
City/State ____ Zip ____
Phone ( ) ____

HIGH TECH ELECTRONICS

SCRAMBLER PHONES! Phone Bug Detectors! Electronic Countermeasures Equipment! Executive and personal protection products! And much more!!! Catalog $3.00 (Refundable with first order) **DIVERSIFIED WHOLESALE PRODUCTS,** P.O. Box 1275-RE, Redondo Beach, CA 90278.

INVENTORS

INVENTORS! Can you patent and profit from your idea? Call **AMERICAN INVENTORS CORPORATION** for free information. Over a decade of service 1 (800) 338-5656. In Massachusetts or Canada call (413) 568-3753.

EDUCATION & INSTRUCTION

MAGIC! Four illustrated lessons plus inside information shows you how. We provide almost 50 tricks including equipment for four professional effects. You get a binder to keep the materials in, and a one-year membership in the International Performing Magicians with a plastic membership card that has your name gold-embossed. You get a one-year subscription to our quarterly newsletter "IT'S MAGIC!" Order now! $29.95 for each course + $3.50 postage and handling. (New York residents add applicable state and local sales tax.) **THE MAGIC COURSE,** 500-B BiCounty Boulevard, Farmingdale, NY 11735.

F.C.C. Commercial General Radiotelephone license. Electronics home study. Fast, inexpensive! "Free" details. **COMMAND,** D-176, Box 2223, San Francisco, CA 94126.

BE A RECORDING ENGINEER; Train at home for high paying-exciting careers. **FREE** information. **AUDIO INSTITUTE** 2174 Union St., Suite 22K, San Francisco, CA 94123.

DO it yourself guide on how to maintain & clean your VCR. Hookup diagrams. Basic problems & solutions. Illustrations included. Send $7.95. **AMERICAN GIFTS** 1445 N. Murse, Chicago, IL 60676.

CABLE TV CONVERTERS

CABLE TV converters. Scientific Atlanta, Jerrold, Oak, Zenith, Hamlin. Many others. **"New" Video Hopper** "The Copy Killer." Visa, M/C & Amex. **1 (800) 826-7623. B&B INC.,** P. O. Box 21-327, St. Paul, MN 55121.

MASTERCARD AND VISA are now accepted for payment of your advertising. Simply complete the form on the first page of the Market Center and we will bill.

DO YOU OFTEN WISH THAT THE SMITH COMPANY WAS THE SMITH & SMITH & SMITH & SMITH COMPANY?

Business people often find themselves doing so many things that just one of them isn't enough. So hire some of the needy and disadvantaged young people of America this summer to help you. Hiring them can also help you in another very important way. Because a business that hires economically disadvantaged youth during the summer may get as much as an 85% tax credit on the first $3,000 of wages you pay them. Write the National Alliance of Business at P.O. Box 7207, Washington D.C. 20044. And support your local summer-jobs-for-youth programs. You'll be doing something for yourself, for your business, for your community, and for the needy youth of America, too.

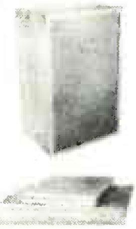
LET'S GET ALL OF AMERICA WORKING AGAIN.

Ad Council — A PUBLIC SERVICE OF THIS PUBLICATION & THE ADVERTISING COUNCIL.

SPEAKERS AND COMPONENTS

PIONEER · MG ELECTRONICS · EMINENCE · MOTOROLA · Polydax

WALNUT SPEAKER CABINET KIT



Super quality, genuine walnut veneer cabinet. Kit includes: routed and mitred top, sides, and bottom in unfinished 3/4" walnut veneer. Cut your own custom holes in the front and rear to match your drivers. 15" x 24" x 11". Volume: 1.9 cu. ft.

#260-350 $22.50 (1-3) **$19.95** (4-up)

12" POLY WOOFER

PIONEER

Super duty, 40 oz. magnet. Polypropylene cone. 100 watts RMS, 145 watts max. 4 and 8 ohm compatible (6 ohm). 2" voice coil. fs = 25 Hz. VAS = 10.8 cu. ft., QTS = .166. Response: 25-1,500 Hz. Net weight: 9 lbs.

#290-125 $36.80 (1-3) **$34.50** (4-up)

12" PIONEER SUB WOOFER

PIONEER

Dual voice coil sub woofer. 30 oz. magnet, 2" voice coil. 100 watts RMS, 145 watts max. fs = 25 Hz. 6 ohm (4 and 8 ohm compatible). SPL = 89 dB 1W/1M. Response: 25-700 Hz. QTS = .31, VAS = 10.3 cu ft. Pioneer #A30GU30-55D. Net weight: 6 lbs.

#290-145 $39.80 (1-3) **$36.80** (4-up)

18" EMINENCE WOOFER

EMINENCE

MADE IN U.S.A.

100 oz. magnet, 3" voice coil. 250 watts RMS, 350 watts max. 8 ohm, 30 Hz resonant frequency. 22-2700 Hz response. Efficiency: 95 dB 1W/1M. Paper cone treated accordian surround. Net weight: 29 lbs.

#290-200 $98.80 (1-3) **$89.50** (4-up)

15" THRUSTER WOOFER

Thruster by Eminence. Made in U.S.A. Forward poly roll foam surround, 56 oz. magnet. 2-1/2", 2 layer voice coil. 150 watts RMS, 210 watts max. 4 ohm. fs = 23.5 Hz, QMS = 9.86, QES = .34, QTS = .33, VAS = 17.9 cu. ft. SPL = 94.8 dB 1W/1M. Net weight: 15 lbs.

#290-180 $43.50 (1-3) **$39.80** (4-up)

15" 3-WAY, 125 WATT SYSTEM

Our "Top-of the Line" system. The system features elements specifically selected to produce a balanced output throughout the full frequency bandwidth of the system. System includes: (1) #290-155 15" polypropylene woofer rated at 145 watts max, (2) #280-020 cup midranges, (1) #270-035 4" soft dome tweeter, (1) #260-215 200 watt 3-way crossover, (2) #260-265 100 watt mid, tweeter "L" pad attenuators, (1) #260-300 speaker terminal, and (1) #260-340 grille cloth.

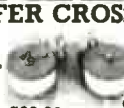
#15-125 **$99.95** Each

PIONEER HORN TWEETER

Mylar dome, 2.93 oz. barium ferrite magnet. 8 ohm. Response: 1,800-20,000 Hz. 35W RMS, 50W max. fs = 2,000 Hz, SPL = 106 dB. Pioneer #AHE60-51F.

#270-050 $6.50 (1-9) **$5.90** (10-up)

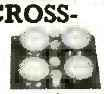
SUBWOOFER CROSSOVER



200 watts RMS. 12 dB per octave, 150 Hz at 8 ohm crossover point.

#260-220 $28.80 (1-5) **$24.40** (6-up)

3-WAY 100W CROSSOVER



12 dB / octave rolloff. 800 Hz, 5000 Hz. 8 ohm. 100 watts RMS.

#260-210 $12.50 (1-9) **$9.95** (10-up)

Parts Express International, Inc.
340 E. First St., Dayton, OH 45402
Local 1-513-222-0173
FAX: 513/222-4644

CALL TOLL FREE 1-800-338-0531

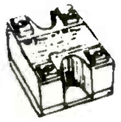
* 15 day money back guarantee. * $10.00 minimum order. * We accept Mastercard, Visa, Discover, and C.O.D. orders. * 24 hour shipping. * Shipping charge = UPS chart rate ($2.50 minimum charge). * Hours: 8:30 am - 6:00 pm EST, Monday - Friday. * Mail order customers, please call for shipping estimate on orders exceeding 5 lbs.

FREE CATALOG

★QUALITY PARTS ★DISCOUNT PRICES ★FAST SHIPPING

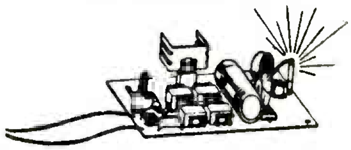
ALL ELECTRONICS CORP.

10 AMP SOLID STATE RELAYS



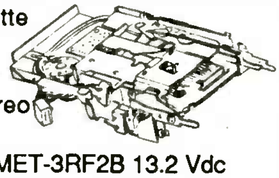
ELECTROL# S2181
CONTROL:
Rated 5.5 to 10 Vdc
(will operate on 3-32 Vdc).
LOAD: 10 amp @ 240 Vac
2 1/4" X 1 3/4" X 7/8"
CAT# SSRLY-10B $9.50 each
QUANTITY DISCOUNT
10 for $85.00 • 25 for $175.00
50 for $300.00 • 100 for $500.00

STROBE KIT



Variable rate strobe kit, flashes between 60 to 120 times per minute. Will operate on either 6 or 12 Vdc depending upon how you wire the circuit. Comes complete with P.C. board and instructions for easy assembly.
CAT# STROBE-1 $7.50 each

CASSETTE MECHANISM



Alpine cassette transport mechanism. Includes stereo tape head, Mitsubishi # MET-3RF2B 13.2 Vdc motor, belt, pulleys, capstan, fast-forward, rewind and eject actuator. Does not include amplifier section.
6 1/2" X 5 1/4" X 1 3/4".
CAT# CMEC-5 $7.50 each
10 for $65.00

PIEZO WARNING DEVICE

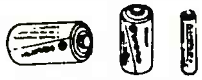
Murata Erie # PKB8-4A0
High pitched audible alarm. Operates on 3 - 20 Vdc @ 20 ma. 1" high x 7/8" dia. P.C. board mount.
CAT# PBZ-84 $1.75 each

XENON TUBE

1" long flashtube with 3 1/2" red and black leads. Ideal for electronic flash or strobe projects.
CAT# FLT-3 2 for $1.00

NICKEL-CAD BATTERIES (RECHARGEABLE)

SPECIAL!! AAA SIZE
Panasonic# P-18AAA
1.2 volt @ 180 MAh
CAT# NCB-AAAX $1.50 each
10 for $13.50 • 100 for $125.00



AA SIZE $2.00 each
1.25 volts 500 mAh
CAT# NCB-AA

AA SIZE $2.20 each
WITH SOLDER TABS
CAT# NCB-SAA

C SIZE $4.25 EACH
1.2 volts 1200 mAh
CAT# NCB-C

D SIZE $4.50 each
1.2 volts 1200 mAh
CAT# NCB-D

TRANSISTORS

CAT#	TYPE	CASE	PRICE
PN2222	NPN	TO-92	5 for 75¢
2N2904	PNP	TO-5	3 for $1.00
2N2906	PNP	TO-18	3 for $1.00
PN2907	PNP	TO-92	5 for 75¢
2N3055	NPN	TO-3	$1.00 each
PN3569	NPN	TO-92	5 for 50¢
2N3904	NPN	TO-92	5 for 75¢
2N3906	PNP	TO-92	5 for 75¢
2N4400	NPN	TO-92	5 for 75¢
2N4402	PNP	TO-92	5 for 75¢
2N5400	PNP	TO-92	4 for $1.00
2N5880	PNP	TO-3	$2.00 each
2N5882	NPN	TO-3	$2.00 each
MJ2955	PNP	TO-3	$1.50 each
MJE2955T	PNP	TO-220	75¢ each
MJE3055T	NPN	TO-220	75¢ each
TIP30	PNP	TO-220	75¢ each
TIP31	NPN	TO-220	75¢ each
TIP32	PNP	TO-220	75¢ each
TIP41	NPN	TO-220	75¢ each
TIP42	PNP	TO-220	75¢ each
TIP121	NPN	TO-220	75¢ each
TIP126	PNP	TO-220	75¢ each

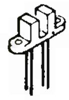
WIDE BAND AMPLIFIER

NEC# UPC1651G. 1200 Mhz @ 3 db.
Gain: 19db @ f=500 hz. 5 volt operation.
Small package 4mm dia. X 2.5 mm thick.
CAT# UPC-1651 2 for $1.00
10 for $4.50 • 100 for $35.00

N-CHANNEL MOSFET

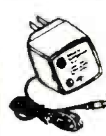
IRF-511 TO-220 case
CAT# IRF 511
$1.00 each • 10 for $9.00
LARGE QUANTITY AVAILABLE

OPTO SENSOR



U shaped package with mounting ears. 1/8" opening. 3/4" mounting holes. **CAT# OSU-6** 50¢ each
10 for $4.50 • 100 for $40.00

WALL TRANSFORMERS



ALL PLUG DIRECTLY INTO 120 VAC OUTLET

6 Vdc @ 200 ma.	CAT# DCTX-620	$2.25
6 Vdc @ 750 ma.	CAT# DCTX-675	$3.50
9 Vdc @ 250 ma.	CAT# DCTX-925	$2.50
12 Vac @ 930 ma.	CAT# ACTX-1293	$3.50
18 Vac @ 1 amp.	CAT# ACTX-1885	$3.50

SWITCHES

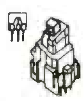
ITT PUSH BUTTON

ITT MDPL series. 3/4" X 1/2" gray rectangular key cap. S.P.S.T. N.O.
Push to close. RATED: 0.1 amp switching, 0.25 amp carry current. P.C. mount. **CAT# PB-8**
65¢ each • 10 for $6.00 • 100 for $50.00

10 POSITION MINI-ROTARY

Grayhill# 56P36-01-1-10N-C
Mini rotary switch. Non-shorting. 1 deck, 10 positions. .125" dia. shaft X .375" long. .377" behind the panel depth. P.C. pins.
CAT# MRS-10 $2.50 each

HALL EFFECT SWITCH



MICROSWITCH# 4BE3
Slanted keyboard switch with hall effect sensor. Snaps into 5/8" square chassis hole. Hall effect sensor slides easily from switch and can be used in other applications.
CAT# HESW 4 for $1.00
10 for $2.00 • 100 for $15.00

SPDT PUSHBUTTON

Marquard# 1843
Rated 6 amps @ 125/250 Vac.
Black plastic pushbutton.
Switch body: .92" X .94" X .65".
CAT# PB-18 $1.65 each • 10 for $1.50 each

LED'S

STANDARD JUMBO
DIFFUSED T 1-3/4 size

RED **CAT# LED-1**
10 for $1.50 • 100 for $13.00
GREEN **CAT# LED-2**
10 for $2.00 • 100 for $17.00
YELLOW **CAT# LED-3**
10 for $2.00 • 100 for $17.00

FLASHING LED

with built in flashing circuit operates on 5 volts...
RED $1.00 each
CAT# LED-4 10 for $9.50
GREEN $1.00 each
CAT# LED-4G 10 for $9.50

BI-POLAR LED

Lights RED one direction, GREEN the other. Two leads.
CAT# LED-6 2 for $1.70

LED HOLDER

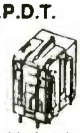
Two piece holder.
CAT# HLED 10 for 65¢

RELAYS

12 VOLT D.C. COIL S.P.D.T.

Omron# G2E-184P
4 Amp contacts.
335 ohm coil.
Sugar cube size.
.61" X .42" X .44" high.
P.C. mount with pins on DIP spacing.
CAT# RLY-787 $1.50 each

120 VOLT A.C. - D.P.D.T.



GUARDIAN# 1220U-04
10 Amp contacts.
1,100 ohm coil
1.703" X 1.578" X 1.687". Clear polycarbonate cover. Gold plated solder or socket mount terminals.
CAT# RLY-228 $3.50 each

CALL OR WRITE FOR OUR FREE CATALOG OVER 4000 PARTS!

MAIL ORDERS TO:
ALL ELECTRONICS
P.O. BOX 567
VAN NUYS, CA 91408

TWX-5101010163 (ALL ELECTRONIC)

OUTSIDE THE U.S.A.
SEND $2.00 POSTAGE
FOR A CATALOG!!

ORDER TOLL FREE
800-826-5432
INFO: (818)904-0524
FAX: (818)781-2653
MINIMUM ORDER $10.00
QUANTITIES LIMITED
CALIF. ADD SALES TAX
USA: $3.00 SHIPPING
FOREIGN ORDERS
INCLUDE SUFFICIENT
SHIPPING. NO C.O.D.

DISCOVER VISA MasterCard

CIRCLE 107 ON FREE INFORMATION CARD

JDR Microdevices®

MMC MICROCOMPUTER MARKETING COUNCIL of the Direct Marketing Association, Inc.

• 30 DAY MONEY BACK GUARANTEE • 1 YEAR WARRANTY ON ALL PRODUCTS • TOLL-FREE TECHNICAL SUPPORT
• COMPLETE CUSTOMER SATISFACTION • SUPERIOR SERVICE • FRIENDLY, KNOWLEDGEABLE SALES STAFF

STATIC RAMS

PART	SIZE	SPEED	PRICE
2112	256x4	450ns	2.99
2114	1024x4	450ns	.99
2114L-2	1024x4	200ns	1.49
TC5516	2048x8	250ns	3.95
TMM2016-200	2048x8	200ns	3.25
TMM2016-150	2048x8	150ns	3.29
TMM2016-100	2048x8	100ns	4.29
HM6116-4	2048x8	200ns	4.95
HM6116-3	2048x8	150ns	5.95
HM6116-2	2048x8	120ns	6.45
HM6116LP-4	2048x8	200ns	5.95
HM6116LP-3	2048x8	150ns	6.45
HM6116LP-2	2048x8	120ns	6.95
HM6264LP-15	8192x8	150ns	9.95
HM6264LP-12	8192x8	120ns	10.95
HM43256LP-15	32768x8	150ns	12.95
HM43256LP-12	32768x8	120ns	14.95
HM43256LP-10	32768x8	100ns	19.95

■ CALL TO CONFIRM CURRENT PRICES ■

DYNAMIC RAMS

PART	SIZE	SPEED	PRICE
4116-200	16384x1	200ns	.89
4116-150	16384x1	150ns	.99
MK4332	32768x1	200ns	6.95
4164-150	65536x1	150ns	2.89
4164-120	65536x1	120ns	3.19
4164-100	65536x1	100ns	3.95
TMS4164	65536x1	150ns	2.89
TMS4416	16384x4	150ns	8.95
41128-150	131072x1	150ns	5.95
TMS4464-15	65536x4	150ns	10.95
TMS4464-12	65536x4	120ns	11.95
41256-150	262144x1	150ns	12.45
41256-120	262144x1	120ns	12.95
41256-100	262144x1	100ns	13.45
41256-80	262144x1	80ns	13.95
HM51258-100	262144x1	100ns	13.95
1 MB-120	1048576x1	120ns	34.95
1 MB-100	1048576x1	100ns	37.95

■ CALL TO CONFIRM CURRENT PRICES ■

EPROMS

PART	SIZE	SPEED	Vpp	PRICE
2708	1024x8	450ns	25V	4.95
2716	2048x8	450ns	25V	3.49
2716-1	2048x8	350ns	25V	3.95
2732	4096x8	450ns	25V	3.95
2732A	4096x8	250ns	21V	3.95
27C64	8192x8	250ns	12.5V	4.95
2764	8192x8	450ns	12.5V	3.49
2764-250	8192x8	250ns	12.5V	3.69
2764-200	8192x8	200ns	12.5V	4.25
MCM68766	8192x8	350ns	21V	15.95
27128	16384x8	250ns	12.5V	4.95
27128A-200	16384x8	200ns	12.5V	5.95
27C256	32768x8	250ns	12.5V	7.95
27256	32768x8	250ns	12.5V	5.95
27256-200	32768x8	200ns	12.5V	7.95
27512	65536x8	250ns	12.5V	11.95
27C512	65536x8	250ns	12.5V	12.95
27C101-20	131072X8	200ns	12.5V	34.95

■ CALL TO CONFIRM CURRENT PRICES ■

CO-PROCESSORS

8087	5 MHz	99.95
8087-2	8 MHz	159.95
8087-1	10 MHz	229.95
80287	6 MHz	179.95
80287-8	8 MHz	249.95
80287-10	10 MHz	309.95
80387-16	16 MHz	499.95
80387-20	20 MHz	799.95
80387-25	25 MHz	999.95

intel

5 YEAR WARRANTY

INCLUDES MANUAL & SOFTWARE GUIDE

CALL FOR VOLUME QUOTES
ORDER TOLL FREE

HIGH-TECH SPOTLIGHT

SCSI HOST ADAPTOR $49.95

A LOW POWER, SHORT SLOT CARD FOR PC COMPATIBLES THAT CAN CONTROL UP TO SEVEN SCSI DEVICES.THIS POPULAR STANDARD OFFERS SPEED, EXPANDABILITY AND THE ADVANTAGES OF USING A DEVICE INDEPENDENT BUS. INCLUDES CABLES.
MCT-SCSI

30 DAY MONEY-BACK GUARANTEE
TOLL-FREE TECHNICAL SUPPORT

MICROPROCESSORS

6500

6502	2.25
6502A	2.69
6502B	4.25
65C02*	7.95
6520	1.65
6522	2.95
6522A	5.95
6526	13.95
6532	5.95
6545A	3.95
6551	2.95
6551A	6.95

* CMOS

8000

8031	3.95
8035	1.49
8039	1.95
8052AH BASIC	34.95
8080	2.49
8085	1.95
8085A-2	3.75
8086	6.49
8088	5.99
8088-1	12.95
8088-2	7.95
8155	2.49
8156	2.95
8155-2	3.95
8741	9.95
8742	29.95
8748	7.95
8749	9.95
8755	14.95
80286	79.95
80286-8	249.95

8200

8253-5	1.95
8254	2.79
8255	1.49
8255-5	1.59
8256	15.95
8259	1.95
8259-5	2.29
8272	4.39
8274	4.95
8275	16.95
8279	2.49
8279-5	2.95
8282	3.95
8283	3.95
8284	2.25
8286	3.95
8287	3.95
8288	4.95

6800

6800	1.95
6802	2.95
6803	3.95
6809	2.95
68B09	5.99
6809E	2.95
68B09E	5.49
6810	1.95
6820	2.95
6821	1.25
68B21	1.85
6840	3.95
6845	2.75
68B45	4.95
6847	4.75
6850	1.95
68B50	1.75
6883	22.95
68000	9.95

8200

8205	3.29
8212	1.49
8216	1.49
8224	2.25
8228	2.25
8237	3.95
8237-5	4.75
8238	4.49
8243	1.95
8250	6.95
8251	1.29
8251A	1.69
8253	1.59

Z-80

Z80-CPU	1.25
Z80A-CPU	1.29
Z80B-CPU	2.75
Z80A-CTC	1.69
Z80B-CTC	4.25
Z80A-DART	5.95
Z80B-DART	6.95
Z80A-DMA	5.95
Z80A-PIO	1.89
Z80B-P10	4.25
Z80A-SIO/0	5.95
Z80B-SIO/0	12.95
Z80A-SIO/1	5.95
Z80A-SIO/2	5.95
Z80B-SIO/2	12.95
Z8671BASIC	9.95

V-20 SERIES

SPEED UP YOUR PC BY 10 TO 40%!

- HIGH SPEED ADDRESS CALCULATION IN HARDWARE
- PIN COMPATIBLE WITH 8088
- SUPERSET OF 8088 INSTRUCTION SET
- LOW POWER CMOS

V20*	5 MHz	8.95	V20*	8 MHz	10.95
V20*	10 MHz	12.95	V30	8 MHz	13.95

VOLTAGE REGULATORS

7805T	.49	7812K	1.39
7808T	.49	7905K	1.69
7812T	.49	7912K	1.49
7815T	.49	78L05	.49
7905T	.59	78L12	.49
7908T	.59	79L05	.69
7912T	.59	79L12	1.49
7915T	.59	LM323K	3.49
7805K	1.59	LM338K	4.49

PALS

16L8	2.95
16R8	2.95
16R6	2.95
16R4	2.95

UARTS

AY5-1013	3.95
AY3-1015	4.95
TR1602	3.95
2651	4.95
IM6402	3.95
IM6403	9.95
INS8250	6.95
NS16450	10.95

MISCELLANEOUS

ADC0804	2.99	9334	1.75
ADC0809	3.85	9368	2.85
DAC0800	3.29	9602	.69
DAC0808	1.95	ULN2003	.79
DAC1022	5.95	MAX232	7.95
MC1408L8	1.95	MC3470	1.95
8T28	1.29	MC3487	2.95
8T97	.59	AY5-3600	
DP8304	2.29	PRO	11.95

INTERSIL

ICL7107	10.95
ICL7660	1.99
ICL8038	3.85
ICM7207A	5.95
ICM7208	15.95

74LS00 TTL LOGIC

74LS00	.16	74LS112	.29	74LS241	.69
74LS01	.18	74LS122	.45	74LS242	.69
74LS02	.17	74LS123	.49	74LS243	.69
74LS03	.18	74LS124	2.75	74LS244	.69
74LS04	.16	74LS125	.39	74LS245	.79
74LS05	.18	74LS126	.39	74LS251	.49
74LS08	.18	74LS132	.39	74LS253	.49
74LS09	.18	74LS133	.49	74LS257	.39
74LS10	.16	74LS136	.39	74LS258	.49
74LS11	.22	74LS138	.39	74LS259	1.29
74LS12	.22	74LS139	.39	74LS260	.49
74LS13	.26	74LS145	.99	74LS266	.39
74LS14	.39	74LS147	.99	74LS273	.79
74LS15	.26	74LS148	.99	74LS279	.39
74LS20	.17	74LS151	.39	74LS280	1.98
74LS21	.22	74LS153	.39	74LS283	.59
74LS22	.22	74LS154	1.49	74LS290	.89
74LS27	.23	74LS155	.59	74LS293	.89
74LS28	.26	74LS156	.49	74LS299	1.49
74LS30	.17	74LS157	.35	74LS322	3.95
74LS32	.18	74LS158	.29	74LS323	2.49
74LS33	.28	74LS160	.29	74LS365	.39
74LS37	.26	74LS161	.39	74LS367	.39
74LS38	.26	74LS162	.49	74LS368	.39
74LS42	.39	74LS163	.39	74LS373	.79
74LS47	.75	74LS164	.49	74LS374	.79
74LS48	.85	74LS165	.65	74LS375	.95
74LS51	.17	74LS166	.95	74LS377	.79
74LS73	.29	74LS169	.95	74LS390	1.19
74LS74	.24	74LS173	.49	74LS393	.79
74LS75	.29	74LS174	.39	74LS541	1.49
74LS76	.29	74LS175	.39	74LS624	1.95
74LS83	.49	74LS191	.49	74LS640	.99
74LS85	.49	74LS192	.69	74LS645	.99
74LS86	.22	74LS193	.69	74LS670	.89
74LS90	.39	74LS194	.69	74LS682	3.20
74LS92	.49	74LS195	.69	74LS688	2.40
74LS93	.39	74LS196	.59	74LS783	22.95
74LS95	.49	74LS197	.59	25LS2521	2.80
74LS107	.34	74LS221	.59	26LS31	1.95
74LS109	.36	74LS240	.69	26LS32	1.95

LINEAR COMPONENTS

TL071	.69	LM380	.89	XR2206	3.95
TL072	1.09	LM383	1.95	XR2211	2.95
TL074	1.95	LM386	.89	LM2917	1.95
TL081	.59	LM393	.45	CA3046	.89
TL082	.99	LM394H	5.95	CA3146	1.29
TL084	1.49	LM399H	5.95	MC3373	1.29
LM301	.34	TL494	4.20	MC3470	1.95
LM309K	1.25	TL497	3.25	MC3480	8.95
LM310	1.75	NE555	.29	MC3487	2.95
LM311	.59	NE556	.49	LM3900	.49
LM311H	.89	NE558	.79	LM3909	.98
LM311K	3.49	NE564	1.95	LM3911	2.25
LM312H	1.75	LM565	.95	LM3914	1.89
LM317T	.69	LM566	1.49	LM3915	1.89
LM318	1.49	LM567	.79	MC4024	3.49
LM319	1.25	NE570	2.95	MC4044	3.99
LM323K	3.49	NE590	2.50	RC4136	1.25
LM324	.34	NE592	.98	RC4558	.69
LM331	3.95	LM723	.49	LM1360	1.49
LM334	1.19	LM733	.98	75107	1.49
LM335	1.79	LM741	.29	75108	1.49
LM336	1.75	LM747	.69	75110	1.95
LM338K	4.49	MC1330	1.69	75150	1.95
LM339	.59	MC1350	1.19	75154	1.95
LF347	2.19	LM1458	.35	75188	1.25
LF353	.59	LM1488	.49	75189	1.25
LF356	.99	LM1489	.49	75451	.39
LF357	.99	LM1496	.85	75452	.39
LM358	.59	ULN2003	.79	75477	1.29

HIGH SPEED CMOS LOGIC

74HC00	.21	74HC244	.85	74HCT138	.35
74HC04	.25	74HC245	.85	74HCT139	.55
74HC08	.25	74HC273	.69	74HCT157	.59
74HC14	.35	74HC367	.69	74HCT161	.79
74HC32	.35	74HC373	.69	74HCT240	.89
74HC74	.35	74HC390	.79	74HCT244	.89
74HC138	.45	74HC374	.69	74HCT245	.99
74HC139	.45	74HC4040	.89	74HCT273	.99
74HC154	1.09	74HCT00	.25	74HCT373	.99
74HC157	.55	74HCT04	.27	74HCT374	.99
74HC161	.65	74HCT08	.25	74HCT393	.99
74HC164	.65	74HCT32	.27	74HCT4040	.99
74HC175	.59	74HCT74	.45	74HCT4060	1.49

STANDARD CMOS LOGIC

4001	.19	4028	.65	4069	.19
4011	.19	4040	.69	4070	.29
4013	.35	4042	.59	4081	.22
4015	.29	4044	.69	4093	.49
4016	.29	4046	.69	14411	9.95
4017	.49	4047	.69	14433	14.95
4018	.69	4049	.29	14497	6.95
4020	.59	4050	.29	4503	.49
4021	.69	4051	.69	4511	.69
4023	.25	4052	.69	4518	.85
4024	.49	4053	.69	4528	.79
4025	.25	4060	.69	4538	.95
4027	.39	4066	.29	4702	9.95

7400 SERIES LOGIC

7400					
7400	.19	74121	.29	74F240	1.29
7402	.19	74123	.49	74S00	.29
7404	.19	74125	.45	74S02	.29
7406	.29	74150	1.35	74S04	.29
7407	.29	74151	.55	74S08	.35
7408	.24	74153	.55	74S10	.29
7410	.19	74154	1.49	74S32	.35
7411	.25	74157	.55	74S74	.49
7414	.49	74159	1.65	74S86	.35
7416	.25	74161	.69	74S112	.50
7417	.25	74164	.85	74S124	2.75
7420	.19	74166	1.00	74S138	.79
7430	.19	74175	.89	74S153	.79
7432	.29	74367	.65	74S157	.79
7438	.29	**74F/74S**		74S158	.95
7442	.49	74F00	.35	74S163	1.29
7445	.69	74F02	.35	74S175	.79
7447	.89	74F04	.35	74S195	1.49
7473	.34	74F08	.35	74S240	1.49
7474	.33	74F10	.35	74S241	1.49
7475	.45	74F32	.35	74S244	1.49
7476	.35	74F64	.55	74S280	1.95
7483	.50	74F74	.39	74S287	1.69
7485	.59	74F86	.55	74S288	1.69
7586	.35	74F138	.79	74S299	2.95
7489	2.15	74F139	.79	74S373	1.69
7490	.39	74F253	.89	74S374	1.69
7493	.35	74F157	.89	74S471	4.95
				74S571	2.95

CIRCLE 113 ON FREE INFORMATION CARD

CRYSTALS

32.768 KHz	.95
1.0 MHz	2.95
1.8432	2.95
2.0	1.95
2.4576	1.95
3.579545	1.95
4.0	1.95
5.0	1.95
5.0688	1.95
6.0	1.95
6.144	1.95
8.0	1.95
10.0	1.95
10.738635	1.95
12.0	1.95
14.31818	1.95
16.0	1.95
18.0	1.95
18.432	1.95
20.0	1.95
22.1184	1.95

OSCILLATORS

1.0MHz	5.95
1.8432	5.95
2.0	5.95
2.4576	5.95
2.5	5.95
4.0	4.95
5.0	4.95
5.0688	4.95
6.0	4.95
6.144	4.95
8.0	4.95
10.0	4.95
12.0	4.95
14.31818	1.95
15.0	1.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95

DISCRETE

1N751	.49	2N4403	.25
IN5402	.25	2N6045	1.75
IN4004	10/1.00	MPS-A13	.40
IN4148	25/1.00	TIP31	.49
KBP02	.55	4N26	.69
PN2222	.10	4N27	.69
2N2222	.10	4N28	.69
2N2907	.25	4N33	.89
2N3055	.79	4N37	1.19
2N3904	.10	MCT-2	.59
2N3906	.10	MCT-6	1.29
2N4401	.25	TIL-111	.99

CAPACITORS

TANTALUM

1.0µf	15V	.12
6.8	15V	.42
10	15V	.45
22	15V	.99
1.0µf	35V	.45
2.2	35V	.19
4.7	35V	.39
10	35V	.69

DISC

10pf	50V	.05
22	50V	.05
33	50V	.05
47	50V	.05
100	50V	.05
220	50V	.05
.001µf	50V	.05
.005	50V	.05
.01	50V	.07
.05	50V	.07
.1	12V	.10
.1	50V	.12

ELECTROLYTIC

RADIAL

1µf	50V	.14
4.7	50V	.11
10	50V	.11
47	35V	.13
100	16V	.15
100	50V	.23
220	35V	.20
470	25V	.30
2200	16V	.70
4700	25V	1.45

AXIAL

1µf	50V	.14
10	16V	.14
10	50V	.16
22	16V	.14
47	50V	.19
100	35V	.19
470	50V	.29
1000	16V	.29
2200	16V	.70
4700	16V	1.25

SOLBER STATION

JL APPROVED

- ADJUSTABLE HEAT SETTING
- TIP TEMPERATURE READOUT
- REPLACEMENT TIPS AVAILABLE $2.95

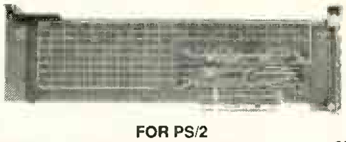
168-2C

$49.95

FULL 1 YEAR WARRANTY ON EVERY PRODUCT!

WIREWRAP PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE WITH GOLD PLATED EDGE-CARD FINGERS AND SILK SCREENED LEGENDS.



FOR PS/2

JDR-PR32	32 BIT PROTOTYPE CARD	69.95
JDR-PR16	16 BIT WITH I/O DECODING LAYOUT	49.95
JDR-PR16PK	PARTS KIT FOR JDR-PR16 ABOVE	15.95
JDR-PR16V	16 BIT FOR VIDEO APPLICATIONS	39.95

FOR AT

JDR-PR10	16BIT WITH I/O DECODING LAYOUT	34.95
JDR-PR10PK	PARTS KIT FOR JDR-PR10 ABOVE	12.95

FOR XT

IBM-PR1	WITH +5V AND GROUND PLANE	27.95
IBM-PR2	AS ABOVE WITH I/O DECODING LAYOUT	29.95

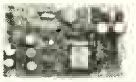
POWER SUPPLIES

APPLE TYPE SUPPLY
- APPLE CONNECTOR
- +5V @ 6A, +12V @ 3A, -5V @ 1A, -12V @ 1A

PS-A $49.95

FLOPPY DRIVE SUPPLY
- +5V @ 2.5A, +12V @ 2A, -12V @ .1A
- +5V @ 5A, IF +12 NOT USED

PS-ASTEC $24.95



75 WATT SUPPLY
- UL APPROVED
- +5V @ 7A, +12V @ 3A, -5V @ 300MA, -12V @ 250MA

PS-1558 $34.95

MICRO SUPPLY
- UL APPROVED, 144 WATTS
- +5V @ 18A, +12V @ 4A, -12V @ 500MA

PS-1554 $29.95

GENDER CHANGERS

GENDER-FF	FEMALE-FEMALE	7.95
GENDER-MM	MALE-MALE	7.95
GENDER-MF	MALE-FEMALE	7.95
GENDER-NM	NULL MODEM	8.95
GENDER-JB	JUMPER BOX	8.95
GENDER-MT	MINITESTER	14.95

BIT RATE GENERATORS

MC14411	9.95
BR1941	4.95
4702	9.95
COM5016	16.95
COM8116	8.95
MM5307	4.95

BYPASS CAPACITORS

.01xx	CERAMIC DISC	100/5.00
.01xx	MONOLITHIC	100/10.00
.1xx	CERAMIC DISC	100/6.50
.1xx	MONOLITHIC	100/12.50

CLOCK CIRCUITS

MC146818	5.95	MM58174	9.95
MM58167	9.95	MSM5832	2.95

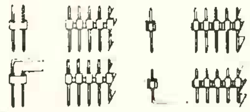
DISK CONTROLLERS

1771	4.95	2797	29.95
1791	9.95	8272	4.39
1793	9.95	UPD765	4.39
1795	12.95	MB8876	12.95
1797	12.95	MB8877	12.95
2791	19.95	1691	6.95
2793	19.95	2143	6.95

"SNAPABLE" HEADERS

CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

1x40	STRAIGHT LEAD	.99
1x40	RIGHT ANGLE LEAD	.49
2x40	2 STRAIGHT LEADS	2.49
2x40	2 RIGHT ANGLE LEADS	2.99

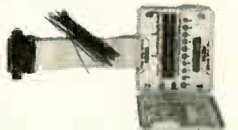


RS-232 BREAKOUT BOX

FOR TROUBLESHOOTING SERIAL COMMUNICATIONS

- OPEN/CLOSE INDIVIDUAL CIRCUITS
- 20 JUMPERS CROSS-CONNECT ANY TWO CIRCUITS
- 10 LEDS SHOW CIRCUIT ACTIVITY

GENDER-BO $34.95



IDC CONNECTORS/RIBBON CABLE

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WIREWRAP HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WIREWRAP HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.63	.89	.95	1.29	1.49	1.69
RIBBON HEADER	IDMxx	–	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	.85	1.25	1.35	1.75	2.05	2.45
10' PLASTIC RIBBON CABLE	RCxx	1.60	3.20	4.10	5.40	6.40	7.50

FOR ORDERING INSTRUCTIONS, SEE D-SUBMINIATURE CONNECTORS BELOW

D-SUBMINIATURE CONNECTORS

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.45	.59	.69	.69	1.35	1.85
	FEMALE	DBxxS	.49	.69	.75	.75	1.39	2.29
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	.49	.69	–	.79	2.27	–
	FEMALE	DBxxSR	.55	.75	–	.85	2.49	–
WIREWRAP	MALE	DBxxPWW	1.69	2.56	–	3.89	5.60	–
	FEMALE	DBxxSWW	2.76	4.27	–	6.84	9.95	–
IDC RIBBON CABLE	MALE	IDBxxP	1.39	1.39	–	2.25	4.25	–
	FEMALE	IDBxxS	1.45	2.35	–	2.35	4.49	–
HOODS	METAL	MHOODxx	1.05	1.15	1.25	1.25	–	–
	PLASTIC	HOODxx	.39	.39	–	.39	.69	.75

ORDERING INSTRUCTIONS:
INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED. EXAMPLE : A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR.

MOUNTING HARDWARE 59¢

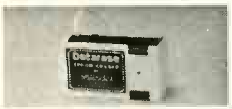
EPROM ERASERS

SPECTRONICS CORPORATION

Model	Timer	# of Chips	Intensity (uW/Cm²)	Unit Cost
PE-140	NO	9	8,000	$ 89
PE-140T	YES	9	8,000	$139
PE-240T	YES	12	9,600	$189

DATARASE *$34.95*

- ERASES 2 EPROMS IN 10 MINUTES
- VERY COMPACT, NO DRAWER
- METAL SHUTTER PREVENTS UV LIGHT FROM ESCAPING



JOYSTICK

- SET X-Y AXIS FOR AUTO CENTER OR FREE MOVEMENT
- FIRE BUTTON FOR USE WITH GAME SOFTWARE
- COMPATIBLE WITH IBM, APPLE II, IIE, IIC, ATARI & VIC 20/64

GC-10

$19.95

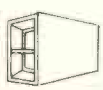
IC SOCKETS/DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
SOLDERTAIL SOCKETS	xxST	.11	.11	.12	.15	.18	.15	.20	.22	.30
WIREWRAP SOCKETS	xxWW	.59	.69	.69	.99	1.09	1.39	1.49	1.69	1.99
ZIF SOCKETS	ZIFxx	–	4.95	4.95	–	5.95	–	5.95	6.95	9.95
TOOLED SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
TOOLED WW SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIERS	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
DIP PLUGS (IDC)	IDPxx	.95	.49	.59	1.29	1.49	–	.85	1.49	1.59

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE CONNECTORS ABOVE

SHORTING BLOCKS

5/$1.00



LITHIUM BATTERIES

- 6.8V FOR 286/386 COMPUTERS
- MOTHERBOARD CONNECTOR
- ADHESIVE VELCRO STRIP FOR EASY MOUNTING

LITHIUM 6.8V $11.95

LITHIUM-3V	3V COIN TYPE LITHIUM BATTERY	$1.95
3V-MHW	BATTERY HOLDER	$1.49

VISA MasterCard

JDR MICRODEVICES, 110 KNOWLES DRIVE, LOS GATOS, CA 95030
LOCAL (408) 866-6200 FAX (408) 378-8927 TELEX 171-110

RETAIL STORE: 1256 SOUTH BASCOM AVE., SAN JOSE, CA (408) 947-8881
HOURS: M-F 9-7 SAT. 9-5 SUN. 12-4

TERMS: MINIMUM ORDER $10.00 FOR SHIPPING AND HANDLING INCLUDE $2.50 FOR UPS GROUND AND $3.50 UPS AIR. ORDERS OVER 1 LB. AND FOREIGN ORDERS MAY REQUIRE ADDITIONAL SHIPPING CHARGES—PLEASE CONTACT THE SALES DEPARTMENT FOR THE AMOUNT. CA RESIDENTS MUST INCLUDE APPLICABLE SALES TAX. PRICES ARE SUBJECT TO CHANGE WITHOUT NOTICE. WE ARE NOT RESPONSIBLE FOR TYPOGRAPHICAL ERRORS. WE RESERVE THE RIGHT TO LIMIT QUANTITIES AND TO SUBSTITUTE MANUFACTURER. ALL MERCHANDISE SUBJECT TO PRIOR SALE. A FULL COPY OF OUR TERMS IS AVAILABLE UPON REQUEST. ITEMS PICTURED MAY ONLY BE REPRESENTATIVE.

MMC MICROCOMPUTER MARKETING COUNCIL

MEMBER DIRECT MARKETING ASSOCIATION

ORDER TOLL FREE 800-538-5000

CONTINENTAL U.S. AND CANADA

CIRCLE 170 ON FREE INFORMATION CARD

CIRCLE 171 ON FREE INFORMATION CARD

BUILD YOUR OWN SYSTEM!

OVER 20,000 JDR SYSTEMS HAVE ALREADY BEEN BUILT. EASY TO ASSEMBLE IN JUST 2 HOURS WITH A SCREWDRIVER. SAVE MONEY AND LEARN MORE ABOUT YOUR COMPUTER AT THE SAME TIME!

VIDEO INSTRUCTIONS

$4.95 WITH KIT PURCHASE

A JDR EXCLUSIVE! 20-MIN. VHS OR BETA TAPE SHOWS YOU STEP-BY-STEP HOW TO BUILD AN XT COMPATIBLE SYSTEM. W/O KIT $19.95

10 MHz TURBO 8088

$661.00

■ INCLUDES SERIAL PORT, 2 PARALLEL PORTS, CLOCK/CALENDAR AND GAME ADAPTOR ■ RUNS COLOR GRAPHICS ON A MONOCHROME MONITOR. ■ MOTHERBOARD ■ 256K RAM MEMORY ■ 135 WATT POWER SUPPLY ■ FLIP-TOP CASE ■ 84 KEY KEYBOARD ■ 360K FLOPPY DRIVE ■ MONOGRAPHICS I/O CARD ■ MONOCHROME MONITOR

12 MHz MINI-286

$1232.75

■ 12 MHZ MINI-286 MOTHERBOARD ■ 512K RAM MEMORY ■ MINI CASE WITH POWER SUPPLY ■ 84 KEY KEYBOARD ■ MONOCHROME MONITOR ■ 1.2 MB FLOPPY DRIVE ■ FLOPPY / HARD CONTROL ■ GRAPHICS ADAPTOR

16 MHz 1 Mb 386

$2348.65

■ MYLEX 386 MOTHERBOARD ■ 1 MB RAM ON BOARD ■ 200 WATT POWER SUPPLY ■ CASE ■ ENHANCED KEYBOARD ■ 1.2 MB FLOPPY DRIVE ■ FLOPPY/HARD CONTROLLER ■ MONOGRAPHICS CARD ■ MONOCHROME MONITOR

MOTHERBOARDS

TURBO 4.77/8 MHz — $99.95

■ XT COMPATIBLE ■ NORTON SI 1.7 ■ 4.77 OR 8 MHZ OPERATION WITH 8088-2 AND OPTIONAL 8087-2 CO-PROCESSOR ■ FRONT PANEL LED SPEED INDICATOR AND RESET SWITCH SET SUPPORTED ■ CHOOSE NORMAL/TURBO MODE OR SOFTWARE SELECT PROCESSOR SPEED

MCT-TURBO

MCT-XMB STANDARD MOTHERBOARD $87.95

10 MHz TURBO SINGLE CHIP 8088 — $129.95

■ XT COMPATIBLE ■ NORTON SI 2.1 ■ USES LESS POWER, IMPROVES RELIABILITY ■ KEY SELECTABLE SPEED, 4.77 MHZ OR 10 MHZ ■ 2.3 TIMES FASTER THAN A STANDARD ■ RESET SWITCH, KEYLOCK, AND SPEED / POWER INDICATORS SUPPORTED

MCT-TURBO-10

80286 6/10 MHz — $379.95

■ AT COMPATIBLE ■ LANDMARK AT SPEED 10 MHZ ■ NORTON SI 10.3 ■ 8 SLOTS (TWO 8-BIT, SIX 16-BIT) ■ HARDWARE SELECTION OF 6 OR 10 MHZ ■ FRONT PANEL LED INDICATOR ■ SOCKETS FOR 1MB OF RAM AND 80287 ■ ONE WAIT STATE ■ BATTERY BACKED CLOCK ■ KEYLOCK SUPPORTED ■ RESET SWITCH

MCT-286

12 MHz MINI-286 — $399.95

■ AT COMPATIBLE ■ LANDMARK AT SPEED 13.2 MHZ ■ NORTON SI 11.6 ■ 6 MHZ, 10 MHz (0/1 WAIT STATE), 12 MHZ (1 WAIT STATE) ■ ZYMOS ASICS FOR FEWER CHIPS, GREATER RELIABILITY ■ SUPPORTS 512K-1024K MEMORY ■ RECHARGEABLE HIGH CAPACITY NI-CAD BATTERY ■ SIX 16-BIT SLOTS, TWO 8-BIT SLOTS ■ MOUNTS IN STANDARD XT CASE

MCT-M286-12

MCT-M286 6 /10 MHZ MINI 80286 BOARD $389.65

16 MHz MYLEX 386 — $1699.00

■ 1 MB RAM ON BOARD ■ 8 SLOTS (TWO 8-BIT, SIX 16-BIT) ■ USES AMI BIOS ■ SUPPORTS 80287 MATH CO-PROCESSOR ■ SUPPORTS 80387 WITH ADAPTOR ■ 64KB CACHE FOR NEAR Ø WAIT STATE ■ 20 MHZ VERSION AVAILABLE

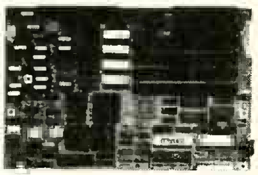
MY-386MB

MY-386MB-4 FOUR MB MEMORY INSTALLED $2999.00

MY-386MB-MCB MATH CO-PROCESSOR ADAPTOR BOARD $149.00

16 MHz MYLEX MINI 386

$1249.00



■ LANDMARK AT SPEED 23.2 MHZ ■ NORTON SI 18.7 ■ 64KB HIGH SPEED DIRECT MAPPED STATIC RAM CACHE ■ 1 MB OR 2 MB MEMORY ON STD. MEMORY BOARD ■ UP TO 8 MB OF 32-BIT MEMORY ON PIGGYBACK MEMORY BOARD, FOR TOTAL OF 10 MB ■ AMI BIOS WITH 32 BIT EGA SUPPORT ■ SOCKETED FOR 80387 MATH CO-PROCESSOR ■ ONE 8-BIT, FOUR 16-BIT AND ONE 32-BIT SLOTS ■ DALLAS CMOS /CLOCK DEVICE ON BOARD W/ BATT.

MY-386 JR (MEMORY CARD REQUIRED)

MY-386JR20 20 MHZ VERSION $1695.00

MY-386JR-M 1 TO 2 MB MEMORY CARD (REQUIRED) ØK INSTALLED $159.00

MY-386JR-M8 8 MB PIGGYBACK MEMORY BOARD ØK INSTALLED $159.00

NEW! MODULAR PROGRAMMERS

THE IDEAL SYSTEM FOR DEVELOPERS. ALL MODULES USE A COMMON HOST ADAPTOR CARD

HOST ADAPTOR CARD — $29.95

■ A UNIVERSAL INTERFACE FOR ALL THE PROGRAMMING MODULES ■ USER SELECTABLE PROGRAMMABLE ADDRESSES PREVENT ADDRESSING CONFLICTS ■ MENU-DRIVEN SOFTWARE PACKAGE ■ INCLUDES MOLDED CABLE

MCT-MAC

UNIVERSAL MODULE — $499.99

■ PROGRAMS EPROMS, EEPROMS, PALS, BI-POLAR PROMS 8748 & 8751 SERIES DEVICES ■ TESTS TTL, CMOS, DYNAMIC & STATIC RAMS

MCT-MUP

DIGITAL IC MODULE — $129.95

■ TESTS TTL, CMOS, DYN. & STATIC RAM ■ AUTO SEARCH

MCT-MIC

EPROM MODULE — $119.95

■ PROGRAMS 24-32 PIN EPROMS, CMOS EPROMS AND EEPROMS FROM 16K TO 1024K

MCT-MEP

MCT-MEP-4 FOUR-EPROM PROGRAMMER $169.95

MCT-MEP-8 EIGHT-EPROM PROGRAMMER $259.95

PAL MODULE — $249.95

■ PROGRAMS MMI, NS, TI 20 & TI 24-PIN DEVICES

MCT-MPL

8748 MODULE — $179.95

■ PROG. 8741, 8742, 8748, 8749 & 8750 EPROMS & PROMS.

MCT-MMP

BI-POLAR MODULE — $259.95

■ PROG. AMD, MMI, NS, TI & SIGNETICS BI-POLAR PROMS

MCT-MBP

JDR Microdevices®

MEMBER DIRECT MARKETING ASSOCIATION

MMC MICROCOMPUTER MARKETING COUNCIL

VISA — MasterCard

JDR MICRODEVICES, 110 KNOWLES DRIVE, LOS GATOS, CA 95030
LOCAL (408) 866-6200 FAX (408) 378-8927 TELEX 171-110

ORDER TOLL FREE 800-538-5000

BBS (408) 374-2171

CONTINENTAL U.S. AND CANADA

CIRCLE 173 ON FREE INFORMATION CARD

#29-260

VCR Battery Pack

- Fits many RCA and Panasonic portable VCRs
- Replaces RCA battery #149722 and Panasonic #LCR1812
- Manufactured by Hitachi
- 12V, 1.9Ah
- Used in Panasonic models #NV8410, #PV3100, #PV3200, #PV4510 and others

See pages 73-84 of Catalog #19 for more VCR parts and accessories

#20-220

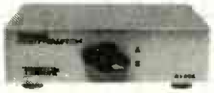
Circuit Cooler

- Cools circuits instantly for rapid location of heat related problems
- Will not leave residue

For more chemicals see pages 24-27 of Catalog #19

RS-232 Port Switches

For more port switches and computer equipment see pages 40-52



Two-Way #83-605

Four-Way #83-600

#55-445

PYLE

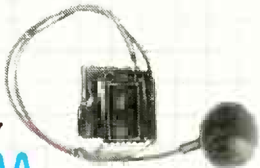
15″ Polypropylene Woofer

- Poly cone with polyfoam surround
- Display packaged
- Made in USA
- Magnet weight: 60 oz.
- Power handling: RMS/peak 100W/144W
- Frequency response: 20-3500Hz

For more speakers and accessories see pages 94-109 of Catalog #19

Sharp Type Flyback

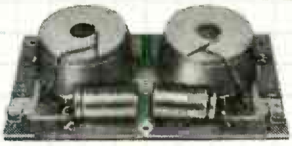
#33-975



- Popular flyback for Sharp color TVs
- Replaces Sharp #RTRNF0009

For more flybacks see page 57 of Catalog #19

NEW



PYLE

Subwoofer Crossover

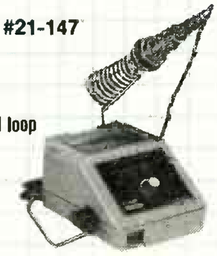
- To be used with one dual voice coil subwoofer or two single voice coil woofers
- Crossover frequencies: Rolls off at 100Hz at 12dB per octave
- 4ohm impedance
- 150 watt RMS continuous — 220 watt peak
- 4″ (W) x 7″ (L) x 1⅜″ (D)

#50-220

TENMA

Soldering Station

#21-147



- Adjustable temperature range of 150° - 420° C (300° - 790° F)
- Grounded tip for soldering static sensitive devices
- Overheat protection with closed loop temperature control
- Replaceable iron clad tip

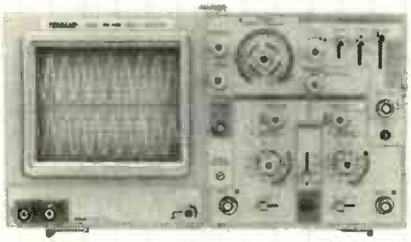
Catalog #19 contains other soldering equipment on pages 37-39

#75-010

Replacement Magnetron

- A quality replacement for many magnetrons on the market
- Intended for use in microwaves of 600-700 watts, 950 watts maximum

Catalog #19 contains additional microwave oven parts on page 125



#72-720

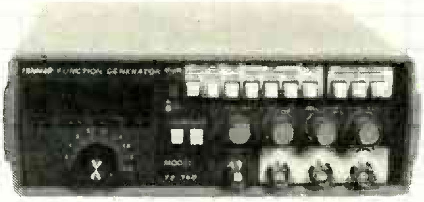
For more specifications and test equipment see pages 8-23 in Catalog #19

TENMA

Dual Trace 20MHz Oscilloscope with Component Tester

This oscilloscope combines quality craftsmanship with ease and flexibility of operation. Specifications include 5mV/div. sensitivity and a frequency characteristic response with a smooth roll-off exceeding 20MHz.

The component tester is a valuable troubleshooting tool that gives a visual display of the characteristics, value and condition of resistors, capacitors, inductors and diodes; in or out of circuit.



#72-380

TENMA

Digital Function Generator/Frequency Counter

- A versatile function generator with a 10MHz frequency counter, to be used either externally or to measure the output frequency of the generator
- Produces square, sine, triangle, ramp and pulse waveforms
- Six digit frequency counter is switchable for internal or external use

MCM is making waves

- With our 172 page catalog
- Dedicated sales personnel
- Efficient customer service
- Next-day shipping

Be sure to call for your FREE catalog!
Over 11,000 items!
Call Toll Free
1-800-543-4330

SOURCE NO. RE-53

MCM ELECTRONICS
858 E. CONGRESS PARK DR.
CENTERVILLE, OH 45459-4072
A PREMIER Company

Jameco ELECTRONICS — Mail Order Electronics · Worldwide

Mail-Order Electronics

24 HOUR ORDER HOTLINE 415-592-8097 — **CUSTOMER SERVICE (7AM-5PM PST) 415-592-8121**

NEC V20 & V30 CHIPS

Replace the 8086 or 8088 in Your IBM PC and increase its Speed by up to 30%!

Part No.		Price
UPD70108-5	(5MHz) V20 Chip	$ 7.49
UPD70108-8	(8MHz) V20 Chip	$10.75
UPD70108-10	(10MHz) V20 Chip	$12.95
UPD70116-8	(8MHz) V30 Chip	$ 9.95
UPD70116-10	(10MHz) V30 Chip	$16.95

7400

Part No.	1-9	10+	Part No.	1-9	10+
7400	.29	.19	7485	.69	.59
7402	.29	.19	7486	.45	.35
7404	.29	.19	7489	1.95	1.85
7405	.35	.25	7490	.49	.39
7406	.39	.29	7493	.45	.35
7407	.39	.29	74121	.39	.29
7408	.35	.25	74123	.49	.39
7410	.29	.19	74125	.55	.45
7414	.49	.39	74126	.55	.45
7416	.35	.25	74143	4.95	4.85
7417	.35	.25	74150	1.35	1.25
7420	.29	.19	74154	1.35	1.25
7430	.29	.19	74158	1.49	1.39
7432	.39	.29	74173	.79	.69
7438	.39	.29	74174	.59	.49
7442	.49	.39	74175	.59	.49
7445	.79	.69	74176	.79	.69
7446	.89	.79	74181	1.95	1.85
7447	.89	.79	74189	1.95	1.85
7448	1.95	1.85	74193	.79	.69
7472	.39	.29	74198	1.85	1.75
7473	.39	.29	74221	.99	.89
7474	.39	.29	74273	1.95	1.85
7475	.49	.39	74365	.59	.49
7476	.45	.35	74367	.59	.49

74LS

Part No.	1-9	10+	Part No.	1-9	10+
74LS00	.26	.16	74LS165	.75	.65
74LS02	.28	.18	74LS166	.89	.79
74LS04	.28	.18	74LS173	.39	.29
74LS05	.28	.18	74LS174	.39	.29
74LS06	.59	.49	74LS175	.39	.29
74LS07	.59	.49	74LS189	3.95	3.85
74LS08	.28	.18	74LS191	.59	.49
74LS10	.26	.16	74LS193	.69	.59
74LS14	.49	.39	74LS221	.69	.59
74LS27	.35	.25	74LS240	.59	.49
74LS30	.28	.18	74LS243	.69	.59
74LS32	.28	.18	74LS244	.69	.59
74LS42	.49	.39	74LS245	.79	.69
74LS47	.89	.79	74LS259	.99	.89
74LS73	.39	.29	74LS273	.89	.79
74LS74	.35	.25	74LS279	.49	.39
74LS75	.39	.29	74LS322	3.49	3.39
74LS76	.39	.29	74LS365	.49	.39
74LS85	.59	.49	74LS366	.49	.39
74LS86	.29	.19	74LS367	.49	.39
74LS90	.49	.39	74LS368	.49	.39
74LS93	.49	.39	74LS373	.79	.69
74LS123	.49	.39	74LS374	.79	.69
74LS125	.49	.39	74LS393	.89	.79
74LS138	.49	.39	74LS590	5.95	5.85
74LS139	.49	.39	74LS624	1.95	1.85
74LS154	1.19	1.09	74LS629	2.49	2.39
74LS157	.45	.35	74LS640	1.09	.99
74LS158	.39	.29	74LS645	1.09	.99
74LS163	.49	.39	74LS670	.99	.89
74LS164	.59	.49	74LS688	2.39	2.29

74S/PROMS*

Part No.	Price	Part No.	Price
74S00	.25	74S188*	1.49
74S04	.25	74S189	1.49
74S08	.29	74S196	1.49
74S10	.25	74S240	1.39
74S32	.29	74S244	1.19
74S74	.29	74S253	.59
74S85	.89	74S287*	1.49
74S86	.29	74S288*	1.49
74S124	1.49	74S373	1.49
74S174	.49	74S374	1.49
74S175	.49	74S472*	2.95

74F

Part No.	Price	Part No.	Price
74F00	.25	74F139	.59
74F04	.25	74F157	.59
74F08	.25	74F193	2.95
74F10	.25	74F240	.69
74F32	.25	74F244	.69
74F74	.29	74F253	.59
74F86	.39	74F373	.79
74F138	.59	74F374	.79

CD—CMOS

Part No.	Price	Part No.	Price
CD4001	.19	CD4076	.59
CD4008	.59	CD4081	.22
CD4011	.19	CD4082	.22
CD4013	.29	CD4093	.35
CD4016	.29	CD4094	.89
CD4017	.49	CD40103	1.49
CD4018	.59	CD40107	.49
CD4020	.59	CD4510	.69
CD4024	.45	CD4511	.69
CD4027	.35	CD4520	.75
CD4030	.35	CD4522	.79
CD4040	.65	CD4538	.79
CD4049	.29	CD4541	.89
CD4050	.29	CD4543	.79
CD4051	.59	CD4553	3.95
CD4052	.59	CD4555	.79
CD4053	.59	CD4559	7.95
CD4063	1.49	CD4566	1.95
CD4066	.29	CD4583	.59
CD4067	1.49	CD4584	.49
CD4069	.19	CD4585	.69
CD4070	.25	MC14411P	7.95
CD4071	.22	MC14490P	4.49
CD4072	.22		

MICROPROCESSOR COMPONENTS

MISCELLANEOUS CHIPS

Part No.	Price
D765AC	3.95
WD9216	3.95

Z80, Z80A, Z80B SERIES

Part No.	Price
Z80	1.19
Z80-CTC	1.29
Z80-PIO	1.29
Z80A	1.29
Z80A-CTC	1.65
Z80A-DART	4.95
Z80A-PIO	1.89
Z80A-SIO/0	3.95
Z80B	2.75
Z80B-CTC	3.95
Z80B-PIO	3.95

6500/6800/68000 SER.

Part No.	Price
6502	2.65
65C02 (CMOS)	7.75
6520	1.95
6522	2.95
6532	5.49
6551	2.95
65C802 (CMOS)	15.95
6800	1.95
6802	2.95
6810	1.25
6821	1.75
6840	3.49

6500/6800/68000 Cont.

Part No.	Price
6845	2.75
6850	1.95
6852	.75
6854	1.19
MC68000L8	9.95
MC68000L10	11.95
MC68010L10	49.95
MC68020RC12B	99.95

8000 SERIES

Part No.	Price
8031	3.95
80C31	9.95
8035	1.49
8073	6.95
8080A	2.25
8085A	2.49
8086	3.95
8086-2	6.95
8087 (5MHz)	99.95
8087-1 (10MHz)	229.95
8087-2 (8MHz)	159.95
8088	4.95
8088-2	6.95
8116	4.95
8155	2.49
8155-2	3.49
8156	2.95
8203	6.95
8212	2.29
8224	2.25

8000 SERIES Cont.

Part No.	Price
8228	1.95
8237-5	4.25
8243	1.75
8250A	4.95
8250B (For IBM)	5.95
8251A	1.69
8253-5	1.95
8254	3.95
8255A-5	2.95
8259-5	2.25
8272	3.95
8279-5	2.95
8741	9.95
8742	19.95
8748 (25V)	7.95
8748H (HMOS) (21V)	9.95
8749	9.95
8751 (3.5-8MHz)	39.95
8751H (3.5-12MHz)	44.95
8755	13.95

DATA ACQUISITION

Part No.	Price
ADC0804LCN	2.79
ADC0808CCN	5.95
ADC0809CCN	3.69
ADC1205CCJ-1	19.95
DAC0808LCN	1.75
DAC1008LCN	5.95
AY-3-1015D	4.95
AY-5-1013A	1.95

MICROPROCESSOR SALE!

Part No.		Price
8052AHBASIC	CPU w/BASIC Interpreter	$24.95
MC68000P12	16-Bit MPU (12MHz)	$12.95
MC68701	8-Bit EPROM Microcomputer	$14.95
MC68705P3S	8-Bit EPROM Microcomputer	$9.95
MC68705U3S	8-Bit EPROM Microcomputer	$10.95
80286-10	16-Bit Hi Performance MPU	$69.95
80287-8	Math Co-processor (8MHz)	$244.95
80287-10	Math Co-processor (10MHz)	$309.95
80387-16	Math Co-proc. (16MHz) GRID ARRAY	$474.95
80387-20	Math Co-proc. (20MHz) GRID ARRAY	$749.95

DYNAMIC RAMS

Part No.			Price
*4116-15	16,384 x 1	(150ns)	1.39
4128-20	131,072 x 1	(200ns) (Piggyback)	3.25
*4164-100	65,536 x 1	(100ns)	3.49
*4164-120	65,536 x 1	(120ns)	2.95
*4164-150	65,536 x 1	(150ns)	2.59
*4164-200	65,536 x 1	(200ns)	1.75
*TMS4416-12	16,384 x 4	(120ns)	7.75
*41256-80	262,144 x 1	(80ns)	13.49
*41256-100	262,144 x 1	(100ns)	12.49
*41256-120	262,144 x 1	(120ns)	11.95
*41256-150	262,144 x 1	(150ns)	11.49
*41464-15	65,536 x 4	(150ns) (4464)	14.75
*511000P-10	1,048,576 x 1	(100ns) 1 Meg	39.95
*514256P-10	262,144 x 4	(100ns) 1 Meg	59.95

STATIC RAMS

Part No.			Price
*2016-12	2048 x 8	(120ns)	4.49
2018-45	2048 x 8	(45ns)	6.95
2102	1024 x 1	(350ns)	.89
2114N	1024 x 4	(450ns)	.99
2114N-2L	1024 x 4	(200ns) Low Power	1.49
21C14	1024 x 4	(200ns) (CMOS)	.49
5101	256 x 4	(450ns) (CMOS)	2.95
*6116P-3	2048 x 8	(150ns) (CMOS)	4.95
*6116LP-3	2048 x 8	(150ns) LP CMOS	5.99
*6264LP-12	8192 x 8	(120ns) LP CMOS	10.49
*6264P-15	8192 x 8	(150ns) (CMOS)	9.95
*6264LP-15	8192 x 8	(150ns) LP CMOS	10.25
6514	1024 x 4	(350ns) (CMOS)	3.75
*43256-15L	32,768 x 8	(150ns) Low Power	16.49
*62256LP-12	32,768 x 8	(120ns) LP CMOS	17.95

EPROMS

Part No.			Price
TMS2516	2048 x 8	(450ns) 25V	6.95
TMS2532	4096 x 8	(450ns) 25V	5.95
TMS2532A	4096 x 8	(450ns) 21V	4.49
TMS2564	8192 x 8	(450ns) 25V	6.95
TMS2716	2048 x 8	(450ns) 3 Voltage	6.95
1702A	256 x 8	(1µs)	4.95
2708	1024 x 8	(450ns)	6.95
2716	2048 x 8	(450ns) 25V	3.75
2716-1	2048 x 8	(350ns) 25V	4.25
27C16	2048 x 8	(450ns) 25V (CMOS)	4.25
2732	4096 x 8	(450ns) 25V	3.95
2732A-20	4096 x 8	(200ns) 21V	4.25
2732A-25	4096 x 8	(250ns) 21V	3.95
27C32	4096 x 8	(450ns) 25V (CMOS)	4.95
2764-20	8192 x 8	(200ns) 21V	4.25
2764-25	8192 x 8	(250ns) 21V	3.59
2764A-25	8192 x 8	(250ns) 12.5V	3.69
2764-45	8192 x 8	(450ns) 21V	3.39
27C64-15	8192 x 8	(150ns) 12.5V (CMOS)	5.95
27128-20	16,384 x 8	(200ns) 21V	6.95
27128-25	16,384 x 8	(250ns) 21V	5.95
27128A-25	16,384 x 8	(250ns) 12.5V	5.25
27C128-25	16,384 x 8	(250ns) 21V (CMOS)	5.95
27256-20	32,768 x 8	(200ns) 12.5V	6.95
27256-25	32,768 x 8	(250ns) 12.5V	5.49
27C256-25	32,768 x 8	(250ns) 12.5V (CMOS)	6.25
27512-20	65,536 x 8	(200ns) 12.5V	10.95
27512-25	65,536 x 8	(250ns) 12.5V	9.95

EEPROMS

Part No.			Price
2816A-25	2048 x 8	(250ns) 5V Read/Write	6.25
2817A	2048 x 8	(350ns) 5V Read/Write	7.95
2865A-30	8192 x 8	(300ns) 5V Read/Write	9.95
52B13 (21V)	2048 x 8	(350ns) 5V Read Only	1.49

COMMODORE CHIPS

Part No.	Price
LAG570	9.95
WD1770	8.95
SI3052P	1.25
6504A	1.19
6507	2.95
6510	12.95
6522	2.95
6525	4.95
6526	14.95
6532	5.49
6545-1	3.95
6560	10.95
6567	24.95
6569	15.95
6572	10.95
6581 (12V)	12.95
6582 (9V)	14.95
8502	7.95
8564	4.95
8566	9.95
8701	9.95
8721	14.95
8722	13.95
*251104-04	12.95
310654-05	9.95
318018-03	12.95
318019-03	12.95
318020-04	12.95
325302-01	14.95
325572-01	17.95
*82S100PLA**	15.95
901225-01	15.95
901226-01	15.95
901227-03	15.95
901229-05	15.95

*No specs. available
**Note: 82S100PLA = U17 (C-64)

74C/CMOS

Part No.	Price	Part No.	Price
74C00	.29	74C174	.49
74C02	.29	74C175	.49
74C04	.29	74C221	1.79
74C08	.29	74C240	1.19
74C10	.19	74C244	1.79
74C14	.49	74C373	1.95
74C32	.29	74C374	1.95
74C74	.49	74C912	7.95
74C85	1.49	74C915	1.39
74C86	.29	74C920	4.95
74C89	3.95	74C921	4.95
74C90	.99	74C922	3.95
74C154	2.95	74C923	3.95
74C173	.59	74C925	5.49

MISC. COMPONENTS

TANTALUM CAPACITORS

TM1/35 .1µf @ 35V	.19	TM4.7/35 4.7µf @ 35V	.45
TM1/35 1µf @ 35V	.19	TM6.8/35 6.8µf @ 35V	.49
TM2.2/35 2.2µf @ 35V	.25	TM10/35 10µf @ 35V	.59

POTENTIOMETERS

Values available (insert ohms into space marked "XX"): 500Ω, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 1MEG

43PXX ¾ Watt, 15 Turn	.99	63PXX ½ Watt, 1 Turn	.89

TRANSISTORS AND DIODES

PN2222	.13	PN2907	.13	1N4004	.12
2N2222A	.29	2N4401	.12	1N4148	.07
2N3055	.65	1N270	.25	1N4735	.29
2N3904	.12	1N751	.15	C106B1	.49

SWITCHES

JMT123 SPDT, On-On	1.19	206-8 SPST, 16-pin DIP	1.25
MPC121 SPDT, On-Off-On	1.19	MS102 SPST, Momentary	.39

D-SUB CONNECTORS

DB25P Male, 25-pin	.69	DB25S Female, 25-pin	.75

LEDS

XC556R T1¾, Red	.13	XC556Y T1¾, Yellow	.17
XC556G T1¾, Green	.17	XC556C T1¾, Clear/Red	.17

IC SOCKETS

Low Profile		Wire Wrap (Gold) Level #2	
8LP	.11	8WW	.59
14LP	.12	14WW	.65
16LP	.13	16WW	.69
24LP	.25	24WW	1.19
28LP	.27	28WW	1.39
40LP	.29	40WW	1.89

Soldertail Standard (Gold & Tin) & Header Plug Sockets Also Available

74HC HI-SPEED CMOS

Part No.	Price	Part No.	Price
74HC00	.19	74HC175	.59
74HC02	.19	74HC221	.89
74HC04	.19	74HC240	.69
74HC08	.19	74HC244	.79
74HC10	.25	74HC245	.79
74HC14	.29	74HC253	.49
74HC30	.25	74HC259	.49
74HC32	.29	74HC273	.59
74HC74	.29	74HC373	.69
74HC75	.35	74HC374	.69
74HC76	.35	74HC595	1.29
74HC85	.55	74HC688	1.49
74HC86	.35	74HC943	8.95
74HC123	.69	74HC4040	.89
74HC125	.49	74HC4049	.39
74HC132	.49	74HC4050	.39
74HC138	.45	74HC4060	.99
74HC139	.45	74HC4511	1.19
74HC154	1.49	74HC4514	1.79
74HC163	.49	74HC4538	1.19
74HC174	.59	74HC4543	1.19

74HCT — CMOS TTL

Part No.	Price	Part No.	Price
74HCT00	.17	74HCT139	.39
74HCT02	.17	74HCT157	.29
74HCT04	.19	74HCT174	.35
74HCT08	.17	74HCT175	.39
74HCT10	.17	74HCT240	.69
74HCT32	.19	74HCT244	.59
74HCT74	.29	74HCT245	.69
74HCT86	.25	74HCT373	.49
74HCT138	.39	74HCT374	.49

LINEAR

Part No.	Price	Part No.	Price
DS0026CN	1.95	LM1458N	.35
TL074CN	.99	LM1488N	.45
TL084CN	.89	DS14C88N (CMOS)	1.19
AF100-1CN	8.95	LM1489N	.45
LM307N	.39	DS14C89N (CMOS)	1.19
LM309K	1.25	LM1496N	.69
LM311N	.39	MC1648P	2.95
LM317T	.65	LM1871N	1.95
LM318N	.99	LM1872N	1.95
LM319N	1.29	LM1896N-1	1.49
LM323K	3.49	ULN2003A	.75
LM324N	.35	XR2206	3.95
LM338K	4.49	XR2211	2.95
LM339N	.39	XR2243	1.95
LF347N	1.49	26LS29	2.95
LM348N	.69	26LS31	.99
LM350T	2.95	26LS32	.99
LF351N	.39	26LS33	1.49
LF353N	.49	LM2901N	.25
LF355N	.79	LM2907N	1.29
LF356N	.79	LM2917N (8 pin)	1.79
LF357N	.89	MC3419CL	3.95
LM358N	.49	MC3446N	.99
LM360N	1.95	MC3450P	.49
LM361N	1.49	MC3470P	1.19
LM380N-8	.99	MC3471P	.99
LM386N-3	.89	MC3479P	3.95
LM387N	1.09	MC3486P	1.19
LM393N	.39	MC3487P	.99
LM399H	3.49	LM3900N	.49
LF411CN	.79	LM3905N	1.25
TL497ACN	1.49	LM3909N	.89
NE540H (C540H)	.99	LM3914N	1.79
NE555V	.29	LM3916N	1.49
XRL555	.59	NE5532	.69
LM556N	.45	NE5534	.69
NE558N	.79	7805K (LM340K-5)	1.39
LM565N	.89	7812K (LM340K-12)	1.39
LM567V	.75	7815K (LM340K-15)	1.59
NE592N	.75	7805T (LM340T-5)	.45
LM741CN	.29	7812T (LM340T-12)	.45
LM747CN	.49	7815T (LM340T-15)	.45
MC1350P	.89	7905K (LM320K-5)	1.49
MC1377P	2.29	7905T (LM320T-5)	.49
MC1398P	4.95	75472	.49
LM1414N	.99	75477	1.29
		MC145106P	1.95
		MC145406P	2.95

PARTIAL LISTING • OVER 4000 COMPONENTS AND ACCESSORIES IN STOCK! • CALL FOR QUANTITY DISCOUNTS

*RAM'S SUBJECT TO FREQUENT PRICE CHANGES

Worldwide • Since 1974

• QUALITY COMPONENTS • COMPETITIVE PRICING • PROMPT DELIVERY

MEMBER DIRECT MARKETING ASSOCIATION — MEMBER MMC MICROCOMPUTER MARKETING COUNCIL of the Direct Marketing Association Inc.

COMPUTER PRODUCTS

Jameco IBM AT Compatible 16MHz 80286 *NEAT* Motherboard

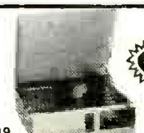
- Expandable to 8MB RAM (Zero-K included)
- 8/12 or 8/16MHz switchable
- Supports all *NEAT* functions including shadow RAM, EMS 4.0, RAM re-mapping and selectable wait states
- 80287-10 Coprocessor capability
- Norton SI rating of 15.6
- AMI BIOS ROMs included
- One-year warranty

JE3010 8/12/16MHz *NEAT* (AT) . . **$499.95**

— Additional Motherboards —

JE1001	4.77/8MHz (PC/XT)	$ 89.95
JE1002	4.77/10MHz (PC/XT)	$109.95
JE3005	8/12MHz (AT)	$329.95

Jameco IBM PC/XT/AT Compatible Computer Cases

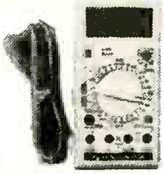


JE1019 Pictured

JE1010	Standard PC/XT Flip-Top Case	$34.95
JE1011	Standard PC/XT Slide Case	$39.95
JE1014	Baby XT Turbo Flip-Top Case	$69.95
JE1017	Baby AT Flip-Top Case	$54.95
JE1018	Baby AT Slide Case	$69.95
JE1019	Baby AT Flip-Top Case	$69.95

TEST EQUIPMENT

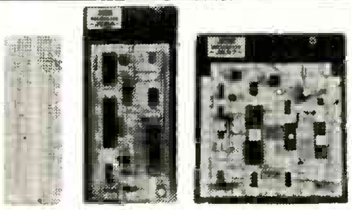
Metex **M4650:**



- Handheld, high accuracy
- 4½ Digit LCD
- Manual ranging with Overload Protection
- Audible continuity tester
- Tests: AC/DC Voltage, Resistance, Continuity Capacitance, Frequency
- One Year Warranty
- Size: 7"L x 3.5"W x 1.5"H

M4650. . . . $99.95

JAMECO SOLDERLESS BREADBOARD SOCKETS



JE23 JE24 JE27

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE20	6½ x ¾	200	0	$ 2.95
JE21	3¼ x 2⅛	400	0	$ 4.95
JE22	6½ x 1⅜	630	0	$ 5.95
JE23	6½ x 2⅛	830	0	$ 7.95
JE24	6½ x 3⅛	1,360	2	$14.95
JE25	6½ x 4¼	1,660	3	$22.95
JE26	6⅞ x 5¾	2,390	4	$27.95
JE27	7¼ x 7½	3,220	4	$37.95

DATA BOOKS

400041	NSC Linear Data Book-Vol. I (88)	$14.95
400042	NSC Linear Data Book-Vol. II (88)	$ 9.95
400043	NSC Linear Data Book-Vol. III (88)	$ 9.95
210830	Intel Memory Handbook (88)	$17.95
230843	Intel Microsystem Hndbk. Set (88)	$24.95

Jameco IBM PC/XT 8MHz Turbo Compatible Kit With 256K RAM

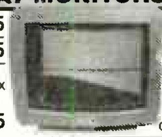
- *Free! QAPLUS Diagnostic Software Included!*
- *Free! PC Write Word Processing Software Included!*
- *256K RAM Included, Expandable to 640K*
- *4.77 or 8MHz Switchable*
- *AMI BIOS ROM Included*
- *Save $128.06*

Part No.	Description	Price
JE1001	4.77/8MHz Turbo Motherboard (Zero-K RAM – includes AMI BIOS ROM)	$89.95
JE1010	Flip-Top Case	34.95
JE1015	XT/AT Compatible Keyboard	59.95
JE1020	5.25" DSDD Disk Drive (Black Bezel)	89.95
JE1030	150 Watt Power Supply	59.95
JE1040	360K Floppy Controller	29.95
JE1050	Mono/Graphics Card with Printer Port	59.95
AMBER	12" Monochrome Amber Monitor	99.95
41256-150	256K RAM (9 chips)	103.41

Save $128.06 ***Regular List*** **$628.01**

JE3002 IBM Compatible PC/XT 8MHz Turbo Kit. . . . **$499.95**

IBM COMPATIBLE DISPLAY MONITORS



CTX2410

AMBER 12" Amber Monochrome . . . **$99.95**

CTX2410 14" RGB Color. **$279.95**

14" EGA Color - EGA/CGA Compatible, 720 x 350 Max. Resolution (PC/XT/AT)
TM5154. . . . . **$399.95**

14" EGA Monitor and EGA Card - EGA compatible, 720 x 350 Max. Resolution – displays up to 16 colors (PC/XT/AT)
JE1059 ***SAVE $40.00*** **$519.95**

14" Multiscan Color-VGA/PGC/EGA compat., 800 x 600 Max. Res. (PC/XT/AT)
TM5155. . . . . **$549.95**

13" VGA Monitor and VGA Card - VGA compatible, 800 x 560 Max. Resolution – displays up to 256 colors (PC/XT/AT)
JEVGA. **$649.95**

JAMECO IBM PC/XT/AT COMPATIBLE CARDS

Graphic Display Cards

JE1050

JE1050	Mono Graphics Card w/Printer Port (PC/XT/AT)	$59.95
JE1052	Color Graphics Card w/Printer Port (PC/XT/AT)	$49.95
JE1055	EGA Card with 256K Video RAM (PC/XT/AT)	$159.95
JE1071	Multi I/O with Drive Controller and Mono Graphics (PC/XT)	$119.95

Multifunction, I/O and Expansion Cards

JE1060	I/O Card with Serial, Game, Parallel Printer Port and Real Time Clock (PC/XT)	$59.95
JE1061	RS232 Serial Half Card (PC/XT)	$29.95
JE1062	RS232 Serial Half Card (AT)	$34.95
JE1065	I/O Card w/Serial, Game & Parallel Printer Port (AT)	$59.95
JE1081	2MB of expanded or extended memory (zero-K on-board) (AT)	$119.95
JE1082	3MB of expanded or extended memory, parallel printer port, serial port and game port (zero-K on-board) (AT)	$169.95

Floppy and Hard Disk Controller Cards

JE1041	20/40MB Hard Disk Controller Card (PC/XT)	$79.95
JE1043	360K/720K/1.2MB/1.44MB Floppy Disk Cont. (PC/XT/AT)	$49.95
JE1044	360K Floppy/Hard Disk Controller Card (PC/XT)	$129.95
JE1045	360K/720K/1.2MB/1.44MB Floppy/Hard Disk Controller Card (AT)	$149.95

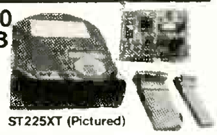
COMPUTER PERIPHERALS

AMI 80386 Motherboards

- Expandable to 2MB (Zero-K incl.) of 32-bit RAM with expansion board (included)
- Expand an additional 8MB using the JE3030 (below, Zero-K incl.)
- XT footprint-AT compatible
- 80387-16/20 capability
- Built-in set-up and diagnostics
- Includes AMI BIOS ROMs
- One-year warranty

JE3020	16MHz 80386 (AT)	$1399.95
JE3025	20MHz 80386 (AT)	$1699.95
JE3030	8MB (Zero-K) Daughterboard	$299.95

Seagate 20,30 40 and 60MB Half Height Hard Disk Drives



ST225XT (Pictured)

ST225	20MB Drive only (PC/XT/AT)	$224.95
ST225XT	20MB w/Controller (PC/XT)	$269.95
ST225AT	20MB w/Controller (AT)	$339.95
ST238	30MB Drive only (PC/XT/AT)	$249.95
ST238XT	30MB w/Controller (PC/XT)	$299.95
ST238AT	30MB w/Controller (AT)	$389.95
ST251	40MB Drive only (PC/XT/AT)	$429.95
ST251XT	40MB w/Cont. Card (PC/XT)	$469.95
ST251AT	40MB w/Controller Card (AT)	$539.95
ST251-1	40MB Fast 28ms (Drive only)	$499.95
ST277	60MB Drive only (PC/XT/AT)	$499.95
ST277XT	60MB w/Controller (PC/XT)	$549.95
ST277AT	60MB w/Controller Card (AT)	$639.95

40MB Tape Back-Up for IBM PC/XT/AT

DJ10	40MB Back-Up and Tape	$349.95
TB40	40MB Tape Cartridge	$24.95

Jameco 5.25" PC/XT & AT Compatible Disk Drives

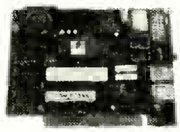
JE1022 (Pictured)

JE1020	360K Black Bzl. (PC/XT/AT)	$ 89.95
JE1021	360K Beige Bzl. (PC/XT/AT)	$ 89.95
JE1022	1.2MB Beige Bzl. (PC/XT/AT)	$109.95

3.5" PC/XT/AT Compatible Disk Drives

MF353B	3.5" 720KB (Mounting Frame Included) (PC/XT/AT)	~~$129.95~~ $109.95
MF355B	3.5" 1.44MB (Mounting Frame Included) (PC/XT/AT)	~~$149.95~~ $129.95

Datatronics 2400/1200/300 Modems



NEW, Pocket Version!

- Hayes command compatible
- Bell 103/212A compatible
- Auto-dial/auto-answer
- FCC approved
- 1-year warranty
- Includes MaxiMite Communication Software (except 1200P)

1200P	1200/300 Baud Pocket Modem	$ 99.95
1200H	1200/300 Baud Internal Modem	$ 69.95
2400S	2400/1200/300 Internal Modem	$129.95
1200C	1200/300 Baud External Modem	$ 99.95
2400E	2400/1200/300 External Modem	$169.95

U.S. Funds Only
Shipping: Add 5% plus $1.50 Insurance
(May vary according to weight)

California Residents: Add 6%, 6½% or 7% Sales Tax

©1989 Jameco Electronics 2/89

$20 Minimum Order

IBM is a registered trademark of International Business Machines

MasterCard — Mail Order Electronics • Worldwide — **Jameco ELECTRONICS**® — VISA®

1355 Shoreway Road, Belmont, California 94002

Data Sheets — 50¢ each
Prices Subject to Change
Send $2.00 Postage for a FREE 1989 CATALOG
FAX Numbers: 415-592-2503 or 415-595-2664
Telex: 176043

24 HOUR ORDER HOTLINE (415) 592-8097 • The Following Phone Lines Are Available From 7AM-5PM P.S.T.:
• Customer Service (415) 592-8121 • Technical Assistance (415) 592-9990 • Credit Department (415) 592-9983 • All Other Inquiries (415) 592-7108

CIRCLE 114 ON FREE INFORMATION CARD

What's New at
AMERICAN DESIGN COMPONENTS?

We warehouse 60,000 items at American Design Components–expensive, often hard-to-find components for sale at a fraction of their original cost!

You'll find every part you need—either brand new or removed from equipment (RFE) in excellent condition. But quantities are limited. Order from this ad, or visit our retail showroom and find exactly what you need from the thousands of items on display.

OPEN MON.–SAT., 9–5

THERE'S NO RISK!

With our 90-day warranty, any purchase can be returned for any reason for full credit or refund.

5¼" FULL-HEIGHT HARD DISK DRIVES

40Mb *(AT/XT Compat.)*
High speed, 40 ms. access time. Quantum #Q540
Item #17765 *New* – **$379.00**

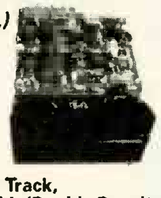
10Mb *(ST412 Compat.)*
Major manufacturers — *Get them while they last!*
Item #17199 **$99.00** ea.

5¼" HALF-HT. 10Mb HARD DISK DRIVES

10Mb *(IBM® Compatible)*
Mfr – NEC #D5124
Item #19704 *New* – **$99.00**

20Mb *(ST225 Compatible)*
Mfr – Olivetti #EM5520/2
Tested—Like New!
Item #20060 *New* – **$159.00**

5¼" FULL-HEIGHT DISK DRIVE *(IBM® Compat.)*



48 TPI, 40 Track, Double Side/Double Density
Tandon #TM100-2 or equiv.
Item #7928 **$79.00** New
2 for **$150.00** New

3½" MICROFLOPPY DISK DRIVE

1 Mb (unformatted), 135 TPI, 3 ms. access time. Power requirements: +12, +5 volts. Removed from operational computers — *TESTED — LIKE NEW!*
Mfr — NEC, model FD1035
Item #17171 **$79.00** ea.
2 for **$150.00**

COMMODORE PLUS 4 COMPUTER...

Built-in software includes a word processor, spread sheet, graphics, & filing system. Comes complete with power supply and instruction manual.
(Customer Returns — Tested Good!)
Item #19202 **$49.95**

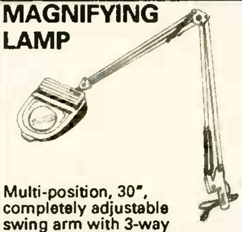
115 CFM MUFFIN®-TYPE FANS

115VAC; 60Hz.; 21W.; 28A.; 3100RPM; 5-blade model; aluminum housing. Can be mtd for blowing or exhaust. Dimen.: 4 11/16" sq. x 1½" D. Mfr: Howard Industries or equiv.
Item #1864 *New* – **$9.95**
W/Adjustable Speed Control
Item #20611 **$12.95**

27VDC MINI FAN... (12VDC)

12VDC; .20A.; brushless fan motor. Can be mtd. for cooling or exhaust. 5 plastic blades; aluminum housing. Dim.: 3⅛" sq. x 1½" deep. ,Mfr – FlowMax #3115PL-04W-B30-90
Item #16540 *New* – **$12.95**

MAGNIFYING LAMP



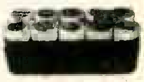
Multi-position, 30", completely adjustable swing arm with 3-way metal C-clamp. Has 4" diopter magnifying lens, w/ruler. Porcelain lamp socket & on/off switch; uses up to a 60W bulb. Color: beige. UL listed.
Item #13136 *New* – **$29.95**

NICAD BATTERY PACKS *(Rechargeable)*

"AA" Cells

12V @ 450ma
Contains 10 "AA" cells, connected in series. Recharge rate: 45ma., 16–18 hrs. Case w/tab output connex.
Dim.: 2 1/16" x 2¼" x 2 15/16"
Mfr – GE #123233
Item #5443 **$5.95** RFE

"Sub C" Cells



12V @ 1.2Ah.
Consists of 10 "Sub C" cells. Connected in series. Case w/tab output connex. Recharge rate: 100 ma. for 14–16 hrs.
Dim.: 4½" x 1¾" x 1⅞"
Mfr – GE or equiv.
Item #19677 **$9.95** RFE

"C" Cells

7.2V @ 1.25Ah.
Consists of 6 "C" cells. Connected in series. Recharge rate: 80–100 ma. for 16 hrs. Dim.: 6" x 1⅞" x 1". Major Mfrs.
Item #19676 **$9.95**

EXTERNAL DISK DRIVE CHASSIS

With 60W power supply fan cooled).
Can accommodate any of the following:
2 full-ht. drives .... *ADC* Item #7928
2 floppy drives .... #10005/17171
1 hard drive .... #19704
& 1 floppy .... #10005
Input: 115/230V, 50/60 Hz. Orig. for Burroughs computer. Dim.: 11"W x 8"H x 12"D
Item #14541 **$59.50**

STEPPING MOTORS for ROBOTICS...

Precision steppers with increments from 1 to 7.5°. Speeds up to 5,000 steps.

Fig. 1 Fig. 2

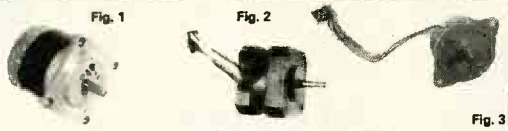


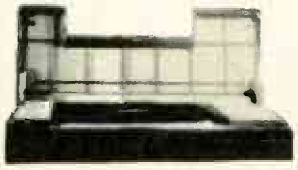
Fig. 3

Item No.	Step Angle	DC Voltage	Torque oz/in.	Type	Mfr. & Part No.	Dimensions	Fig.	Price
5275	1.8°	1.8	72	PM 2Ø	Superior MO61-FF-6201B	2"L x 2¼" dia. x 2¼"H	1	$19.95 ea. 2 for $37.50
7630	1.8°	3.0	200	PM	Superior MO92-FT-402	2"L x 2¼" dia. x 2¼"H	1	$34.50 ea. 2 for $59.50
16410	1.8°	12.0	700*	PM	Applied Motion 4017-839	1½" sq. x 1¼"D	2	$9.95 ea. 2 for $14.95
16406	3.6°	12.0	700*	PM	Applied Motion 4017-838	1½" sq. x 1¼"D	2	$9.95 ea. 2 for $14.95
7014	7.5°	12.0	900*	PM	Mitsubishi 55SI-25DAYA	2⅛" sq. x 1"D	3	$10.95 ea. 2 for $19.95

*Grams per Cm.

DISK DRIVES — MONITORS — COMPUTER COMPONENTS — INTEGRATED CIRCUITS — CAPACITORS — POWER SUPPLIES — VOLTAGE REGULATORS — OPTO ELECTRONICS — SEMICONDUCTORS —

THERMAL PRINTER
Dot Matrix—120 CPS



Print speed: 120 CPS; paper width: 8½". 80/132 columns/line. With RS-232 IBM serial interface. Operates on 115/230V, 50/60Hz. Hewlett Packard #HP2671A
Item #19705 **$79.00**
(Removed from working systems!)

ADAM COMPUTER ACCESSORIES...

CASSETTE DIGITAL DATA DRIVE...

Serial format. Search 80IPS, Read/Write 20IPS. 12V motor; 5V logic; 8- & 9-pin connector cables. Orig. designed for the *Adam*. Dimen.: 5"W x 3¾"H x 4"D.
Item #6641 *New* – **$19.95**

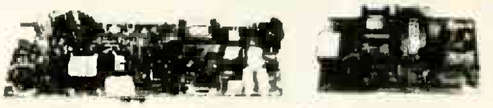
PRINTER POWER SUPPLY...
DC Output: -5V @ 200ma; +5V @ 3A; +12V @ 2.9A.; +18V @ 1A.
Item #6642 **$14.95**

ASCII KEYBOARD... 75-Key, 8-Bit, Serial Output
21 user-defined keys; 7-pin modular connection. Dimen.: 15"W x 2½"H x 6½"D.
Item #6643 *New* – **$19.95**

***ADAM/COLECOVISION* GAME CONTROLLERS...**
Can also be used w/Atari!
Set of 4...
Item #7013 *New* – **$9.95**

***ADAM* CASSETTES...**
Incl. Smart Basic, Buck Rogers & blank cassette. Item #7786
Baker's Dozen *New* – **$19.95**

SWITCHING POWER SUPPLIES...



Input Voltage: 115/230VAC, 50/60Hz.

Item No.	+5V	Output Voltages (DC) +12V	-12V	+24V	Mfr. & Part No.	Dimensions (L x W x H)	Price
17210	18.0	2.5	2.5		Sola #39-139	13" x 4½" x 1½"	$29.95
17897*	8.0	2.0	1.5		Power Systems #11627AY52021	8½" x 5" x 2½"	24.95
17223	4.0	.8	.2		Power Systems #1556	8⅝" x 5½" x 2"	19.95
5353	3.0	.17		2.2	Astec #AA11101	7⅜" x 6½" x 2"	19.95

*Mounted on base

NEON TRANSFORMER (Hi-Voltage)

7300 VAC @ 5 Ma.
May be used for powering neon lights, replacing oil burner ignition transformer, building Jacob's ladder (spark gap). Hi-voltage output: ¼ quick connect terminal & case ground input fully enclosed metal case. Wt. 12 lb. Base mt.: 4½"H x 5¼"W x 6⅞".
Item #151 *New* – **$14.95**

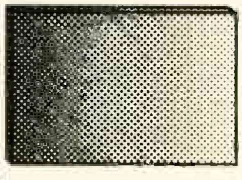
COLECOVISION Accessories...

EXPANSION MODULE #2
Play arcade quality driving & racing games on your *ColecoVision*. Incl. *Turbo* cartridge.
Item #13146 *New* – **$39.95**

ROLLER CONTROLLER
Gives full 360° game control. Hi-speed action of an arcade. Can be used w/the *Adam*. Incl. *Slither* cartridge.
Item #13147 *New* – **$39.95**

SUPER ACTION CONTROLLER SET
Gives you indiv. control of 4+ on-screen players. Includes *Baseball* cartridge.
Item #13148 *New* – **$39.95**

COPPER-CLAD PRINTED CIRCUIT BOARD *(Double-Sided)*



Glass coated, epoxy laminated. 1 oz. Double sided, .022" thick. Dimensions: 24"L x 18.5"H
Item #13606
3 sheets / **$9.95**

IC SOCKETS... *Low Profile...*

No. of Pins	IHM #	Price
8	13518	$ .11
14	7350	.12
16	7354	.13
18	13649	.15
20	7353	.18
22	16875	.19
24	1230	.20
28	12865	.22
40	7351	.30
64	16169	1.75

CIRCLE 106 ON FREE INFORMATION CARD

"The First Source"— for electromechanical & electronic equipment and components — AMERICAN DESIGN COMPONENTS!

12" EGA COLOR MONITOR
25 KHz — High Res...

Perfect for text, CAD, & other graphics. 8-color display. Scanning frequency to 25KHz. Res.: 752 x 410. Input: 110/220V, 50/60Hz., 75W. Mtd in metal chassis. Works ideally w/the EGA "Wonder Card." Diag. incl. Hitachi #CD1215-DTL

Item #18059 **$129.00**

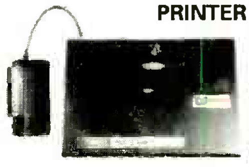
ATI Wonder Card — Item #19693 *New* – **$229.00**

9" COMPOSITE MONITOR...
Black & White

Input: 115VAC. Mounted in metal chassis. Mfr – Motorola #XM226-21.

Item #19694 *New* – **$22.95**

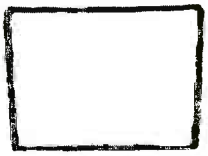
TIMEX-SINCLAIR...
2040 PRINTER



32-column – compatible with any of the Timex-Sinclair computers, as well as our PC8300 Computer. Uses standard $4^1/_2$" thermal paper.

Item #15851 *New* – **$39.95**

ANTI-GLARE SCREENS...
Glare & reflection filters that improve speed, accuracy, & operator comfort...



IBM PC Monochrome .... Item #19215
IBM PC Color .... Item #19216
AT&T Monochrome .... Item #19223
APPLE Macintosh .... Item #19225
COMPAQ Portable .... Item #19226

New – **$8.95** ea.; 2 for **$15.00**

WALL TRANSFORMER
12V @ 54VA

Output: 12VAC, 54VA Input: 120VAC/60Hz., .60Amps. With 7' power jack & 6' long AC plug. UL approved. Dimensions: 3"H x $4^1/_2$"W x 3" deep. Mfr – Ault #374-5412-0003

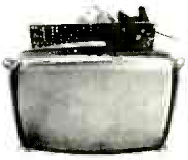
Item #19785 **$7.95** ea. or 2 for **$15.00**

COMPUTER/GAME ADAPTERS...

DC Output: +5VDC @ .9A, -5VDC @ .1A, +12VDC @ .3A
Input: 120VAC/60Hz., .25A
Coleco #55416 (black)
Item #1882 *New* – **$4.95**

DC Output: 9.5V @ 1A.
Input: 115VAC., 50/60Hz.
Commodore #251539-01/02 (black)
Item #9393 *New* – **$4.95**

TTL MONITORS...
(Open Frame)



9"– 12VDC Green phosphor. Schematic incl. Motorola #MD2003-190

Item #17198 *New* – **$19.95**

12"– 28VDC, green phosphor. Sub-assemblies, CRT, board & transformer incl. Comes w/hook-up diagram.

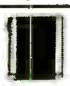
Item #6811 *New* – **$19.95**

RECORDING TAPE
$7^1/_2$" Reel, 2400 ft.

1/4 Mil. Bulk erased. Major mfrs.: Ampex, Scotch, etc. Item #6711.

15 reels for **$9.95**

CRYSTALS...
(Microprocessor HC-18U)



$1.29 ea.

MHz.	Item No.	MHz.	Item No.
1.8432	7915	10.738635	1953
3.579545	12361	12.0	7920
3.6864	13501	14.31818	7359
4.0	7045	16.0	13425
4.32	13041	18.0	13617
4.9152	13666	18.432	19332
5.0	13043	19.6608	12112
5.0688	6786	20.0	12360
6.0	12362	24.0	14117
6.144	13226	32.768	13911
7.3728	13502	48.0	7389
8.0	1957	64.0	20093
10.0	17727	122.666	7037

INTEGRATED CIRCUITS...

— STATIC RAMS —

TMM2016-100	2,048 x 8	$4.00	6116-3	2,048 x 8	$4.00
2101-45	256 x 4	1.75	6116-4	2,048 x 8	3.50
2102L-2	256 x 4	.99	6116LP-2	2,048 x 8	4.50
2114-150	1,024 x 4	1.25	6116LP-4	2,048 x 8	4.00
2114-200	1,024 x 4	.95	6264LP-12	8,192 x 8	10.50
2114L-2	1,024 x 4	1.00	6264LP-15	8,192 x 8	10.25
2148-55	1,024 x 4	3.49	6264LP-20	8,192 x 8	9.75
2149	1,024 x 4	2.49	62256LP-12	32,768 x 8	20.95
2167S-55	16,384 x 1	2.00	62256LP-15	32,768 x 8	19.95
MK4027N-4	4,096 x 8	2.00	6514	1,024 x 4	3.50
5101	256 x 4	4.95			

— DYNAMIC RAMS —

4116-150	16,384 x 1	$ 1.55	4164-250	65,536 x 1	$ 1.25
4116-200	16,384 x 1	.69	4416-120	16,384 x 4	10.00
4116-250	16,384 x 1	.49	4416-150	16,384 x 4	9.00
41256	262,144 x 1	15.00	4464-15	65,536 x 4	18.95
41464	64,536 x 4	18.95	511000P-10	1,048,576 x 1	39.95
4164-15	65,536 x 1	1.95	514256	262,144 x 4	69.95
4165-200	65,536 x 1	1.50	6665	65,536 x 1	1.50

— EPROMS —

TMS2516	2,048 x 8	$3.75	2764-45	8,192 x 8	$ 2.95
TMS2532	4,096 x 8	5.95	27C64	8,192 x 8	6.49
TMS2564	8,192 x 8	4.25	27128-25	16,384 x 8	5.95
2708	1,024 x 8	4.50	27C128-25	16,384 x 8	6.95
27L08	1,024 x 8	7.50	27128-30	16,384 x 8	5.45
2716	2,048 x 8	3.75	27256-25	32,768 x 8	5.95
27C16	2,048 x 8	5.49	27C256-25	32,768 x 8	7.95
2732	4,096 x 8	3.95	27512-25	65,536 x 8	11.75
27C32	4,096 x 8	5.95	27C512	65,536 x 8	14.95
2732-35	4,096 x 8	4.45	68764	8,192 x 8	15.95
2764-20	8,192 x 8	4.25	68776	8,192 x 8	15.95
2764-25	8,192 x 8	3.75			

— VOLTAGE REGULATORS —

7805T	$ .49	7905T	$ .49	7920T	$ .49
7806T	.49	7906T	.49	7805K	1.59
7808T	.49	7908T	.49	7812K	1.59
7812T	.49	7912T	.49	7905K	1.59
7815T	.49	7915T	.49	7912K	1.59
7818T	.49	7918T	.49	LM323K	4.50
7820T	.49			LM338K	3.95

...We carry a complete line of Computer & Game Accessories and Equipment...

...Please call or write with any other requirements!

OSCILLATORS...

$2.49 ea.

MHz.	Item No.	MHz.	Item No.
1.0	10268	11.0	10267
2.0	7980	15.360	10264
2.4	15478	16.0	8158
4.0	17020	17.6	16425
4.808	12118	18.432	13227
4.9152	9419	20.0	17262
5.0	10266	20.43468	12117
6.0	12113	22.2912	7357
7.0	12406	24.0	18005
7.3728	10181	28.0	18262
8.0	13038	30.0	12407
9.0	13228	51.2	10178
9.6	16421	64.0	17238
10.0	12408		

PC/XT/AT Compatible ENHANCED LAYOUT 101-KEY KEYBOARD

★ Membrane
★ 12 Function Keys
★ Separate Numerical Cursor
★ LED indicators for Scroll, Caps and Number locks
★ 1" inclination Foot Stand

Manufacturer #29079

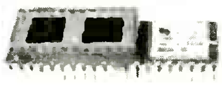
Item #19680 *New* – **$49.95**

SMART WATCH DS1216

DS1216 is a 28-pin, 6"-wide dip socket w/built-in CMOS watch function. Non-volatile RAM controller & lithium energy source. Accepts either 24-pin 2K x 8 or 28-pin 8K x 8 CMOS static RAM. Communication w/Smart Watch function is established by pattern recognition on a serial bit stream of 64 bits on D.O. Mfr — Dallas Semiconductor

Item #15939 *New* – **$29.95**

PROTOTYPING DEVICE w/EPROM INTERFACE — (Z8603)
Complete microcomputer



2Kb ROM; 128 bytes RAM; 32 I/O lines; up to 62Kb addressable extern. space ea.; 144 byte reg. file;. 124 G.P. reg.; 4 I/C port reg.; 16 status & contr. reg; Full duplex UART; 2 program. 8-bit counter/timers On-chip oscill. accepts crystal or external clock drive; 1.5V power supply. TTL compat.

Item #18515 **$24.95**

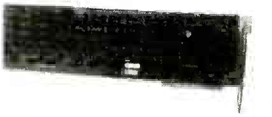
VOICE-ACTIVATED SWITCH

"Activate 'on' or 'off' with the sound of your voice, a whistle or clap..."

Ideal for robotics, lights, etc. Turns on w/the first sound & off w/the second. Solid-state units w/adjust. sens. control & pick-up microphone attached to PC board. Dim.: $2^3/_4$" x $3^1/_{16}$" x $^7/_8$". VOX input: 6–9VDC; can be used w/any standard battery. Item #16440.

3 switches / **$9.95**

DYNAMIC MEMORY BOARD



★ Software incl.
★ 0-256Kb memory in 64Kb increments
★ Fully socketed for easy upgrade (IBM parity checking)
★ Memdisk: simulates high-speed disk in RAM memory
★ Allows you to print while still using the computer

Techmar #MU203010 (w/o RAM)

Item #19977 *New* – **$29.95**

★ 64Kb RAM in sets of 9

Item #19983 *9 chips for* **$17.50**

AMERICAN DESIGN COMPONENTS, 815 FAIRVIEW AVE., P.O. BOX 220, FAIRVIEW, N.J. 07022

MINIMUM ORDER $15.

RE-289

YES! Please send me the following items —

Item No.	How Many?	Description	Price	Total

Total

Shipping & handling: we ship UPS unless otherwise specified. Add $3 plus 10% of total. Canadian: $3 plus P.O. cost. Charge only.

Sales Tax (N.J. residents only, please add 6% of total)

ORDER TOTAL

FREE! Fall '88 Catalog with every order!

☐ My check or money order is enclosed.
☐ Charge my credit card.
☐ Visa ☐ Master Card ☐ Amex

Card No. ____
Exp. Date ____
Signature ____
Telephone: Area Code ____ Number ____
Name ____
Address ____
City ____
State ____ Zip ____

All inquiries and free catalog requests—call (201) 941-5000.

For all phone orders, call **TOLL FREE 800–524–0809.** *In New Jersey call (201) 941-5000.*

CIRCLE 106 ON FREE INFORMATION CARD

America's Communications Leader Presents Its All-New 10-Meter SSB/CW Mobile Transceiver

Realistic, America's premier brand of scanners, CB radios and satellite TV systems introduces the HTX-100, the perfect first rig for a beginning Ham and a superb 10-meter mobile radio for any amateur. It's compact, yet loaded with "big rig" features.

Pushbutton Memory Tuning

An easy-to-program memory stores 10 favorite frequencies and mike-mounted pushbuttons permit safe and easy up/down frequency selection while you drive. A front-panel lock control prevents accidental frequency changes. You can fine-tune reception with the ±1.5 kHz RIT control. Coverage is 28.0 to 29.6999 MHz, USB or CW. Convenient semi break-in keying and CW sidetone are built in.

Ultracompact and includes everything you need for underdash installation

Selectable Power Output

You can select 25-watt or 5-watt QRP power output from the front panel. The HTX-100 has a backlit LCD frequency display with mode and tuning-step indicators. You also get a 5-step LED signal/RF power meter, noise blanker, hefty 3-watt audio output, high-quality built-in speaker, front-panel headphone jack and a rear-panel jack for adding an external speaker.

Join the Action on "10"

With improving band conditions and new Novice voice and digital privileges, the 10-meter fun is just beginning. Be a part of it with this affordable, top-quality transceiver! Only $259.95 and in stock today at our store near you.

Exclusively at

Radio Shack®

The Technology Store™

A DIVISION OF TANDY CORPORATION

Price applies at participating Radio Shack stores and dealers

FREE 184-Page Radio Shack Catalog! Write Dept. 452, 300 One Tandy Center, Fort Worth, TX 76102

CIRCLE 78 ON FREE INFORMATION CARD

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

Free Information Number		Page
176	ACS Supply	93
108	AMC Sales	28
107	All Electronics	119
—	Amazing Concepts	132, 117
106	American Design Components	128
76	Associated Electronics/3M	18
191	Atlantic Cable Distribution	114
77	B&K Precision	33
181	Banner Technical Books	88
98	Beckman Industrial	7
85	Blue Star Industries	93
109	C & C Sales	5
188	CEI	116
60	CIE	31, 70
50	Caig Laboratories	24
—	Cary Distribution	90
54	Chemtronics	32
—	Command Productions	94
177	Communications Specialists	82
58	Cook's Institute	32
185	Crystek	90
127	Deco Industries	93
82	Digi-Key	130
187	Digimeter	93
—	Digital Research Computers	114
—	Educalc Publications	3
—	Electronics Book CLub	56
—	Electronic Tech. Today	77
121	Fluke Manufacturing	CV2
—	Grantham College of Engineering	50
86	Heathkit	16
184	ICS Computer Training	88
—	ISCET	116
65	J & W	34
59	JDR Instruments	17
113, 170	JDR Microdevices	120, 121
171, 172	JDR Microdevices	122, 123
173	JDR Microdevices	124
114	Jameco	126
104	Jan Crystals	94
—	Joseph Electronics	27
—	Lindsay Publications	69
87	MCM Electronics	125
53	MD Electronics	132
—	Mainline Supply	92
93	Mark V. Electronics	115
—	McGraw Hill Book Club	38
—	McGraw Hill (C.E.S)	85
61	Microprocessors Unltd.	102
—	NRI	21, 53
186	Optoelectronics	25
—	Pacific Cable	113, 114
56	Parts Express	118
101	Pomona Electronics	23
78	Radio Shack	131
190	SCO Electronics	28
—	Scope Electronics	CV4
182, 183	Sencore	CV3, 15
74	Solid State Sales	117
—	Star Circuits	24
92	Tektronix	8
180	U.S. Instrument Rentals	13
189	United Electronics Supply	86
179	WPT Publications	82

Gernsback Publications, Inc.
500-B Bi-County Blvd.
Farmingdale, NY 11735
1-516-293-3000
Fax 1-516-293-3115
President: **Larry Steckler**
Vice President: **Cathy Steckler**

For Advertising ONLY
1-516-293-3000
Fax 1-516-293-3115
Larry Steckler
publisher
Arline Fishman
advertising director
Shelli Weinman
advertising associate
Lisa Strassman
credit manager
Christina Estrada
advertising assistant

SALES OFFICES

EAST/SOUTHEAST
Stanley Levitan
Eastern Sales Manager
Radio-Electronics
259-23 57th Avenue
Little Neck, NY 11362
1-718-428-6037, 1-516-293-3000

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Midwest Sales Manager
Radio-Electronics
540 Frontage Road—Suite 339
Northfield, IL 60093
1-312-446-1444
Fax 1-312-446-8451

PACIFIC COAST/ Mountain States
Marvin Green
Pacific Sales Manager
Radio-Electronics
5430 Van Nuys Blvd. Suite 316
Van Nuys, CA 91401
1-818-986-2001
Fax 1-818-986-2009

Find The Defective Capacitors, Coils, Resistors, SCRs And Triacs That All Other Testers Miss . . .

Presenting a new, improved, dynamic and mistake proof LC Analyzer that finds defective components all other testers miss.

• Dynamically tests capacitors for value from 1 pF to 20 F, leakage with up to 1000 volts applied, dielectric absorption and equivalent series resistance (ESR).

• Dynamically tests inductors, in-or-out of circuit, from 1 uH to 20 Henrys for opens, shorts, value, and detect even one shorted turn.

• Dynamically test SCRs, Triacs, High Value Resistors, and locates the distance to within feet of an open or short in a transmission line for an added bonus.

• Automatically makes all of the tests, compares them to EIA (Electronic Industries Association) standards and reads the results as Good or Bad. Enter all information right from the component without look-up charts, calculations, or errors.

• Extends your testing capability to places where an AC cord won't reach, with rechargeable 9 hour battery or AC operations.

• An added feature alerts you that the fuse has opened, and that there may be residual high voltage on the component under test.

New!

With The All New, LC102 AUTO-Z™ Automatic Capacitor-Inductor Analyzer.

Four Patents

CIRCLE 182 ON FREE INFORMATION CARD

THE Z STANDARD

It's like having your own Standards Engineer with you at all times.

Call 1-800-843-3338

In Canada Call 1-800-851-8866

SUPER VALUES!

B&K 40 MHZ OSCILLOSCOPE

SAVE $250 ■ 20 Calibrated sweeps ■ 6″ CRT with internal graticule and scale illumination ■ Video sync separator ■ Single sweep ■ X-Y operation ■ Z axis output ■ V mode displays 2 unrelated frequency signals ■ Two 10: 1 direct probes

Reg. $848.00

Our Price $598.00

Model 1541A

COBRA® RADAR DETECTOR Trapshooter®

SAVE $60 ■ Mounts on dash, visor — even windshield ■ Graduated signal strength meter ■ 2 power cords for permanent or detachable installation ■ City/highway switch ■ X and K band indicators ■ 3 anti-falsing circuits

Reg. $199.95

Our Price $139.95

Model RD-3168

ALL PURPOSE 92-Pc. TOOL CASE

SAVE $40 ■ Complete with everything you need for home, shop, auto ■ Includes 52-pc. socket set with ratchets and extenders ■ 2 tool pallets with roomy rear storage compartments ■ Rugged, handsome carry case

Reg. $169.95

Our Price $129.95

Model FTK-28

ASK FOR FREE CATALOG.

FREE BONUS

VM-520 20K OHM/Volt Multi-tester with purchase of any item on this page. Sale Prices and BONUS Offer expires 1/31/89.

SCOPE ELECTRONICS

260 Motor Pkwy., Hauppauge, NY 11788

TOLL FREE 800-648-2626

(In NY State 800-832-1446 Ext. 242)

TELEPHONE ORDERS NOW!

VISA · MasterCard · AMERICAN EXPRESS

Money orders, checks accepted.

C.O.D.'s require 25% deposit.

Service & Shipping Charges Continental U.S.A.

FOR ORDERS	ADD
$0-50	$ 4.50
$51-100	$ 5.50
$101-200	$ 7.00
$201-300	$ 8.00
$301-400	$ 9.00
$401-500	$10.00
$501-750	$12.50
$751-1,000	$15.00
$1,001-1,250	$17.50
$1,251-1,500	$20.00
$1,501-2,000	$25.00
$2,001 & Up	$30.00