Stop those annoying wrong telephone numbers!!!

Build our add-on and STOP WRONG NUMBERS

Automate your home

Build our HOME CONTROL COMPUTER

Should I buy that new ink-jet printer?

WHAT'S NEW IN COMPUTER PRINTERS

New back-to-school series starts this issue

DESIGNING WITH LINEAR IC'S

PORTABLE AND TOTABLE COMPUTERS

Are they more than just toys?

DON'T GET STUCK

What to look for when buying new software
Now there's a new breed of Beckman hand-held DMMs tough enough to withstand accidental drops, input overloads and destructive environments.

The new HD100 and HD110 DMMs are drop-proof, packed with overload protection and sealed against contamination. You won't find more rugged meters than the Beckman HDs. Inside or out.

**Drop Proof**
- Constructed of double-thick thermoplastics, the HD100 series DMMs resist damage even after repeated falls. All components are heavy-duty and shock mounted.

**Contamination Proof**
- The HD series meters are designed to keep working even around dirt, heavy grime, water and oil. The special o-ring seals, ultrasonically-welded display window and sealed input jacks protect the internal electronics of the HD meters. The oops-proof meters are sealed so tightly, they even float in water.

**Accidental Overload Protection**
- All DC voltage inputs are protected up to 1500 Vdc or 1000 Vrms. Current ranges are protected to 2A/600V with resistance ranges protected to 600 Vdc. Transient protection extends up to 6KV for 10 microseconds.

**More Meter for Your Money**
- For starters you can get 2000 hours of continuous use from a common 9V transistor battery. You can run in-circuit diode tests and check continuity. You even get a one year warranty.
- The 0.25% basic dc volt accuracy HD meters serve you with 7 functions and 27 ranges. The HD 110 also gives you 10 AMPS ac and dc. With one simple turn of the single selector switch, you can go directly to the function and range you need. There's less chance of error.
- Also available is the electrical service kit. It includes the meter of your choice, a current clamp, deluxe test leads and a heavy-duty case designed to carry both meter and accessories, conveniently.
- Feature for feature you can't find a more dependable meter with prices starting at just $169 (U.S. only).
- To locate your nearest distributor, write Beckman Instruments, Inc., Instrumentation Products, 2500 Harbor Blvd., Fullerton, CA 92634 or call (714) 993-8803.

BECKMAN
A new concept in sitting.

THE BACK CHAIR

CONVENTIONAL CHAIR
Sitting in a conventional chair forces your lower back forward, creating excess stress on your spine & back muscles.

THE BACK CHAIR
The Back Chair allows you to sit comfortably with your spine & back muscles in perfect alignment.

THE FIRST INTELLIGENT CHAIR
Consider the alternative – THE BACK CHAIR, the new chair designed with one goal in mind, the care of your back, spine, health & well-being.

REDUCE THE EFFECT OF GRAVITY ON YOUR BACK
If you're sitting regularly in a conventional chair, your lower back is supporting the total weight of your body, plus additional weight due to the downward effect of gravity on your body. No wonder millions of people complain about backaches every year! Most doctors have long recognized that many back and neck problems are the result of improper posture when sitting. Unfortunately most chairs are designed for appearance, not for the health of your back. The BACK CHAIR'S therapeutic design was created by a team of designers collaborating with doctors and physical therapists.

THE BACK CHAIR SOLUTION
Sitting on the BACK CHAIR relieves your back from supporting the total weight of your body by distributing the weight between your lower back and legs. The BACK CHAIR design is nothing more than simple common sense. Your legs support you when standing, your lower back supports you when sitting – combine them both in a comfortable sitting posture and you relieve the unnecessary stress on your back. When sitting on the BACK CHAIR you'll surprisingly feel much more relaxed, you'll sit up absolutely and comfortably straight, and with the pressure off your lower back you'll breathe deeper with less effort. At home or especially at work the BACK CHAIR will help you in improving your posture and enhance your fitness and exercise program throughout the day. Made of multiple layers of hardwood with a final layer of oak, the BACK CHAIR assembles in 15 minutes with a screwdriver. Enjoy one for two weeks as our guest and see how intelligent chair design can soothe your aching back and greatly improve your sense of wellbeing throughout the day.

SHOP FASTER BY PHONE
1 - 805 - 966 - 7187

Or send a check or your credit card # (Diner's Club, VISA, MasterCard, American Express) for THE BACK CHAIR @ $89.95 ea. plus $5.95 shipping (Canadian orders $13.00 shipping). CA residents add 6% sales tax. Sorry no C.O.D. If not satisfied return within 15 days for a refund (less shipping).

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</table>

STARSHINE OF SANTA BARBARA
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CE price $264.00 NEW LOW PRICE
8-Band, 16 Channel • No-crystal scanner
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Beep, Scan, and Retune modes. A.F.M.
AM band, Auto Navigation Band, Fish & Game, Immigration, Paramedics, Amateur Radio, Jus-
tice Department, State Department, plus thou-
sands of restricted channels. No other scanner is programmed to pick up.

Regency® MX3000
List price $599.95 CE price $379.00
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Sidetone liquid crystal display
Frequency range: 30-50, 144-174, 440-512 MHz.
The new handheld Regency MX1000 is fully
keyboard programmable for the ultimate in versatility. You can tape to 20 channels any time. When you activate the priority control, you automatic-
ally override all other calls to listen to your favorite frequency. The LCD display is even side-lit for night use. A die-cast aluminum chassis makes this the most rugged and durable handheld scanner available. There is even a backup lithium battery to main-
tain memory for two years. Includes wall charger, carrying case, belt clip, and nicad battery. Reserve your Regency MX1000 now.

Regency® R106
List price $149.95 CE price $92.00
5-Band, 10 Channel • Crystal scanner
AC/DC
Frequency range: 30-50, 146-174, 440-512 MHz.
This scanner offers Public service service, plus
Air and FM broadcast stations. You can listen to 
Bach or a Boeing 747, the Rolling Stones or 50 channels. 
100% solid state. A.C. and D.C. 
input. Ideal for police, fire, emergency, anyone of your favorite channels.

Regency® R1040
List price $199.95 CE price $124.00
6-Band, 10 Channel • Crystal scanner
AC/DC
Frequency range: 30-50, 144-174, 440-512 MHz.
Now you can enjoy even more scanner ver-
satility at a price that’s less than some crystal units. The Regency R1040 lets you in on all the action of police, fire, emergency and more.

Regency® MX3000
List price $299.95 CE price $181.00
6-Band, 30 Channel • No-crystal scanner
Search • Lockout • Priority • Scan delay
Channel Handheld crystal scanner
Bands: 30-50, 144-174, 440-512 MHz.
The Regency Touch MX3000 provides the ease of 
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check box. You’ll even hear a “beep” tone
that lets you know you’ve made contact.
In addition to scanning the programmed 
channels, the MX3000 has the ability to scan through too much and retain frequency for an active
New Limited-time offer: The MX3000 includes channel 1
priority, dual scan speeds, scan or delay
and a brightness switch for day or night operation.

NEW! Regency® Z30
List price $269.95 CE price $179.00
6-Band, 30 Channel • No-crystal scanner
Bands: 30-50, 144-174, 440-512 MHz.
Cover your choice of over 15,000 frequencies on 30 channels at the touch of your finger.

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Panasonic RF-799 Shortwave receiver
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Panasonic RF-2900 Shortwave receiver
$399.00
Panasonic RF-8350 Shortwave receiver
$195.00
Panasonic RF-8350 Shortwave receiver
$239.00
Panasonic RX-6300 Shortwave receiver
$539.00
Bearcat® 350 Scanner
$399.00
Bearcat® 200 Scanner
$399.00
Bearcat® 250 Scanner
$259.00
Bearcat® 20/20 Scanner
$289.00
Bearcat® 151 Scanner
$169.00
Bearcat® 100 Scanner
$289.00
Bearcat® Five-Scanner
$129.00
Bearcat® 2000 Shortwave Receiver
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Freedom Phone 400 Cordless telephone
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$139.00
SP50 Carrying case for Bearcat Five-Scanner
$15.00
SR-4000 Radio Frequency Directory
$15.00
CE/Military
$12.00
TSG "Top Secret" Registry of U.S. Government Fre-
quencies
$15.00
ESD Energy Services Directory
$10.00
ASD Frequency Directory for Aircraft Band
$10.00
SRA Survival Radio Frequency Directory
$12.00
$12.00
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$12.00
A.C. 12 Volt for special use
$12.00
1.2 A-C Car-Certified batteries (set of four)
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A.T.C. Crystal Case Certified
$12.00
A.M0 Magnet mount mobile antenna
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Add $3.00 shipping for all accessories ordered at the same time.
$12.00 per short wave, $25.00 per U.S.P.S. add $3.00 shipping per scanner. 

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For Canada, Puerto Rico, Hawaii, Alaska, or 
anywhere outside U.S., you are responsible for shipping charges up to $50.00 for single 
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ON THE COVER

Owners of personal computers know that one of the natural uses for those devices is as a controller for the appliances, lights, or what have you in your home. But if you use it for that, your computer can not be used for any other task at the same time. This month we show you a way around that problem—a computer that you can build that's specifically for use as a controller. The story begins on page 47.

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"Your Own Computer" has appeared as a special section in Radio-Electronics, twice a year, for the past several years. It has ranged from as small a section as 16 pages to as large a section as 101 pages.

We know from the mail that our editors received that there is great reader interest in personal computers and we intend to continue our coverage of the subject.

However, instead of occasional, large-space sections, we will report on a regular, consistent basis with 16-page units in every issue of Radio-Electronics.

I want to emphasize that this will be an expansion of our editorial content; a bonus to Radio-Electronics readers over and above the regular features to which they are accustomed on every facet of the fast-moving world of electronics—video, computers, stereo, MRO, servicing, and technology.

So, starting next month, in the May issue of Radio-Electronics, you will find a special 16-page tear-out section titled, "ComputerDigest". It is a complete magazine within a magazine.

It's entirely possible that continued reader response may encourage us to convert this section into a separate magazine rather than an insert within the covers of Radio-Electronics.

So watch for Volume I Number I of "ComputerDigest". We think you'll like it!

And this month, enjoy "Your Own Computer".

LARRY STECKLER
Publisher
Tek's best-selling 60 MHz scopes: Now 25 ways better for not a penny more!

Now Tek has improved its 2213/2215 scopes with brighter displays. Greater accuracy. And more sensitive triggering. At no increase in price.

The 30 MHz 2213 and dual time base 2215 have been the most popular scopes in Tektronix history. Now, Tek introduces an "A" Series update with more than 25 specification and feature enhancements — things you have asked for such as single sweep — all included at no added cost.

A brighter display and new vertical amplifier design provides sharp, crisp traces. That makes the 2213A/2215A a prime candidate for tasks like TV troubleshooting and testing, where fast sweeps are typical.

New features include 10 MHz bandwidth limit switch, separate A/B dual intensity controls (2215A only), and power-on light; additions customers have suggested for giving these scopes the final measure of convenience.

Triggering, sweep accuracy, CMRR and many more major specifications are better than ever.

Check the performance chart: not bad for scopes already considered the leaders in their class!

The price: still $1200* for the 2213A, $1450* for the 2215A. Or, step up to the 100 MHz 2235 for just $1650*!

You can order, obtain literature, or get expert technical advice, through Tek's National Marketing Center. Direct orders include operator manuals, two 10X probes, 15-day return policy, world-wide service backup and comprehensive 3-year warranty.

Talk to our technical experts.

Call toll-free: 1-800-426-2200 Ext. 153.

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DIGITAL TV DELAY?

The planned introduction of digital television sets in the United States this year could stretch out into 1985. ITT Semiconductors is said to be behind schedule in delivering the VLSI ICs. At least some of the delay is attributed to the fact that American manufacturers wanted such special features as automatic tint-correction and comb filter as part of the special NTSC-system IC. The two manufacturers known to be planning to field digital sets—General Electric and Zenith—say there's still hope they'll introduce the sets late this year, but full-scale deliveries may not start until 1985.

GERMAN TVs—MADE IN U.S.

The newest American TV brand name is an old familiar German one—Grundig. An American-owned firm, Display Devices, Inc., has purchased a former TV-cabinet plant in Monticello, IN from RCA and will assemble color-TV sets from modular kits produced in Germany by Grundig, one of Europe's largest television manufacturers. The company will specialize in deluxe sets, priced in the same range as those from Sony, JVC, and Mitsubishi. It plans to have a capacity of 120,000 sets a year to start. Grundig will be the 13th foreign brand to have assembly operations in the U.S.—all of the others are Japanese, Korean, or Taiwanese.

"NEW LOOK" FOR TV

RCA has revealed a two-step plan to change the appearance of the television set in the United States. Though the Japanese were first to announce the FST (Flatter Squarer Tube), a tube with a flatter faceplate and squared-off corners, RCA has outlined the American approach to the new look—and it will make the transition in two steps. The first step will be squaring off the corners without flattening the faceplates, with new versions of the 25-, 19- and 13-inch tubes in completely rectangular shapes—measured diagonally as 26, 20, and 14 inches. These FS (for Full Square) tubes will be followed by two new tubes to be called SP (Square Planar). The SP tubes are computer-designed and have a surface that appears flat, but actually is in the shape of a plateau when viewed in profile. RCA will make SP tubes available in 27- and 20-inch sizes.

The FS tubes, whose faceplates have the same curvature as today's tubes, will start appearing in TV sets this summer. RCA thinks that the introduction of the new tube sizes means the end of the line for the 25-inch tube in 1986 or 1987, while the 19-inch will last a little longer because it will fill a need in the more price-competitive smaller-screen area.

VHS vs. BETA

Although Sony claims that the Beta format is increasing its share of the market thanks to the new Beta Hi-Fi sound system, the VHS format appears to be gaining new adherents in the VCR-format race. The two developers of the competing Video-2000 format in Europe—Philips and Grundig—both will be introducing VHS recorders there this year. Sanyo, a pioneer Beta follower, already is producing VHS recorders through its subsidiary, Tokyo Sanyo, which is making them for sale under the Fisher label. Zenith, which has been marketing Sony-made Beta VCRs, is expected to add VHS recorders this year. Toshiba, a pioneer in the Beta group, will make VHS recorders in Europe for sale there. And another Beta proponent, NEC, probably will add VHS soon. Sony, the inventor of Beta, says it will not succumb to VHS fever and will continue to field Beta recorders only, although it manufactures cassettes for both Beta and VHS formats. VHS recorder sales outnumber Beta by at least three to one.

DBS GETS STARTED

The first direct-to-home satellite broadcasting system, owned by United Satellite Communications Inc. (USCI), is now transmitting to homes in the East and Midwest. The initial transmissions are on three channels, to be increased to five, on a monthly subscription basis. Radio Shack is the exclusive sales agent for the receiving equipment, which it sells for $750 installed (including a four-foot dish) if the buyer subscribes for at least one year's service at $29.95 monthly. Radio Shack will also lease the receiving systems at $300 for installation plus $39.95 monthly for one year (reception service included). RCA Service Co. is handling installation and service.
The Digital vs. Analog battle is over.

$85 buys you the new champion.

The new Fluke 70 Series.

They combine digital and analog displays for an unbeatable two-punch combination.

Now, digital users get the extra resolution of a 3200-count LCD display.

While analog users get an analog bar graph for quick visual checks of continuity, peaking, nulling and trends.

Plus unparalleled operating ease, instant autoranging, 2000+ hour battery life and a 3-year warranty.

All in one meter.

Choose from three new models. The Fluke 73, the ultimate in simplicity. The feature-packed Fluke 75. Or the deluxe Fluke 77, with its own multipurpose protective holster and unique "Touch Hold" function (patent pending) that captures and holds readings, then beeps to alert you.

Each is Fluke-tough to take a beating. American-made, to boot. And priced to be, quite simply, a knockout.

For your nearest distributor or a free brochure, call toll-free anytime 1-800-227-3800, Ext. 229. From outside U.S., call 1-402-496-1350, Ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

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<th>Audible continuity</th>
<th>Touch Hold</th>
<th>2000+ hour battery life</th>
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* Suggested U.S. list price, effective October 1, 1983.

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COOL IC'S
A major advance in semiconductor cooling techniques was announced last month by YoYodyne of Los Angeles. The encapsulating material of the semiconductor is cast with a series of channels buried inside it. All the channels are interconnecting and join a pair of common input and exhaust fittings at one end of the IC (see above). A small gate valve is incorporated in the device and it controls the flow of coolant being pumped through the IC by a compressor located on the circuit board. YoYodyne claims that one compressor can adequately cool up to twelve standard 7400 series IC's and that power requirements are minimal, although the special compressor used in the new technique requires a separate three-phase, 440-volt line.

The actual coolant can be as simple as distilled water, but a special fitting is needed if a pressurized refrigerant such as freon is used. Preliminary literature from YoYodyne indicates that the results of supercooling have produced dramatic results. A standard 78-series regulator didn't fail until over three hundred amperes were drawn from it. That was accomplished by using liquid nitrogen as a coolant, and YoYodyne was quick to point out that the techniques involved were still "in the early experimental stages."

CALLING DICK TRACY
Rumors that have been flying around the computer industry for months were confirmed at last November's Comdex show in Las Vegas. A new breakthrough in ULSI (Ultra Large Scale Integration) fabrication techniques has produced a new computer. All the circuitry needed for the device is contained on one chip that is housed in a package that measures less than 1/4-inch square. The display is an improved version of the LCD's currently being used in miniature TV sets. The increased efficiency of the new LCD's, however, has made possible resolution fine enough to feature an 80 × 24 character display, with each character being formed by an impressive 18 × 26 matrix. The keyboard for the new computer is similar to the ones found on the calculator watches, and features 56 keys for input of a complete ASCII character set including upper- and lower-case letters. Because of the single IC design, the computer measures only 1 × 2 inches. It is powered by body heat, with a silver-oxide battery for memory backup. Dubbed the Wrist Computer, it is available with either a stainless steel or brushed gold finish. An executive, deluxe model is planned that will have all of the above features as well as a numeric keypad and ten user-definable keys.

NICE DAY
The American National Standards Institution has announced the introduction of a new symbol to be incorporated in the standard ASCII character set (see above). The code will be 96 decimal or $60h. A spokesman said that this was only the beginning of a new series of characters to be introduced over the next year or so.

QUICK NOTES
Sosy Corporation has announced a working prototype of the long expected "TV on a chip." At the present time the prototype IC measures 2 × 3 feet, and is 6 inches thick.

The FCC is considering standards for stereo CB-transmission.

BCB has introduced a new series of fast-recovery diodes designated the FR4000 series. Those are special application parts that feature two paralleled inverted diodes on the same substrate. As a result they will pass current in either direction and BCB engineers claim that new doping techniques make the voltage drop across the diode less than one microvolt in either direction.

Ball Labs has announced the discovery of a new atomic particle, the anti-neutrino. According to the report issued by the researchers, the particle has all the characteristics of the neutrino but is opposite in charge.
Do your skills suffer from half-life crisis?

Five years is the average half-life of technical information. Skill upgrading is critical because, every five years, half of your electronics skills can become outdated. But Heathkit/Zenith Educational Training Systems will put you back in the lead. We've helped thousands keep pace with high-tech self-instruction courses. From fundamentals to state-of-the-art. Learn more about us. We can pull you through the half-life crisis.

FUNDAMENTAL ELECTRONICS
A complete six-course core curriculum covering DC and AC Electronics, Semiconductors, Electronic Circuits, Electronic Communications and Test Instruments.

DIGITAL AND MICROPROCESSORS
Six comprehensive courses spanning the spectrum of Microprocessor Technology. From Digital Techniques through Microprocessors to the latest in Voice Synthesis.

ADVANCED MICROPROCESSING
A valuable course in advanced 16-bit Microprocessor Technology. Course uses a new state-of-the-art trainer that becomes a fully capable 16-bit computer.

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A complete, comprehensive education in robotics theory and applications. Train on "HERO 1," a mobile programmable robot with arm, gripper, voice and sensors.

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Seven exceptional courses for overview, or beginning training: Soldering, Printed Circuits, Concepts of Electricity or Microprocessors plus Automotive Electronics and Ignition Systems.

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Eight courses on operating systems and languages: MS-DOS, CP/M, Assembly, BASIC, MBASIC, Pascal, FORTRAN and COBOL.

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ROBOTICS TECHNOLOGY
INDUSTRIAL ARTS
COMPUTER PROGRAMMING
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NEW VIDEO COURSES
COMPUTERS OR TEST EQUIPMENT
ALL COURSES

Mail to: Heathkit/Zenith Educational Systems Heath Company, Dept. 020-166 Benton Harbor, MI 49022
Scientific-Atlanta has introduced a dual-beam prime-focus feed assembly designed to receive simultaneous signals from two adjacent C-band satellites spaced 3° or 4° apart. The new dual-beam device, which can be used with 4.6- and 5-meter earth stations, allows single-dish reception from Satcom IIIR and Galaxy I, the major cable programming birds.

Paradigm Manufacturing has incorporated an innovative hub design and rib configuration in its new 3.8-meter aluminum-mesh antenna. The new design is said to improve structural integrity and reduce weight. A redesigned LNA tube support increases rigidity and reduces noise temperature and side lobes for the polar-mounted, eight-rib unit. (Paradigm Manufacturing, 6911 Eastside Road, Redding, CA 96001)

National Microtech has introduced the Apollo Elite receiver/dish-rotator system. The receiver and the rotator-control units feature individual microprocessors and an infrared remote-control unit with a 25-foot range (see photo). All remote command functions can be sent to either the receiver or rotator control units. Thus, you can mount one unit at each of two TV's and use your remote control at either location to change the channel, volume, antenna, or audio fine tuning. The system can be programmed for up to 100 satellite locations. (National Microtech, PO Drawer E, Grenada, MS 38901)

Hughes Communications has asked the FCC for permission to build and launch two Galaxy satellites using the Ka-band (30 GHz), a virtually unused part of the spectrum that could handle several times the capacity of current birds. The $450 million Hughes system has a 1988 timetable and will mainly be used for teleconferencing, data transmission, and paging signalling services. The medium-powered satellites would send signals to two-meter dishes via "spot beams" aimed at 150-mile radius areas around 16 major cities.

"Personal Satellite Phone," a five-pound cordless communicator, has been proposed as a system to take advantage of two electronic ranges: portable phones and satellite transmission. Skylink Corp., a Colorado firm, is seeking FCC authorization to develop the service that will use a high-powered satellite to relay voice and data signals from Personal Satellite Phones into the conventional phone system. Skylink sees the system as one which will let people talk from vehicles as well as from remote areas. The Skylink system could be launched by 1987. (Skylink, 3000 Pearl St., Boulder, CO 80301).

Warner Electronic Home Services hopes to launch a video-on-demand retrieval system in Pittsburgh by mid-1984. The service, a spin-off of Warner Amex Cable's QUBE interactive technology, would offer text as well as full video images that could be requested by viewers using a hybrid arrangement involving phone lines and cable-TV circuits. Videodisc players at the cable-TV offices would feed short programs—including music-video clips, teleshopping demonstrations and other material—directly into customers' homes.
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OOOOOPS!

For those of you who want to order a kit of parts for the MHD generator that we described in our February issue, the correct address is: Images Co., PO Box 313, South Richmond Hill Station, Jamaica, NY 11419. (The address given in the Parts List had the box number omitted.)

Readers: don't forget to let us know about your results with MHD generators!—Editor

SHORT PROGRAM

Radio-Electronics, my favorite hobby magazine, has given me so many usable ideas that I would like to pass on an item that may be of help to those who, like me, are still learning how to write good programs for the Sinclair ZX81 and the Timex/Sinclair 1000. Although those computers provide a total of 24 lines on the screen, the lower two are reserved for inputs and reports, unlike several other home or hobby computers. The 22 remaining lines are often just one or two lines short of what a programmer would like the computer to display.

The short program below will result in screen printing on the bottom two lines, lines 22 and 23 in the Sinclair line-numbering method, which numbers the top line as "0." The first two statements provide the text input for lines 22 and 23 respectively. Warning: neither text can exceed 32 characters in length.

9000 LET A$ = "(INSERT TEXT FOR LINE 22)"
9001 LET B$ = "(INSERT TEXT FOR LINE 23)"
9002 FOR N = 0 TO LEN A$ - 1
9003 POKE (727 - N + PEEK 16396 + 256*PEEK 16397), CODE A$
9004 NEXT N
9005 FOR N = 0 TO LEN B$ - 1
9006 POKE (760 + N + PEEK 16396 + 256*PEEK 16397), CODE B$
9007 NEXT N

If the display on line 22 only is wanted, delete statements 9001, 9005, 9006 and 9007. If line 23 only is wanted, delete statements 9000, 9002, 9003, and 9004.

The computer will probably crash if either line of text exceeds 32 characters, or if any character is used that takes up more than one space. Thus, characters like "", "", the quote image, and "", the exponent operator, cannot be used.

This method of obtaining screen printing on the bottom two lines is much simpler than poking the print-position system variable, 16398, 16399, as hinted at by the ZX81 manual. Note that this program does not POKE...
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the D_FILE system variable, an action that the manual warns against, but finds the D_FILE start address and then poxes the desired character codes into the addresses of the display file proper.

Any report from the computer will overwrite the first several characters of line 23, which is only occasionally a problem when a program is run. If the program here is typed in for a test by itself, a program line such as PAUSE 4E4 can be added. Then pressing any key except SHIFT will "unlock" the computer and display the overwriting report.

If printout on lines 22 and 23 is used several times in a program, it might be best to use statements 9302 through 9007 as a subroutine. Don't forget to add the RETURN statement. The main program would then need only statements 9000 and 9001. If one or the other, only, of the two lines is wanted at a particular place in the program, the empty string can be the text for the unwanted line.

H. E. FELTHAUSER
Mabank, TX

NEED FULFILLED

Congratulations to you and your publication for remaining a magazine dedicated to the electronics enthusiast and not going the way of all the other electronics publications (into computers). This is the first time that I have ever written to a publication in this way, and I will say that if your publication changes over to computer articles, or leans heavily toward computer circuitry and accessories, then I will cancel my subscription.

Computers have a place in our society, but let the others in the electronics field go that way—as most of them have done.

This country needs a publication like yours, so that the younger generation has a place to learn and experiment with the many projects that your magazine has published in the past and, I hope, will continue to print. I have enjoyed the many articles printed over the years, so please continue that way and thanks for a job well done.

RONALD STORCK
Dallas, PA

TRANSIENT SUPPRESSOR

In reference to the "Transient Suppressor" article in Radio-Electronics, September 1983: That item sounds like a good thing to have, however, I would like to discuss a safety problem. The article shows the line neutral, the white wire, being switched by the relay. That is an extremely unhealthy practice. The hot side of the line, the black wire, remains unswitched as shown in the article. Even though the device has its current path interrupted by the relay, whatever is plugged into the receptacle still has full line voltage from the hot (black wire) side of the line. An accidental ground path through a person who believes that the device is off can occur even when relay R1 is unatched. The suggestion of adding an ON/OFF switch in the article further increases the chance of an electric shock.

I would suggest that both sides of the line be switched by RY1 using a similar relay, but having an extra set of contacts. The ground wire, of course, should be carried through the suppressor uninterrupted.

If you do not want to change the relay type, then at a minimum the builder should be very careful to keep the hot (black wire) side of the line and the neutral (white wire) side of the line functions consistent with standard wiring practices—that is, not switching the neutral. Good wiring practices in dwellings, and electric codes, should be thought about when distributing line current around places where we work and live. Safety first, etc.

STUART MARCINIAK
San Francisco, CA

AUDIO TAPES

In reference to "Audio Tapes—How Different Are They?" in the November 1983 Radio-Electronics, that article is very misleading. The main difference in cassette tapes is not the tape, but the mechanics of the cassette—the little wheels that start to squeak. Take a look at the tape-head pressure mechanics. Will it fall apart or wear out? Those are the big differences.

One of the companies mentioned in your article will just disappear if you try to get replacements for bad junk.

GUS OSITIS
Orinda, CA

THE 55-MILE-PER-HOUR SPEED LIMIT

In reading the letter from Mr. Raymond Kostanty ("Letters," Radio-Electronics, November 1983), I find myself a bit miffed at an over-simplistic view of the 55-mile-per-hour speed limit and its "minimal" benefits. I feel that this department would be far better serving to your readers if the content were kept to matters concerning the industries and

continued on page 20
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trends that your publication serves so well. But if highway safety is a viable topic, I would like to make a response to several remarks that I found to be somewhat flawed.

The 55-mph-per-hour speed limit was enacted by Congress, not by local state or local law-enforcement agencies, for several reasons (faulty or otherwise). It is therefore unfair to attribute the speed limit to a tactic or means for traffic officers to keep up to their quotas. The principal duties of a highway patrolman or traffic officer is the enforcement of highway regulations that are duly enacted into law by elected officials. Investigating murders, robberies, and drug dealing are matters assigned to officers who specialize in criminal activities.

I feel, personally, that 10,000 lives saved each year is a significant figure. That reflects a 20% reduction in highway fatalities. It’s quite a significant number, especially when we consider the increase in the number of licensed vehicles and drivers during the ten years that the law has been in effect.

But the bottom line remains this: Driving over 55 miles per hour is illegal. The only way to change that fact is to convince our federal legislators that there is a valid reason for increasing the legal speed limit. I doubt that belittling highway officers, or stating that 10,000 lives annually is not in perspective, will get much favorable attention from any of our congressmen.

You have a fine magazine, but I still feel that there are more appropriate places to deal with issues on highway regulation than Radio-Electronics. (Does that include issues on radar detectors?—Ed) I am one of your most devoted readers and will continue to be so.

HULBERT F. SATTERFIELD
Memphis, TN

AUTO-ALARM SYSTEM

Just a short note to tell you about the “Auto Alarm System” by Ed Loxterkamp in the May 1983 issue of Radio-Electronics. I built it; it installed—it and it works great!

I have also incorporated a motion detector into the system, which works off the hood and trunk switches. It’s an excellent system and I am well pleased. Keep up the great job you’re doing with “do-it-yourself” projects.

J. JOSEPH HLASNEY
Whitehall, PA

NO RECORDS

In the November 1983 Radio-Electronics, the writeup on Heathkit’s Electronics Course EE-3104 (“Equipment Reports”) states that the course includes instructional records. That isn’t so. My course arrived without any records. Checking back on their catalog for the past six months, I find that Heath does not include records with their course.

BILL TOMPKINS
Oakland, CA

Authors’ Reply: Our review copy of EE-3104 was received some time ago and, did, indeed, include instructional records. Apparently, Heathkit has decided to make those instructional aids optional. Our copy of the latest catalog confirms that: and while you can do the course without them, they do help personalize things. So we’d suggest buying them.

THE 7805

I suppose that by now you must have received many letters supporting the circuit in National Semiconductor’s Voltage Regulator Handbook that was mentioned in the letter from Mr. Lawrence J. Jones, appearing in the January 1984 Radio-Electronics. That book explains how to use their regulators, and how to hook up the circuit indicated. I myself find National’s Semiconductor’s arguments persuasive.

The 7805 is a hard-to-damage IC. When the output of the IC is held to ground (shorted), the chip will supply current until it overheats. When the IC overheats, it will supply reduced current so as to prevent its being damaged. If you really want to burn out a 7805, you must supply it with excessive voltages—either inputs or outputs. The circuit described in Mr. Jones’s letter cannot damage the 7805. The only danger is that the transistor, or some other discrete component, will be damaged. Believe me, the circuit works.

PIANOMATIC PROBLEMS

Two errors crept into the parts-placement diagrams for the Pianomatic project. In Fig. 12 (page 67 of the October 1983 Radio-Electronics), IC4 is shown upside down. It must be turned around, with pin 1 pointing toward the top left of the diagram, for the project to work correctly. Also, in Fig. 14, C22 is actually C16.—Robert Grossblatt
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We recently had the opportunity to examine a counter that can be used for more than just measuring frequency. (Thus it is called a "universal counter.") So if you've ever needed to make duty-cycle measurements of, say, a power supply, or if you ever had to measure the frequency ratio of two signals, or the length of time between two once-only events, then the following should interest you.

Recently the B&K Precision Co. (a division of Dynascan Corp., 6460 West Cortland St., Chicago, IL 60635) introduced the latest in its rather lengthy line of electronic test equipment—the model 1822 150-MHz universal counter. That counter has several features that make it versatile including: two separate input...
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**DC Volts**

<table>
<thead>
<tr>
<th>RANGE</th>
<th>ACCURACY</th>
</tr>
</thead>
<tbody>
<tr>
<td>200mV</td>
<td>± (0.5% rdg + 4d)</td>
</tr>
<tr>
<td>2V</td>
<td>± (0.7% rdg + 4d)</td>
</tr>
<tr>
<td>20V</td>
<td>± (0.7% rdg + 4d)</td>
</tr>
<tr>
<td>1000V</td>
<td>± (1% rdg + 4d)</td>
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**AC Volts**

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<th>ACCURACY</th>
<th>RANGE</th>
<th>ACCURACY</th>
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<td>2V</td>
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<td>2V</td>
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</tr>
<tr>
<td>600V</td>
<td>± (1.2% rdg + 8d)</td>
<td>600V</td>
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**DC Current**

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<th>RANGE</th>
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<tr>
<td>200mA</td>
<td>± (1.5% rdg + 4d)</td>
</tr>
<tr>
<td>10A</td>
<td>± (1.7% rdg + 4d)</td>
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**AC Current**

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<th>RANGE</th>
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<td>± (2% rdg + 8d)</td>
<td>200mA</td>
<td>± (2% rdg + 8d)</td>
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<tr>
<td>10A</td>
<td>± (2.2% rdg + 8d)</td>
<td>10A</td>
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**Resistance**

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<th>RANGE</th>
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<tr>
<td>2K</td>
<td>± (0.8% rdg + 5d)</td>
</tr>
<tr>
<td>20K</td>
<td>± (1% rdg + 10d)</td>
</tr>
<tr>
<td>200K</td>
<td>± (2% rdg + 10d)</td>
</tr>
</tbody>
</table>

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**DM-6590**

<table>
<thead>
<tr>
<th>RANGES</th>
<th>DC VOLTS</th>
<th>ACCURACY</th>
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</thead>
<tbody>
<tr>
<td>2V</td>
<td>± 0.5% rdg ± 4 dgt</td>
<td></td>
</tr>
<tr>
<td>20V</td>
<td>± 0.7% rdg ± 4 dgt</td>
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<tr>
<td>200V</td>
<td>± 1.0% rdg ± 4 dgt</td>
<td></td>
</tr>
<tr>
<td>500V</td>
<td>± 1.0% rdg ± 4 dgt</td>
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**DM-6500**

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<th>RANGES</th>
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<th>ACCURACY</th>
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<tbody>
<tr>
<td>2K</td>
<td>± 0.7% rdg ± 4 dgt</td>
<td></td>
</tr>
<tr>
<td>20K</td>
<td>± 0.7% rdg ± 4 dgt</td>
<td></td>
</tr>
<tr>
<td>200K</td>
<td>± 1.2% rdg ± 4 dgt</td>
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</tbody>
</table>

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channels, a time-interval mode, and a frequency-ratio mode, just to name a few. We'll look a little more closely at some of its capabilities in a moment; but first, let's look at its outward appearance.

The model 1822 is housed in a 3.5 x 9.5 x 12.6-inch aluminum cabinet with a bail mounted at its sides. The bail can be locked in any one of several positions for easy reading on a bench and it doubles as a carrying handle. The unit has an eight-digit 0.43-inch LED display at the top of the front panel. There are also MHz, kHz, ms. µs, and GATE annunciator LED's to the right of the display. Decimal-point placement is automatic.

Below the display is a row of thirteen pushbutton switches. Going from left to right, the first seven switches are used to power-up the unit and select its various functions (frequency, period, ratio, time-interval, totalize, and the self-test function). The unit has four decades of resolution (in each operating mode) that are selected using the next four switches. There is a handy chart printed on the panel (directly over those switches) that shows you which one you're using. The next switch in that line is used to select either kHz/µs or MHz/ms. The right-most switch is for the display-hold function. Just above the HOLD switch is the RESET button that's used to clear the stored count.

To the far right of the front-panel are five more pushbutton switches and a rotary control. That rotary control selects the trigger level (for channel A only). The top pushbutton switch is used to select the degree of attenuation of the input (either X10 or X1). The next switch, labeled GATE, is used to select the slope of the trigger signal so that the measurement can start on either the positive or negative edge of the input signal. The third switch, labeled 1PPS, is used to select the low-pass filter. (That filter has a 10-MHz 3-dB corner frequency.) The last two switches are the attenuator and slope-selection switches for the B channel.

We mentioned that the 1822 has two input channels. Let's look at their characteristics and how each is used. Each channel has an input impedance of 1 megohm in parallel with 40 pF and uses a standard BNC connector. Those characteristics make it possible to use standard oscilloscope probes. The A channel has a bandwidth of 5 Hz–175 MHz and its sensitivity ranges from 20 to 100 mV RMS over its full frequency range. (Note: Although the instrument's front panel claims that the 1822 is a 150-MHz frequency counter, an addendum to the service manual says that the unit operates well beyond 150 MHz at slightly reduced sensitivity. Operation is extended to at least 175 MHz at a sensitivity of 100 mV RMS. That takes care of any possible problems that might arise when using the unit in the 150-174 MHz public-service band application.) The B channel has an input bandwidth of 5 Hz–2 MHz with a sensitivity of 30 mV RMS. The A channel is used when measuring frequency, period, or for totalizing events. The B channel is used along with the A channel when ratio and time-interval measurements are made.

Operating modes

The first operating mode we'll look at is the frequency mode. In that mode, the unit measures signal frequencies from 5 Hz to 175 MHz in two ranges. In the frequency mode, its resolution is ±1 Hz to 1 kHz (depending on the scale chosen), with a rated accuracy of ±1 count, ± the timebase error. The basic unit comes with a crystal timebase that's stable to ±1 ppm-per-year.

The 1822 can also measure the period of input signals from 5 Hz to 2 MHz and display the result in either milliseconds or microseconds. Accuracy in this mode is
rated at ± 1 count, ± timebase error, ± trigger error. The trigger error is typically ± 0.3% of the reading, divided by the average number of cycles for signals with a better than 40-dB signal-to-noise ratio and an amplitude greater than 100 mV. The period mode is useful because you can more accurately determine the frequency of low-frequency signals by first measuring the period and then converting that value to its equivalent frequency.

Besides simply measuring the frequency and period of an input signal (as most frequency counters do), the /822 can work in other modes. In the frequency-ratio mode, the unit compares the frequencies of two input signals and displays their ratio. That's useful, for example, when you want to calibrate a timebase against a frequency standard.

The time-interval mode can be used to read the elapsed time (in microseconds) between two once-only events. The counter can also be used in that mode to make duty-cycle measurements. (Duty cycle is defined as the ratio of ON time to idle or OFF time expressed as a decimal or percentage.) To make that measurement, both probes are connected to the same signal source. Using the SLOPE switches, one channel is set to trigger on the leading or positive-going edge of the signal and the other on the negative edge. The counter measures the time between those two events and displays to ON time. Now, reverse the triggering so that the first channel triggers on the negative edge and the other channel triggers on the positive edge. The counter now measures the OFF time.

Another useful feature of that counter is its totalize mode. Using the switch labeled TOTAL the unit will count events and display their total. The counting process can be gated either by using the front-panel HOLD and RESET switches, or by using an external gating pulse fed through a jack on the rear panel.

The HOLD switch can be used to freeze (store) the displayed value. That value can be cleared from the display and storage by simply pressing the RESET button. When that button is pressed, the counter is ready to start a new measurement. A self-test function is also provided. When the self-test button is pressed, the frequency of the internal clock, a 10 MHz crystal-controlled oscillator, is displayed. The clock's stability is rated at 10 ppm (parts-per-million) over a temperature range of from 0°C to 50°C.

The unit is provided with a clearly written instruction manual that contains all the information needed to run the counter in any range or operating mode. The manual also provides full maintenance and calibration instructions, along with circuit descriptions and parts-placement diagram. There are some extremely handy tables for frequency and period measurements and B&K has also included some time-interval examples and handy circuits for contact debouncing.

There are three available accessories: the PR-45-×10 probe priced at $52.20, the PR-37-×10 direct probe at $44.75, and the optional TCXO (temperature-compensated crystal-oscillator), available through the manufacturer's service department, at $130. That TCXO has a temperature stability that's rated at better than ±0.0001% variation (±1ppm) from 0°C to 50°C ambient.

All in all, the model /822 frequency counter (priced at $450) is quite a handful of test equipment. It should give good service for a long time to come.

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Look at the changes of the last 15 years and you’ll see what we mean. Back then, much of the circuitry we worked with was discrete, consisting of the usual variety of transistors, resistors, capacitors, diodes, and other components. But that has changed drastically. With the advent of large-scale integrated-circuit techniques, those discrete components have been replaced by a variety of IC’s, all handling the same functions and more. Even such things as simple transistor switching circuits are now available in IC form.

One of the most exciting developments of this period has been the introduction of CMOS (Complementary Metal-Oxide-Semiconductor) technology. That low-power-consumption logic family allows you to do things that just can’t be done with other types of IC logic. Its flexibility allows you to build devices that incorporate analog switching, oscillators, pulse shapers, phase-locked loops, and more. But, what’s even better, its low power consumption and its virtual immunity to noise make it use very attractive in a wide range of applications.

But there is a drawback with CMOS. Because of its sensitivity to high voltages, including static electricity, it requires some special handling.

All that leads us to one question: How does one learn more about CMOS technology and how to use it? One excellent way is through another of the excellent Heath (Benton Harbor, MI 49022) Educational Systems Courses. This one is their $79.95 CMOS Digital Techniques Course (EE-3202), and it is a good one. As usual, this course is complete in itself, but it does fit neatly into the overall Heath Educational Systems series of continuing-education courses. Heath does, however, urge anyone considering the course to be sure they have a knowledge of the material covered by their Digital Techniques course (EE-3200) first.

The key to this course is learning-by-doing. While we were completing it, we found many hands-on experiments dealing with CMOS technology, and, in truth, we found the hands-on portions more instructive than the well-written course material. In fact, much of the written material seems to act only as a backup to the hands-on portion.

As usual, Heath provides you with all the components you will need to complete the varied experiments in the course, including many 7400 series CMOS devices, as well as all the capacitors, resistors and other devices needed.
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What's covered

As to the course material itself, just about every aspect of CMOS digital technology that you might need to know is covered in seven units. For instance, Unit One discusses CMOS basics and summarizes them. It then moves on through CMOS logic gates and how the devices are packaged. It also discusses CMOS characteristics including such things as input protection, propagation delay, and power-supply requirements.

Unit Two takes that same knowledge, which is also tested during the chapter by two programmed review tests, and applies it to interfacing considerations, such as logic levels, output drive, and fan-out. Interfacing techniques for various types of logic systems, including TTL and ECL, as well as such devices as operational amplifiers, LED's, and optocouplers are discussed.

Taking that knowledge even further, Unit Three goes into CMOS logic, including basic logic gates, and discusses logic-gate topics including state definitions, the one-input logic gate, the two-input logic gate, and the use of logic gates as switches. It then goes through the various types of gates—and, NAND, OR, NOR, EXCLUSIVE OR, and EXCLUSIVE NOR as well as other two-input gates and then discusses gates with more than two inputs. From there it goes on to DeMorgan's equivalence, transmission-gate logic, and three-state logic. The unit concludes with a discussion of advanced logic techniques including data-selector logic, read-only memories, programmable logic arrays, and microprocessors.

Unit Four takes the knowledge you have acquired in the previous three units and applies them to CMOS multiplers. It discusses direct-logic circuits, bistable circuits, astable circuits, crystal oscillators, voltage-controlled oscillators, nonstable circuits, and duty-cycle integrators. It also presents some application guidelines and then moves through clocked-logic circuits and master-slave flip-flop applications.

Building on that knowledge, Unit Five discusses counters and registers, including CMOS counters, counter applications, and shift registers.

Unit Six discusses some practical applications of CMOS analog devices and includes a discussion of operational amplifiers and their uses, as well as their limitations. Also covered is using CMOS analog-switches in such applications as sample-and-hold circuits, tracking filters, microprocessor data-entry, and as video combiners. It also discusses the CMOS phase-locked loop and how it can be used as a low-frequency oscillator, digital thermometer, or a frequency synthesizer.

All the knowledge you accumulate in the previous units is applied to advanced CMOS applications in Unit Seven. That unit goes into using CMOS information processing circuits, such as analog-to-digital and digital-to-analog, sample-and-hold, and peak-detector circuits, frequency modulation and demodulation, and multiplexing and demultiplexing. It also discusses commutating filters and then moves onto various CMOS projects, including a code-practice radio transmitter, a camera shutter delayed-release timer, a capacitance meter, a multichannel adapter for single-trace oscilloscopes, and a CMOS electronic watch circuit.

One thing you must note about the course is that you need certain items to complete it successfully, including the LT-3200H breadboard/trainer, an oscilloscope, and a digital multimeter. Now, if you have a well-equipped bench available, it should be no problem. But if you are just equipping yourself for this course, you will find the cost of the course rising significantly above the $79.95 price. The breadboard/trainer alone costs $99.95 and a good, inexpensive oscilloscope can cost $300 or more. Still, those items are things that any workbench should have, and once they are purchased they are yours to use for many years to come. R-E
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How it works

The circuit is powered by a single-ended 12-volt DC supply (not shown) consisting of a 12.6-volt transformer and a 7812 voltage regulator. Though a regulated supply isn’t really necessary, it does improve the timer’s accuracy. The 741 op-amp is used to form a comparator with hysteresis that monitors the outside light level using a photoresistor. That means that the comparator’s output goes high only after the input to pin 3 crosses a certain DC value (determined by R2). The feedback applied to pin 3 of the comparator causes the output to remain high until a negative voltage of sufficient quantity to overcome the feedback is applied. Only then will the output change states. Note that there are two switching voltages. In the dead zone (the area between the two switching voltages), the output will remain in the same state that it was previously set to. In other words, if the output is high, it will remain so as long as the input is in the dead zone.

Resistor R1 and photoresistor SR1 form a voltage divider. R1 should be selected to have the same resistance as SR1 at the light level at which the lamp is to be turned on. The photoresistor should be mounted near a window and shielded from the lamp that it is to control, or it can be mounted in the same enclosure as the other components if the device is to be mounted near a window. As the light level drops, the photoresistor increases in resistance. That increased resistance causes a greater voltage drop across the photoresistor, an equal voltage is applied to the non-inverting input to the comparator through the 120-kilohm resistor. When the voltage at the non-inverting input reaches a level that’s about equal to the voltage at the inverting input of the op-amp, its output goes from low to high. The level at which that change occurs is controlled by R2.

When the comparator’s output goes high, a pulse is generated through capacitor C1 that triggers the 2240 timer. The timer stays on for a set period that is determined by capacitor C2 (10 µF) and resistor R2 (8.2 megohm). With the component values shown, the timer period is about 3 hours with switch S3 open and about twice as long with it closed.

The timer’s output is sent to the inverter, transistor Q1. The output of that transistor, taken from the collector, is used to turn transistor Q2 on and off. When Q2 is turned on it completes a path to ground through the MOC3010 optocoupler for an internal LED. That LED triggers a triac driver or diac and that, in turn, triggers the triac in the lamp circuit. When the triac is turned on current flows to the lamp.

The LED in series with the optocoupler serves as a pilot light. The LED lights to indicate that the circuit is in operation.

Switch S1 is used to manually start the timer by applying a high input to the timer at pin 11; while, S2 is used to stop its operation by applying a high to the timer’s reset at pin 10. Any or all of the switches can be eliminated if the functions they control are not needed. The optocoupler and triac can be replaced by a relay if desired.—John A. Wert

NEW IDEAS

This column is devoted to new ideas, circuits, device applications, construction techniques, helpful hints, etc.

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BY THIS TIME WE SHOULD ALL BE FAMILIAR with the unbreakable first rule of electronic design: Brainwork before boardwork. If you can't get it down clearly on paper, you can't design it, much less build it. (I believe that there's some sort of natural law that governs the relationship between the weight of the finished product and the paperwork it generates. If anyone knows what it is, please let us know!) Paperwork always chops mind-boggling design problems down to a manageable size and also lets you concentrate all your energy on specific design problems.

Last month we spent a little time breaking down the problem of using the 4018 to generate sine waves. Although that's certainly not the most complex problem you'll ever see, it is important to remember that the design approach that you take is as important as the design itself. As a matter of fact, the initial approach will more often than not shape the final product.

Generating sinewaves

Take a look at the output waveforms of the 4018 shown in Fig. 1. It puts the procedure to follow (and the problem it causes) in black and white for us to look at. And it should give you some idea as to how to go about using that IC. As you can see, the 4018 provides phase-shifted outputs that are delayed by exactly one incoming clock pulse. Not only that, but we've already seen that the output duty cycle is nice and square. If we sum the outputs together properly, we can produce a digital waveform that can be filtered to any degree of smoothness desired by the circuitry that's tied to it's output.

If the outputs (q1 through q5) of the 4018 are added together using equal value resistors, we're going to wind up with the very familiar and entirely predictable waveform shown in Fig. 2-a. If you squint your eyes and imagine the waveform to be all smoothed out you'll see that the best that we can hope to get from the circuit in Fig. 2-b is a triangular wave. Obviously, our approach is on the right track but the problem is a little more complex than it first appeared. While, it is evident that we have to add the IC's outputs together, it should also be evident that we have to give more thought to how we do it. The shape of the wave that's generated by the 4018 depends on the values chosen for the summing resistors. Determining the values of those resistors, however, is something else. There's no way to avoid doing some math; but let's see if there's some way to at least cut the required calculations down to a slightly less formidable size. Once again we have some paperwork to do.

Now, as everybody knows, there are lots of different ways to go about solving a problem. Which one you pick depends on the problem, but remember that the idea behind all of them is to cut down the amount of work you have to do. Let's attack our problem with the most basic approach—common sense.

In Fig. 2-a we see a composite output waveform from Fig. 1 and we have also overlaid it with an approximation of the sinewave that we're trying to generate. Certain things should become clear almost immediately.

As the sinewave approaches its maximum positive and negative values it flattens out. The staircase shape that was generated using equal value resistors has sharp peaks at those points and therefore, doesn't really fit the curve. That simple observation leads us to a sleighhammer-type fix. All we have to do now is to lose the output of the 4018 that's causing those peaks. In practical terms that means getting rid of the q5 output. As you can see from Fig. 2-b, we're using that output for two purposes. It's one of the data outputs continued on page 113
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The model BJW-3 is operated by two rechargeable nickel-cadmium batteries (not included). It comes with a bit and sleeve, and a 100-foot spool of 30 AWG wire. Refill spools are available in 100-foot lengths and in four colors: blue, red, white, and yellow.

The model BJW-3 is priced at $59.95. —OK Industries, Inc., 3455 Conner Street, Bronx, NY 10475.

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The single unit price for the model DT2818 is $1585.00. The model DT2707 is priced at $149.00. The model DT2818 is shipped complete with a comprehensive user manual, which includes example BASIC programs.

—Data Translation, 100 Locke Drive, Marlboro, MA 01752.

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Low-voltage amplifier circuits

ROBERT GROSSBLATT

DIGITAL AND ANALOG CIRCUITS EACH have their own unique set of design problems. Very often what is a major consideration in one field doesn't even appear in the other. There is, however, one problem that is common to both analog and digital circuits: the problem of tailoring real world signals so that they can be handled by whatever circuitry that is being designed to follow them.

The output of many real-world sensors (from microphones to keyboards to transducers) need a certain amount of conditioning before they can be reliably processed by either analog or digital circuitry. One of the most frequent problems that turns up is that the voltage level coming out of the input device is too low to be used by the following circuitry. Because of that, those signals must be amplified to a usable level. This month we'll look at two general-purpose amplifier circuits. The first uses a single transistor and the other a CMOS IC. Either one can really come in handy when you're faced with the problem of low-voltage input signals. We'll look at the transistor amplifier first.

Transistor amplifier

Figure 1 shows a simple single-transistor amplifier that can be used anytime you need a boost for a signal that's in the microvolt range. That circuit can be assembled from the sort of spare parts that fall into the cracks of your parts box. Not only that, but the it uses so few parts that it takes up less space on a PC-board than an IC. In addition, the circuit has a flat frequency response across the audio spectrum and a gain of about 100 with the component values shown. None of the component values are particularly critical, therefore a wide range of substitutions can be made without seriously affecting the performance of the circuit.

The gain of the circuit can be lowered by dropping the value of feedback resistor R2. And the capacitor values shown can be changed if you don't happen to have those values on hand. Transistor Q1 is a small-signal high-gain NPN transistor: substitutions can be made here as well. A 2N2222 transistor can be used but it will give you a lower gain than the 2N3301 shown; again it's a matter of trial and error on one hand, and how much gain you need on the other.

The circuit can be used anytime that a really low input signal needs to be boosted to a workable level. Anyone who has ever had to deal with the output level of a dynamic microphone (in the microvolt range) will find that little amplifier really handy because it will boost the mike's output signal level enough so that it can be fed into a standard line input. The other low-voltage amplifier circuit that we will look at uses CMOS inverters rather than a single transistor.

CMOS amplifier

The second amplifier circuit is shown in Fig. 2. It uses three sections of a CMOS 4049 hex inverter IC (but any CMOS inverter can be used). It features a high input impedance. It also features all the good things we've come to expect from CMOS: a wide power-supply range, high noise-immunity, an output that swings from ground to just about the supply rail, and so on. The response of the circuit can be easily tailored to satisfy a wide range of circuit conditions.

The gain of that circuit is determined solely by the ratio of the feedback resistor (R2) to the input resistor (R1). And the frequency response is a function of the input capacitor. Keep this circuit in mind, it can make life a lot easier when the output signal for the circuit you're designing needs a bit of amplification. Just round up three spare inverters and your problem is solved. The only thing to re-
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STEVEN E. SARNS

HOW OFTEN HAVE YOU THOUGHT: “IF ONLY I COULD hook my computer up to that flame (or model train, coffee pot, security system, etc.), then I could really get it to do what I want”? You probably gave up the idea for one of two reasons. First, your computer is too expensive to be relegated to turning on a coffee pot fifteen minutes before you wake up (especially when you can buy inexpensive timers to do the same thing). Second, your computer is not designed for such control tasks and requires some modifications.

Those are good reasons to abandon the idea. But what if you had an inexpensive computer that could be programmed easily and had an I/O structure designed specifically for control applications? Then you could put some of your ideas into action. This control computer that you can build has—along with its many other I/O capabilities—the ability to control BSR-type wireless remote-control modules. And the computer can be programmed in BASIC using a terminal (or a computer configured as a terminal) that has an RS-232 serial port.

Let’s take a quick look at the abundance of applications for a control computer that surrounds you—some of which you’ve probably considered and, perhaps, some you’ve never even thought of. We won’t go into detail on how to use the controller for the following applications. Keep in mind that your programming capabilities may limit what you want to do. (You need to know at least BASIC programming to use the controller.) But we will explain how to use the control computer in enough detail so that you’ll be able to tailor it to your own applications.

Security systems: A “smart” security system could arm itself in your absence. And the alarm could be dependent on the type or source of breach. For example, with external circuitry, the system could be interfaced to the telephone to alert the police if it sensed a break-in, or it could phone the fire department if it sensed a fire.

Robotics: Even the most drool robot requires some amount of “smarts.” Now you can afford—both in dollars and in development time—to give him some real power. Imagine the convenience of independent drive- and sensory-systems. Imagine how much faster your development would be with a complete computer system for each function.

Model control: Imagine the complexity that you could build into a computer-controlled model train layout, or the acrobatic maneuvers that could be programmed into your radio-controlled model airplane.

Home entertainment: A computer-controlled servo tracking system can position your antenna on the satellite of your choice.

Home energy management: (This is what the author’s prototype was designed for.) The living-room thermostat could be the first target—it could automatically set back when you are at work and warm up before you return (but not on weekends). If you have electric heat, and if your electric company has peak and off-peak rates, your electric bills could be cut in half by averaging your power requirements instead of turning everything on at once. Remember—any equipment you purchase for energy management or control might be a tax credit for you. You’ll have to check your own state’s
laws. If you’re lucky, you might effectively cut the cost of your project in half!

Features of the controller

The underlying design goal for this controller was a small, inexpensive, yet powerful control computer with its own development system. That design had to achieve a successful balance: We wanted the board size and the cost to be kept down, yet we still wanted to include as many features as we could. However, if we tried to give the board too many bells and whistles, the result would be high cost with only limited applications. Of course, we searched for a happy medium.

The result was a rather small board (about 5 1/2 x 6 1/2 inches) that has enough power to do its job at a competitive cost—take a look at the controller’s features:

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- An eight-channel, 8-bit analog-to-digital converter with provisions for digital-to-analog conversion.
- A choice of two operating systems: BASIC or Forth. The high-level language will cut your programming time by 90%.
- An on-board EPROM programmer makes a permanent copy of your RAM-based program.
- A real-time clock for time-of-day functions.
- A start of ROM-based programs.
- A 16-bit power supply controller on a companion power-supply board. That system communicates to readily available receiver modules that you simply plug into the AC lines. All of the hassles of stringing wires from the controller to the control point are eliminated.

A closer look

Now that we have an idea of the basic features of the controller, let’s discuss some of the theory behind it. Unfortunately, we won’t be able to cover all of the points that we just mentioned this month—they will be discussed in upcoming installments of this article.

We’ll start by describing the microprocessor and the support circuitry required to test, debug and program the basic system. The design will be discussed in enough detail so that even those who are not familiar with microprocessor design techniques will be able to get an overview of the process. The control computer’s schematic is shown in Fig. 1.

The microprocessor selected for this project is the Intel 8088—the 16-bit microprocessor that forms the heart of IBM’s personal computer. (Anyone who owns an IBM PC has a complete set of development tools for this board.) The 8088 can be thought of as being made up of two units. The first is the BIU or Bus Interface Unit, which prefetches instructions while the rest of the microprocessor (the EU—Execution Unit) is working on the current instruction. Besides speeding execution, that has an even more fortunate (economic) effect: Memory IC’s with access times as slow as 400 ns will work on the board.

The bus structure

The microprocessor is connected to the memory and I/O through the data bus, the address bus and the control bus. Those buses are shown in the computer’s schematic in Fig. 1.

The data bus is the group of eight lines (D0-D7) over which data can be transferred between the microprocessor and any memory or I/O (Input/Output) device.

The address bus is made up of 20 lines, some of which are time multiplexed. Don’t worry about now—we’ll get to it shortly. You should know, however, that the microprocessor uses the address bus to select the desired memory address or I/O device to send data to or receive data from. That address is represented by the unique combination of address-line states.

We will be concerned with three lines of the control bus. The READ (RD) and WRITE (WR) lines determine whether the data to be transferred to (read by) or from (written by) the microprocessor on the bi-directional data lines. The third line, CS (chip-select), is used to distinguish between a memory access or an I/O access.

The 8088 can address 1 megabyte (220) of memory with its 20 address lines. If we use only the lower 16 lines, we can address 64K. The 8088 combines the data bus and the lower eight address lines into what is called a time-multiplexed bus. That was done so that the 8088’s package could be kept to 40 pins. The first design question is to decide whether to demultiplex the data and address bus or use it as is. Intel (and others) supports the multiplexed bus with an extensive range of products. Leaving the bus multiplexed will result in a smaller board that is easy to lay out. (That is one of our design goals.) However, because of the popularity of the non-multiplexed bus, peripheral IC’s designed for it are more available and are less expensive. Because another of our design goals is to design a low-cost board, we must stick to popular components—or at least ones that we expect to become popular. Fortunately, demultiplexing the bus is an easy matter; it requires only a set of latches. A 74LS373 octal latch (IC15) is used. It is enabled by the ALE (Address Latch Enable) pin of the microprocessor (pin 25). Now we have 8 high-order address lines, A15-A8, (IC18 pins 39, 2-8), and 8 low-order address lines coming from the latch outputs, A7-A0, (IC15 pins 7, 12, 6, 15, 5, 16, 2, 19). We also have 8 bi-directional data lines, AD7-AD0 from the input side of the latch (IC18 pins 9-16). Note that the data lines still contain the multiplexed address-information. They will contain data at the time the appropriate control line (RD or WR) is active.

The memory field must be divided into appropriate banks (or peripheral IC’s). We must make sure that only a single peripheral IC can be active at any one time. If more than one device attempts to place data on the bi-directional data bus simultaneously, a condition known as bus contention may exist. The result of bus contention is an undefined state and, consequently, undefined operation. Thus the output of our memory decoder will be a one-of-N type—only one output will be active at any one time. Each of those outputs will be connected to the chip-enable (CE) input of a peripheral IC.

The selection of the size and type of memory is heavily influenced by our need to convert our finished program into ROM. If we can simply remove a RAM IC and replace it with a pin-compatible ROM, we will have a compact yet flexible board. The 2764 2K x 8 RAM and the 2716 2K x 8 EPROM are pin-compatible; so they will be used. We also need memory space for ROM-ed development tools that can be used during the program testing, and an empty socket for the blank EPROM to be programmed.

Throughout the remaining description of the board, the highest order address lines (A15-A14) will be called the high-order address lines. The most significant high order address line (A15) can be used to chip-select the system ROM. Address lines A14 and A12 are used as the inputs to a 74LS139 one-of-four decoder (IC16), which will be used to chip-select the other memory IC’s. We have mapped our system ROM and 4 memory sockets uniquely into the 64K address space. Table 1 shows a memory map of our system. Note that A15 is inverted by IC19 to select the system ROM and that the one-of-four decoder (IC16) is qualified by IC17-d: when A15 and the A14-A13 lines are low, a memory-field operation is indicated.

<table>
<thead>
<tr>
<th>Address (hex)</th>
<th>IC/Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000-07FF</td>
<td>IC12/RAM</td>
</tr>
<tr>
<td>0800-FFFF</td>
<td>IC10/RAM</td>
</tr>
<tr>
<td>1000-17FF</td>
<td>IC13/ROM</td>
</tr>
<tr>
<td>1800-FFFF</td>
<td>IC14/ROM and EPROM programming socket</td>
</tr>
<tr>
<td>8000-FFFF</td>
<td>IC9/System ROM</td>
</tr>
</tbody>
</table>
When the 8088 is reset, it will begin execution at address FFFF0H. That means our system ROM should occupy the highest memory position. (Remember that we’re not decoding the highest-order address lines, so that when the 8088 looks at address FFFF0, it will see the system ROM.)

**EPROM programming**

Programming the 2716 EPROM is a simple matter. The programming voltage may be applied as a DC voltage to pin 21, the \( V_{PP} \) pin. The address and data must be stabilized for 50 milliseconds, and during that time, a single TTL-level pulse is applied to the \( CE/PGM \) pin (pin 18). (It is pulsed from low to high.)

Rather than the more usual method of surrounding the EPROM being programmed with a bi-directional latch, the address and data information will be taken directly from stabilized address and data busses. The disadvantage of our approach is that the microprocessor cannot be doing anything else during that 50-ms interval when the busses are stabilized—including timing the 50 milliseconds. We will have to use a hardware timer. The advantages of our method are fewer components, software simplicity, and a small board size. (Figures 2 and 3 show full-sized foil patterns for the double-sided printed-circuit computer board. The power supply for the computer is contained on a second board. We’ll talk about that board in a future installment of this article.) In fact, the EPROM programmer is completely invisible to the software—the EPROM appears to the operator as a very slow-to-write RAM-like device.

We will operate the 2716 from the microprocessor bus by externally qualifying RD and CS with IC17-a. The output of that OR gate is applied to the 2716 \( OE \) pin (pin 20).

The 2716’s \( CE/PGM \) line (pin 18) will be normally low and go high whenever \( CE \) and \( WR \) are true. Those two signals (at IC20, pins 1 and 2) are the trigger conditions for the 74LS123 50-ms one shot whose output (IC20, pin 4) is connected to the 8088 RDY input and the 2716 \( CE \) input. Whenever the \( RDY \) line is low, the 8088 inserts wait states into the current microprocessor instruction. The wait state holds the current bus status (for 50 ms, as determined by C14 and R10) until the \( RDY \) line is returned high.

The specifications for the programming voltage are \(+25 \pm 0.5 \) volts DC at 30 milliamps. We have found that reliable programming can be achieved with a programming voltage as low as 22 volts. (A programming voltage of 24 volts has worked well for us.) The maximum \( V_{PP} \)
FIG. 3—THE SOLDER SIDE of the computer printed-circuit board.

voltage specification is an extremely important one to follow. We met up with disaster with a programming voltage of 26 volts. If the $V_{pp}$ voltage is exceeded even for a few nanoseconds, the EPROM will fry! That means that the $V_{pp}$ supply must not overshoot during turn-on or turn-off. Because we need to control the ramp-on and ramp-off characteristics we will use a power supply design that always switches the supply on and off for each byte programmed. (The switching supply makes the control computer more versatile because it allows you to use other EPROMs—for example the 2732—that require a switched $V_{pp}$ supply. The 2716 doesn't require a switched supply.) The switching programming supply is located on the separate power supply board. We'll discuss that circuit and its construction in a future part of this article.

Programming an EPROM involves only setting appropriate locations to "0." A fully erased EPROM has all of its memory locations filled with 1's. The time will come—either because of a programming mistake or because you no longer need a particular program—that you'll want to erase your programmed EPROM. You can erase the EPROM's by exposing them to ultraviolet light. Direct sunlight will erase an EPROM in about a week. Room-level fluorescent light will erase an EPROM in about 3 years. (Although that's not an efficient erasure method, it is still a good idea to cover the window with a label to block out room/sun light.) A commercial EPROM eraser is simply a source of ultraviolet (UV) light that irradiates the EPROM. You can make one yourself with a General Electric G15T18-inch germicidal bulb in a conventional fluorescent-lamp holder. Do not look into the bulb when it is on. The light is much more intense than it appears and quickly damages the eyes. Place the EPROMs to be erased within one inch of the bulb and leave it on for 10–15 minutes. That should change all the bits in the EPROM to 1's.

The microprocessor requires a system clock signal, which we obtain with a conventional TTL-type crystal oscillator (IC19, XTAL1, and other associated components). The frequency of the clock is 4.00 MHz, even though the 8088 could run at 5 MHz. The 33% duty-cycle constraint on the clock signal would require either a special clock generator or additional TTL chips.

A reset pulse is also required by the 8088, which we generate by using one-half of a 74LS123 (IC20-a) during power-up or whenever the reset line is grounded and released.

continued on page 94
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Part 2 IN THE FIRST PART of this article we showed you how to build the video test generator. However, due to space limitations, we could not show you Figs. 6-11; As promised, those appear this month. Now it’s time to check out the unit and learn how to use it.

Checkout and alignment

Once you’re sure that all the circuit connections are OK and that there are no inadvertent shorts to the chassis, you can apply power. Check the power-supply voltages and verify proper outputs. If the voltages are not correct, be sure to rectify the problem before proceeding.

Set S1 to the EXT position. Connect an oscilloscope to TP1 and trigger the scope from TP9 (or the horizontal-rate output from J4 on the front panel). Adjust the scope until the display shows approximately one line of video as depicted in Fig. 12. Be sure that the scope is DC-coupled, because you want to adjust R2 and R3 until the blanking level is at zero volts, and the peak-to-peak amplitude of the signal is two volts. Now set S1 to the UP/DOWN STEP position, and adjust R5 until the blanking level is again at zero.

At this point you should verify that the up/down-step and the gray-level signals resemble those shown in Fig. 1. The gray level should be selectable (8 levels) by momentarily pushing S2. When S2 is held closed, the generator should “walk through” the gray levels successively.

The next step is to align the multiburst generator. To do that, set S1 to the MULTI-BURST position. Put the scope probe on test-point TP1, and trigger the scope from TP6. Adjust R34 until the signal on the scope is about 500 kHz. Then, trigger the scope from TP5 and adjust R36 for 1 MHz. Continue in a similar manner with the other test points, adjusting for the frequencies (at TP1) shown in Table 1.

Leave the probe on TP1 and trigger from the HORIZONTAL RATE jack (or TP9) again. Verify that the multiburst signal looks like the one shown in Fig. 1. Next, place the scope probe on TP7 (with the scope set to trigger internally). Adjust R52 for the best-looking sinewave.

You are now ready to align the RF section. Using 75-ohm coaxial cable, connect a TV to J2 (RF OUT). Be sure to use
the 75-ohm input of the TV or use a balun for impedance matching, if necessary. Set the TV tuner to channel 3, put the fine tuning at mid-range, and disable the AFT if possible. Adjust coil L1 (with a nonconductive tool) until the best display appears. Rotate S1 through 6 positions (don't worry about the EXT position) and check all signals for proper display. At this point, don't be concerned if there is no color on the color-bar display. Place S3 in the internal-audio position and adjust L2 until the 1500-Hz tone is heard.

The last step is to accurately adjust the frequency of the master oscillator. The best way to do that is to use a frequency counter at TP14, and adjust C22 until the counter reads 3.579545 MHz. Alternatively, you can adjust C22 by using the TV; Set S1 to the CLR BARS position and turn C22 until the color locks in. That method is less accurate than using a frequency counter. Whether that is acceptable depends on your application.

Using the video test generator

The video test generator is used, in general, as the source of video reference signals. The output of the generator is connected to the device or system under test, and the output from that device or system is observed on an oscilloscope. By knowing what the system's output should be, and then comparing that to the actual output for any deviations, you can locate the causes of many problems.

In this section, we'll first discuss some of the problems and distortions commonly found in video equipment and systems and how they can be identified using one or more test signals. Some of the problems are peculiar to a particular class of equipment (receivers, for example), and some may be found in most or all types of video gear, including receivers, videocassette recorders (VCR's), distribution amps, repeaters, switches, routing systems, etc. After we look at some of the common problems, we'll address the subject of interfacing for the purpose of gen-locking and, finally, we'll look at the external digital video input.

To begin, let's consider poor frequency response: That is a general class of distortions which we must break up into different cases for closer examination. We'll start by saying that the video signal has a wide bandwidth (from DC to 4 MHz) and all that spectrum plays an important part.

Low-frequency distortions usually show up as gradual picture-shading changes, typically right after an abrupt scene change. The problem can be caused by a poor DC-restoration circuit somewhere in the video chain. Power-line hum can also cause a similar, gradual shading change. To test for that situation, do the following: Place the test generator either in the upper/down-step or the gray-level mode. Depress and hold S2, the auto-step button; That sends gray-level changes to the system under test at a 1-Hz rate. Trigger your oscilloscope from the vertical-rate jack and observe the system output (DC coupled). If the blanking level changes, then low-frequency distortion exists. A good companion check for problems in this part of the spectrum is to use the gray-level mode at its highest level (maximum white). Observe the system output on a DC-coupled oscilloscope at a sweep rate of about 30-Hz, so that two or three fields are visible. Distortion will cause a tilt to the signal such that the sync tips within the vertical-blanking interval are not at the same level as those during the active portion of the picture. And the entire scope display will have a sawtooth component to it. That problem is most frequently caused by insufficiently sized coupling capacitors between stages of a video chain or between stages of individual amplifiers.

Mid- and high-frequency distortions cause problems ranging from simple left/right shading changes to loss of picture detail or image ringing. To test for that problem use the multiburst signal. Observe the output of the system under test at the horizontal rate. If the white-flag portion of the multiburst test signal is tilted, mid-frequency distortion is indicated. Higher-frequency problems show up as...
amplified or attenuated burst packets. The multiburst test signal is versatile and convenient. It will give a quick indication of system performance. An interesting exercise is to apply this signal to a properly adjusted VCR. The output signal from the VCR may surprise you—it is a result of the various compromises that are made in its design.

Amplifier non-linearity is another common distortion in video systems. It is characterized by loss of detail at some gray levels. To test for that condition, use the up/down step test signal and verify that all steps are of equal magnitude in both ascending and descending directions. Increase the vertical gain of your scope when doing this test. Also, check the step transitions for overvolt or round corners.

Scan non-linearity in receivers and monitors is best tested using the hatch-dot-pattern signals. Equidistant spacing within each axis as viewed on the screen indicates proper scanning. Those two signals also serve well for color-convergence adjustments; of course, the alignment should attempt to achieve all white dots and lines.

While we are on the subject of receiver/monitor alignment it is worthwhile mentioning the use of the up/down step signal again. A properly operating receiver or monitor should easily resolve all eight of the gray-level steps contained in the signal. That’s a quick check and should indicate if further testing is called for.

The color-bars signal provides the standard six colors (three primary and three complementary) in order of ascending luminance level (blue, red, magenta, green, cyan, yellow). That signal is primarily used for subjective system evaluation, as well as for adjustment of receivers. But if you have access to a vectorscope, the continued on page 139

TABLE 2

<table>
<thead>
<tr>
<th>Card-edge pin</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>GREEN LSB IN (20°)</td>
</tr>
<tr>
<td>2</td>
<td>VERT RESET CONTROL IN</td>
</tr>
<tr>
<td>3</td>
<td>BLUE MSB IN (20°)</td>
</tr>
<tr>
<td>4</td>
<td>HORIZ RESET IN</td>
</tr>
<tr>
<td>5</td>
<td>GREEN MSB IN (20°)</td>
</tr>
<tr>
<td>6</td>
<td>GROUND</td>
</tr>
<tr>
<td>7</td>
<td>GREEN 2° IN</td>
</tr>
<tr>
<td>8</td>
<td>GROUND</td>
</tr>
<tr>
<td>9</td>
<td>BLUE 2° IN</td>
</tr>
<tr>
<td>10</td>
<td>GROUND</td>
</tr>
<tr>
<td>11</td>
<td>RED LSB IN (20°)</td>
</tr>
<tr>
<td>12</td>
<td>GROUND</td>
</tr>
<tr>
<td>13</td>
<td>RED 2° IN</td>
</tr>
<tr>
<td>14</td>
<td>GROUND</td>
</tr>
<tr>
<td>15</td>
<td>EXT AUDIO IN</td>
</tr>
<tr>
<td>16</td>
<td>GROUND</td>
</tr>
<tr>
<td>17</td>
<td>COMPOSITE SYNC OUT</td>
</tr>
<tr>
<td>18</td>
<td>GROUND</td>
</tr>
<tr>
<td>19</td>
<td>BLUE LSB IN (20°)</td>
</tr>
<tr>
<td>20</td>
<td>GROUND</td>
</tr>
<tr>
<td>21</td>
<td>RED MSB IN (20°)</td>
</tr>
<tr>
<td>22</td>
<td>GROUND</td>
</tr>
<tr>
<td>23</td>
<td>BURST GATE OUT</td>
</tr>
<tr>
<td>24</td>
<td>GROUND</td>
</tr>
<tr>
<td>25</td>
<td>+ 5 VCC (10 mA) OUT</td>
</tr>
<tr>
<td>26</td>
<td>GROUND</td>
</tr>
<tr>
<td>27</td>
<td>BLANKING OUT</td>
</tr>
<tr>
<td>28</td>
<td>GROUND</td>
</tr>
<tr>
<td>29</td>
<td>HORIZ DRIVE OUT</td>
</tr>
<tr>
<td>30</td>
<td>GROUND</td>
</tr>
<tr>
<td>31</td>
<td>VERT DRIVE OUT</td>
</tr>
<tr>
<td>32</td>
<td>GROUND</td>
</tr>
<tr>
<td>33</td>
<td>VERT RESET IN</td>
</tr>
<tr>
<td>34</td>
<td>GROUND</td>
</tr>
</tbody>
</table>
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**Sorting problems**

A “sort” has always plagued low-cost personal-computer software. A few years back one of the major software suppliers came out with a rather good mailing list that had only one substantial problem: it took nominally 20 minutes to sort (alphabetize) 100 names and addresses. That was never mentioned in the advertising or even in the reviews. Several years later a few magazine columnists got up their courage and mentioned the long sort. But that was about 12 months after the software had been replaced with a mailing list that could sort 500 names in under 15 seconds—and even that’s not fast.

Well, you would assume that programmers have finally learned how to write a sort program. Not so! A recent mini-database...
filing system, intended primarily for cataloging, which can locate random information before your finger gets off the RETURN key. Takes just short of 9 minutes to sort two entries (that's correct, two entries). It has some form of "breakthrough in the state of the sorting art" whose speed increases with the number of entries. If you have 500 entries the sort zip through and in seconds everything is alphabetized. But if you have maybe five or ten entries you could prepare lunch while waiting for the sort to finish.

Now you might think that low cost is the reason for sloppy software. That's not necessarily true. Price often has no relationship to sloppy programming or missing features. Three relatively expensive programs, that cost from $200 to almost $1000, prove that price does not go hand in hand with a program's performance or conveniences.

Word processing

Whenever Radio-Electronics runs an article on word processing in which we make any reference whatsoever to MicroPro's (33 San Pablo Ave, San Rafael, CA 94903) WordStar, we invariably get mail from software suppliers to the effect their software is better. (For some reason saying WordStar is like waving a red flag at a bull.) Two recent responses illustrate the difficulty we have in selecting software for coverage. The first "better than WordStar word processor" came with a 140-page reference manual and a 256-page book on how the program was developed. (Right away we knew we were in for trouble because of the principle: "The thinner the documentation the better the program." A tutorial should not be necessary for general use.)

The truth is that the software was dumpy—actually, more like slightly damp dumpy. While it had almost every feature one could think of, it automatically stored each page on the disk. In order to re-read what had been written you had to go into a review mode and search through each page. Also, if you decided to change a word or character, you had to re-enter the review mode, find the desired page, edit the change, and then the page was saved as a new page—leaving you with both the old page and the new page. Unlike CP/M systems, which make one automatic backup, if you edit a page five times you have five disk files, one for each page. By the sixth page you will probably be climbing the walls.

The "automatic page save" was never mentioned in the advertisements. It is, in fact, a carryback to the old dedicated word processors that were intended for the preparation of business letters. You get a lot of work out of the typing pool with auto-saves at the end of the letter, but personal computers are rarely used for that kind of work. The people who wrote the program had their training on the older word processors and simply did not know it wasn't right for personal computers. But the user did not know about the "page save" feature until he or she owned the software.

Another respondent pointed out to us that his word processor, which cost almost three times as much as WordStar (and that piece of software has never been called "inexpensive" to begin with) was better, and provided a long checklist of features to prove the point. Comparing the two feature for feature, they were almost identical, except that the competitor's product could do a screen print—the screen display could be printed exactly as shown (which WordStar cannot do). But the competition did not have a "page break," a line across the screen that shows where one page ends and another begins. While a screen print is a much desired feature, in this day and age there is no excuse for new word-processing software not to have a page break so a user can quickly check and edit a multipage document. And we don't mean a page break called up by exiting the edit mode and loading a view or review mode—we mean an on-screen page break. When you're paying "big bucks" for software you're entitled to all the modern features.

OK, we'll compromise: for inexpensive software a "view mode" page break is all right if it shows the page number being viewed. Either way, if you're into multi-page documents, that is almost a must-have feature; but few advertisements state clearly whether a word processor has a page break, and even fewer tell you what form it takes. One program displays the page formatting in graphics that zips through so fast that if you blink you'll will miss two pages.

Databases

Our third problem came up with a rather decent database-management system that impressed us because it wasn't necessary to take a course in programming to use it. Naturally, it claimed to outperform Ashton-Tate's (9929 West Jefferson Boulevard, Culver City, CA 90230) dBase II. (For competition, dBase III is to database management what WordStar is to word processing.) The problems we ran into were due to the fact that the program was written in BASIC, and really consisted of three separate programs that auto-loaded each other.

Now there is nothing wrong with BASIC—some truly great software is written in BASIC—but BASIC is very fussy about error trapping. First it turned out there were a few unusual conditions during data entry when the errors were not trapped. The program closed the files and recycled from the beginning: no real loss but it's very time consuming and frustrating. But the sort program was even worse. A mistake in the keyboard entry could produce a RESET to BASIC, with all the files on the disk remaining open. In our usual error-trapping tests, the software worked well; it was the unusual error that crushed the program—but error trapping is supposed to catch everything.

Graphics

Graphics software is another award-winner at creating problems; and we have a good number of examples to keep you on your toes. First, there's the software house with an absolutely superb budget-priced graphics program that's suitable for use in school for instruction in graphics; it's also excellent for home- and family and small business use. The problem is that the printer routines are not standard and just a few of the latest model printers will print the graphic display. Unfortunately, unless the salesperson that you are dealing with is an expert, you're not going to find out about the printing problem until after you purchase the software and take it home.

Then we have a superb graphic program that makes those multi-function charts you see in the IBM advertisements. The problem here is that the programmer did not know or realize that the printer for which it was specifically written came in two models. One printer simply zipped through the print; the other would put a single tick on the paper. Then return the print head to the left hand edge of the paper, move it across the page to the position for the next tick, then return to the left and continue to repeat the process until the print was made. A simple six-bar graph took almost 30 minutes to print, and we could hear the
Another graphics program had everything going for it: price, performance, ease of use. It was a really nice little program. We wanted to use one of its graphs to illustrate how it worked. Typically, we run articles through a printer buffer to free the computer for other work, particularly when we’re processing graphics—which can seemingly tie up the computer forever. Low and behold the whole right column of the display didn’t print when using our regular printer buffer. Whether the problem was with the software on the buffer we didn’t take time to uncover. Suffice to say, if you do graphics and you use a printer buffer as a matter of course, make certain the buffer and the software work with each other, or disconnect the buffer.

It doesn’t take big, expensive software to give you heartburn. When evaluating software we often have to transfer the program from one computer to another. That is generally done through a “null modem” at 4800 to 9600 baud, anything slower and we would fall asleep waiting. When we were evaluating software for a particular computer we were limited to transfers at 1200 baud maximum. So we tried some very inexpensive software that claimed it would allow us to do the job at 9600 baud. Only after getting the software did we discover we also had to make a somewhat sophisticated modification to the computer. We had had enough trouble getting that computer to run, there was no way we were going into its guts and mess around with the circuit.

The thing was that the software was so cheap that it didn’t pay to send it back through the whole insurance and return-receipt hassle. (We have to wonder how many others didn’t return the software for the same reason.)

We had several experiences with software it didn’t pay to return. Often, they involve a “screen dump”—a means to print hardcopy of exactly what appears on the screen.

From the early days of personal computing we have had the luxury of the NEWDOS “JKL” screen dump. For those of you not familiar with Radio Shack computers using the NEWDOS operating system, by simply pressing the JKL keys simultaneously the user gets a print of what appears on the screen, often with some degree of graphics representation. (It depends on the printer.) We have evaluated many “screen-dump” routines that profess to print exactly what you see on the screen. Unfortunately, they often turn out to be BASIC subroutines that must be appended to BASIC programs. If the BASIC program runs and produces a screen display, then the routine dumps the screen to the printer. On the other hand, if you’re writing the program and wanted a quick screen-dump (instead of a listing) it doesn’t work, the screen-dump must be part of the program.

Another variation of the screen-dump is software that can be integrated with disk BASIC to run as a command file. The problem is that the instant it’s called up as a command file it prints exactly what’s on the screen, which is usually by the screen prompt and the command line for the program—that’s all. If you need screen-dump software, doublecheck on whether it will work when you need it, even for word processing.

Another thing to watch out for is that the software you purchase is convenient and accurate. First, let’s look at convenience. We had heard about what was supposed to be an absolutely spectacular income-tax package that had all the major and most of the minor schedules. So we assumed that some Radio-Electronics readers with their own business would be interested. The program was fantastic, a magnificent job. The only problem was the printout, which was an electronic spreadsheet format that had to be laboriously transferred by hand to the Internal Revenue Service forms. Income-tax software should really print on the IRS forms, most of which are generally available in tractor feed for those of you who are accountants or do tax preparation.

Admittedly, some electronic spreadsheet programmers (for that’s what they are) are skilled artists; we have seen spreadsheet work that the software house that sells the program claims cannot

be done. There are spreadsheets for just about everything under the sun, even complete payroll systems that include formatted printout for paychecks and W2 forms. We have also seen spreadsheets that are simply wrong. (In fact, for some three years the “tutorial” software supplied with one of the spreadsheets had an accounting error.) We were once demonstrating an IRA retirement spreadsheet that had received many favorable reviews when a financial planner in the audience rose to claim the demonstration was defective because an annuity value was substantially in error. Now the formula was so long that it literally ran off the screen, but the financial advisors in the audience whipped out their calculators and after almost 30 minutes of effort established that not only was the retirement formula incorrect, but so was the compound-interest income formula.

That taught us a good point: namely, before using any calculating software check it out with values you know to be correct. (And if you don’t know, ask an expert.)

Finally, consider whether the software really makes your life or work any easier. Sometimes the effort isn’t worth the result—and you rarely find out about that until you run the software. Our introduction to unnecessarily expanding the workload was a family income-tax program that made the user go through every single entry; there was no way to skip over any of the screen prompts. In our evaluation we did the income tax for a college student whose entire income was on a W2, with no interest or dividends. It could have been written up on IRS form 1040-EZ in about 5 minutes. Some 50 minutes later we managed to get it through the income-tax program, after constantly pressing ENTER (no value) in response to prompts. And then the final tax was in error; by just a few pennies, but nevertheless it did not agree with the tax tables.

By the way, the tax programs offer an interesting thought. In order to keep up with the changes in the tax rates, forms, and laws it’s generally necessary to purchase yearly updates. If you add the cost of the updates to the cost of the basic software, and consider that the program is good for about four years, it will most likely be less expensive and faster to have an accountant or professional tax preparer do your income taxes. (Don’t forget. You must add in the cost of the extra-support software for the income tax forms for your own state.)

We’ve shown just a few of the things that can go wrong with what otherwise appears to be perfectly satisfactory software. The point to keep in mind is always be suspicious about features that aren’t claimed, and always worse-case check your software for features that even the programmer doesn’t know exist.
Portables and Totables

Portable and totable computers are the latest rage in personal computers. In this article we'll find out more about them, including if they're right for you.

Two of the hottest selling items in the computer marketplace are the portable and totable computers. No, they are not the same thing. If it can fit into an attache case or your shirt pocket—and that covers a broad range of sizes and weights—it's a portable. On the other hand, a totable is really a desktop computer that's been shrunk into a case that will just about slip under an airplane seat. It would normally be called a desktop computer except for the fact that the case has a handle. The totable weighs in at a little under 30 pounds, and is best moved by using a luggage carrier; one of those collapsible hand trucks with small wheels that travelers use to move their luggage to and from airports.

Looking at value and performance versus cost, portables, and to a lesser degree totables, grade out relatively expensive. If you get one or the other you are buying convenience, not necessarily performance. In many instances you must trade off performance for something with a handle.

The first of the true portable computers—not a programmable calculator—was Radio Shack's (One Tandy Center, Ft. Worth, TX 76102) *PC-I*, which was manufactured by Sharp (10 Sharp Plaza, Paramus, NJ 07652); it was also sold directly by Sharp. (The only real difference was that the unit sold by Sharp had a more informative manual.) The *PC-I* was a real attention-getter. Powered by camera-type batteries, it had a one-line LCD readout, a moderately small却 doable version of BASIC, a small CMOS memory that "remembered" the program even when the computer was turned off, and a built-in calculator that could be used independent of the computer. Priced at slightly over $200 it was a great gift, particularly for high-school graduates going on to study computer science.

The *PC-I* also had connections for an accessory battery-powered cassette tape interface, or a device that combined a cassette interface with a small printer that used rolls of adding-machine paper. The printouts were small and best-suited for making program listings.

Over the years, pocket-computer features have been greatly expanded. The latest models—though still having single-line displays—feature extended BASIC, have limited graphic capability (though there's not much you can do on one line), have built-in quartz clocks, expandable memory, and even optional printers that can print graphics. On the flip side of the coin, the latest base-model pocket portables, with features similar to those available on the original models, sell for under $100.

The problem with the pocket portables, however, is that they are inconvenient for general use. Among the major limitations are tiny-bitty calculator-type pushbuttons, which means each program must be punched in a key at a time—a long, error-prone process even if the computer has some form of single-key-entry for BASIC programming functions. What does "single-key entry" mean? It means that if you touch the "P" key the entire command print is entered; touch, perhaps, the key "L" and the computer loads a program from the cassette. The computer has its own internal program that knows when a "P" is the letter "P" and when a "P" is the command print.

Programming problems notwithstanding, for persons who work in the field (such as civil engineers, architects, salespersons, and the like), who need immediate access to a few fixed computer programs, or some means of quick data entry and storage, the pocket portables are an unquestioned asset. That's particularly true if all the user needs is information that can be displayed on a single line. (Yes, a printer can be used for multiline output, but a combined computer and printer assembly is too large for the pocket.) Then again, if the primary purpose of the pocket portable is computations, a programmable calculator will possibly do the same thing at substantially lower cost.

And if you're thinking about getting a pocket portable for someone going into computer science, think about it twice. Most schools want the students to have a particular kind of
computer, or one with specific features, and pocket portables rarely meet either requirement.

In your lap

But no matter how the performance of a pocket computer might be rationalized, a one-line display simply is not convenient for anything more than minimal data entry, or a series of individually displayed values.

For portable computer power: that's something more than a substitute for a programmable calculator, the real choice is something usually called a "lap" computer. A lap computer has a full-size keyboard with typewriter keys, yet it is small enough to fit on the user's lap or slip into an attaché case.

Those units are powered by alkaline or rechargeable batteries, or a plug-in AC adapter; the adapter can also operate as a battery charger if the computer has rechargeable batteries. Lap computers feature a multi-line LCD readout, an enhanced BASIC, a substantial amount of CMOS memory that will retain your program and information even after the power switch is turned off and, at the very least, has some kind of built-in text-editing software. Other features depend on the particular model.

Presently there are three lap computers generally available: the Radio Shack Model 100, the NEC (1401 Estes Ave., Elk Grove Village, IL 60007) PC-8201A (which is very similar to the Model 100) and the Epson (3415 Kashiuwa St., Torrance, CA 90505) HX-20. The Model 100 is the most systemized of the lap portables, meaning it can be used to its maximum potential without the need for external accessories. Its basic hardware features include a 40-column by 8-line LCD readout, 8K of RAM (expandable to 24K), a direct-connect answer/originate modem, a parallel printer (Centronics type) output, and a cassette tape interface.

But all things considered, the Model 100's strength is its internal ROM-based software, which includes extended Microsoft BASIC; a decent text editor suitable for the preparation of documents, an address/telephone index file that will automatically dial a telephone number through the internal modem; a mini-database called Schedule that will keep track of appointments, daily expenses, and personal notes; a compact disc (such as who you took to dinner), and a full telecommunications package that controls the data exchange through the modem.

The NEC PC-8201A is similar in appearance to Model 100, and other than the different location of a few keys and a somewhat superior keyboard layout it's difficult to tell them apart at first glance. Even the display is the same 40 columns × 8 lines. In fact, both start out with essentially the same basic package, but they diverge in the concept of their final purpose. Whereas the Model 100 is intended primarily for material that will eventually be used for telecommunications or dumped into a larger computer, the NEC PC-8201A is part of a complete portable package that includes several battery-powered devices: a cassette recorder, a thermal printer, a direct-connect modem, optional nickel-cadmium batteries (the NEC's basic power supply is alkaline batteries), and outboard adapters to drive an 80-character × 24-line monitor or a TV modulator that produces a 40-character × 16-line display on a TV set.

The NEC's internal ROM software is similar to the Model 100's; it includes enhanced Microsoft BASIC, a text editor, and telecommunications software. As for RAM, the NEC is supplied with 16K versus the Model 100's 8K. The NEC's internal RAM can be expanded to 64K, the Model 100's can be expanded to 32K. (Actually, it's possible that even 24K might be sufficient because text processing gets somewhat slow once the document exceeds about 20K.) A port on the side permits an additional 32K of RAM with battery backup to be plugged in. The program or text can be dumped to the plug-in RAM, which can then be unplugged and stored for up to two years without losing its "memory." (Super-memory isn't all that much of a blessing for either unit, because it can make the computer start to run so slowly that the typing gets several words ahead of the display.)

As for what to do with the computers: Both obviously can be used for moderate document preparation since they can feed a standard printer, and both can dump their stored text into a larger personal computer for extensive processing by standard word-processing software. Radio Shack's Scripsit works very well on text prepared with a lap computer. For the journalist, reporter, salesperson, or anyone else in the field, both lap computers are superior to a pencil and a pad, and copy can be submitted by modem rather than telephoned to the rewrite desk.

The original lap computer was the Epson HX-20, which simply didn't work out as conveniently as the later two units. In fact, there are two models of the HX-20, the original which came only with enhanced BASIC in ROM and empty sockets for future ROM programs, and the new model which is simply the old model with a "word processing" ROM added. The HX-20 is about the same size as the Radio Shack and NEC lap computers, its screen is much smaller, only 20 columns × 24 lines, which is simply too small for convenient word processing.

One reason for the small display is the inclusion of a miniature printer that uses small rolls of adding-machine-type paper, and provisions have been made for an optional cassette recorder that slides directly into the top of the case. The printer is fine for listing programs. There is also a standard serial output port so that a standard printer can be used for both BASIC listings and word processing. The cassette recorder, which uses special subminiature cassettes, has its own 80-page manual, which should give you some idea of complexity of its use and operation. The HX-20 has an RS-232-C I/O that can be used with an optional acoustic-coupled modem. Unfortunately, the computer does not have built in telecommunications software. Also, the modem accommodates the older series-500 telephone handsets; the newer "princess" type handsets do not fit into the acoustic cups at all.

Essentially, the HX-20 appears to have been intended for BASIC programming, with word processing and communications an afterthought. But if your needs are for writing sophisticated BASIC programs when away from your desktop computer, the HX-20 will do it nicely.

The totables

A "totable" (sometimes also called a "runtable") is a desktop computer that has somehow been shoehorned into a
An even more advanced version of the Kaypro computer is the Model 10, which features a built in 10-megabyte hard disk as well as a double-sided double-density floppy disk. It comes bundled with the larger software package on the hard disk. A significant variation in features between the Kaypro Model 10 and the other models is that the Model 10 has a parallel printer output and two serial I/O's; one for a modem, the other for a printer or any other purpose, and each can be individually configured (baud rate, etc.).

An important consideration when using a hard-disk drive is that the heads must be parked in a safe area on the disk to prevent rough handling or jarring from causing the head to crash on an active part of the magnetic coating. The “parking” software for the computer is not automatic; it must be specifically run when the user closes down, thereby leaving open the possibility that the computer will be moved with unparked heads. That’s something you must consider if you have any intention of transporting the computer by plane or vehicle.

Three Kaypros deliver about the maximum performance you can expect from an 8-bit computer. They aren’t fancy, and won’t do color or complex graphics, but they will run just about every piece of major 8-bit software. If you need something for small business use, those computers will probably handle all your needs. In fact, some computer dealers will deliver a Kaypro II complete with a daisywheel printer for under $2000—an attractive price.

Among the most recent totable computers is the Radio Shack Model 4P, a portable version of their desktop Model 4. The Model 4P is supplied with 64K of RAM which can be expanded to 128K. It has a 9-inch monitor with an 80-column x 24-line display, two double-density 184K disk drives (368K total), a parallel Centronics-type printer output, and room for a user-installed 300 baud modem. As for software, it is supplied with the TRS-DOS version 6.0 operating system and Microsoft Disk BASIC.

Though the Model 4P is similar to the Model 4, there are a few significant differences between the two. Firstly, the Model 4P contains the Model III ROM’s, which means the Model 4P will automatically function as a Model III if the user runs a Model III program. For both CP/M and the Model 4P; the Model III ROM’s are automatically switched out. In the Model 4P computer, the Model 4P ROM’s are replaced by software. The user loads software that simulates the Model III ROM’s in the lower 16K of RAM; thus the Model 4P will also run Model III programs.

The second variation between the two machines involves the serial output. The dual-disk-drive version of the Model 4 has a built in RS-232-C interface. The Model 4P does not have the serial interface; instead, there is space for an optional 300-baud auto-dial/auto-answer direct connect modem that can be installed by the user.

Since CP/M Plus was not available when this article was prepared (it is now—Editor), the computer could run only TRS-DOS programs intended for the Model III, Model 4, and Model 4P. However, the non-Radio Shack Montezuma Micro Version 2.2 CP/M is specifically designed to run on the Model 4/4P computers; it opens up the computer to most of the available CP/M software.

Do you need a portable or totable?

While the concept of the portable and totable computers is interesting, the major consideration should be: “Does it have any real value for me?” Even the best models trade off something for size: color capability, screen size, speed, or expansion capability—there is always something. However, if your requirements dictate that you simply must have a computer or even just a word processor tucked in your attaché case, or bouncing in the trunk of your car, you have no choice—you must select the model with the specific features needed to make your work easier or more productive.
What's New in Printers

New technologies, new features, and falling prices can make shopping for a printer more exciting, and confusing, than ever before. In this article we'll show you what's new and what's coming in printers for your home and office.

MARC STERN

WHEN YOU TALK ABOUT PRINTERS, THERE'S ONE THING THAT you can be certain of—that is that the state-of-the-art is constantly changing. For instance, technologies that once cost thousands of dollars are now coming within the reach of the average home computerist. Also, conventional printers, such as dot-matrix and daisywheel types, are enjoying both improved performance and decreased cost.

In this article we are going to take a look at the current state-of-the-art in printers. Included will be both a look at what's new in such familiar printer technologies as thermal dot-matrix, and daisywheel, and a look at some new technologies that are now, or may someday be, practical and affordable for the personal-computer owner.

Ink-jet printers

Take the ink-jet printer, for instance. Only a few years ago, a sophisticated ink-jet printer's cost ranged from well over $2,500 to as much as $50,000. Today, those prices have dropped to as low as $895, with the most sophisticated units on the market running upwards of $30,000. What's more, today's ink-jet printers are capable of full-color printing as well as graphics work.

There are basically two main technologies used in ink-jet printing—continuous-stream and drop-on-demand. In continuous-stream printing, a constant stream of ink is ejected from a single channel and letters are formed by the movement of the printhead. As the ink is ejected, it is selectively charged using a pair of electrodes. The charged ink is applied to the paper, forming the output. The uncharged ink falls into a reservoir and is recycled through the printer, after passing through a filtering system. Continuous-stream technology is used in very sophisticated printers, that cost upwards of $30,000.

Drop-on-demand technology is far less expensive, and is available to the personal computer owner in printers from, among others, Siemens Communications Systems, Inc. (240 E. Palais Rd., Anaheim, CA 92805) in its PT88-T2 and 2717-M203 printers.

Let's take a closer look at drop-on-demand ink-jet printers.

Ink-jet basics

If you were to look at the output of a typical drop-on-demand ink-jet printer, you would probably wonder how the unit differs from a dot-matrix printer because the result looks much the same; ink dots are still used to form the characters. But, the technology used to produce those characters is radically different.

Unlike the dot-matrix (and daisywheel) impact printers that you might be familiar with, the drop-on-demand ink-jet printer is a non-impact type. An impact printer is any printer whose printhead element is a part of it actually strikes the paper, while a non-impact printer's printhead never does. For example, a dot-matrix printer has a tiny printhead filled with wires. Each one of those wires is controlled by the printer's logic circuitry and fires after it is activated by a small solenoid. The firing is controlled by the logic and the print produced is based on the character set contained within a special ROM in the printer.

Ink-jet machines also make use of a printhead and platen, but
THE SIEMENS PT88, an ink-jet printers available to personal-computer owners, makes use of drop-on-demand technology.

unlike impact printers, no part of the printhead in an ink-jet machine touches the paper. The result is that there is very little noise, one of the more common complaints about impact printers, whether they are dot-matrix or daisywheel.

Instead, tiny drops of ink are sprayed out of a series of nozzles and those are used to form the letters or graphics of the final output. Either a low-pressure area or special electrostatic circuitry is used to form the characters after the ink is fired at the paper. The nozzles are connected to a series of ink-filled channels, which are linked to an ink cartridge, which supplies the ink for the printing process.

A closer look

If you were to look at the printhead of a drop-on-demand printer, you would see a series of nozzles; the number and pattern of nozzles will vary from machine to machine. Those nozzles are connected to the ink channels. A piezoelectric crystal tube in each channel is stimulated by an electrical pulse. causing the crystal to expand slightly and this increases the pressure inside the channel. In turn, the increased pressure pushes the ink away from the crystal and toward the nozzle, where a tiny ink droplet forms.

As the pressure is decreased when the crystal contracts, the droplet breaks away from the ink stream and is, in turn, deposited on the surface of the paper. Like the dot-matrix-type printers, the dots are arranged in a pattern that forms the letter.

To keep the ink from being deposited where it isn't supposed to be, the ink-jet printer uses a slight negative pressure to keep the ink inside the channel when that particular jet nozzle isn't being used. Thus, if you were to look at a cutaway of the print head, you would see a slightly concave indentation in the surface of the ink.

Ink-jet advantages

An ink-jet printer has several advantages over a dot-matrix or a daisywheel impact printer and the first is the noise level. Quite typically, the ink-jet printer is a fairly quiet machine, one which will fit in well with a home computer setup. Its noise level contrasts quite markedly with the rat-tat-tat of the daisywheel machine or the loud whirring of the dot-matrix printer.

Another advantage is low maintenance cost. Since there are few moving parts in the typical ink-jet printer, its maintenance requirements are very low. Further, because the printhead never touches the paper, it isn't degraded as are those of impact machines. Thus, its life can be much longer. The life of the typical ink-jet printhead is in the vicinity of 10-billion characters, as opposed to about 200-million for the average sophisticated dot-matrix printhead. And, because the ink-jet machine doesn't depend on a ribbon that is subject to wear, the print quality remains constant over time.

Another advantage of ink-jet printers is speed. Quite typically, those machines race along at between 150 to nearly 300 characters-per-second. In contrast, the top print speed of an average dot-matrix machine is about 200 characters-per-second. Most letter-quality printers—daisywheel printers—run from 12 to 40 characters-per-second.

The primary disadvantage of a drop-on-demand ink-jet printer lies in its inability to produce more than one copy at a time and in the fact that its output still looks like a "computer" printout—the dots in its matrix are quite evident. Further, top-quality print runs require special absorbent papers, although bond paper does the job adequately.

An ink-jet printer's printhead. This cross-section shows the key parts in a drop-on-demand system.

Graphics capability

One of the beauties of the ink-jet printer is its graphics capability. Because of their precise tracking capability and because they are not limited to using dot-matrix impact pins, the ink-jet printer is capable of very highly detailed graphics. For instance, it is possible to program the Siemens PT88 printer in 1/2-inch increments. That means you can produce some highly complex graphics with subtle variations of grey, black, and white.

Another area where the ink-jet printer shines is in color-graphic printing. Although dot-matrix printers are capable of color printing, they have some drawbacks. Since they are limited to the use of multi-color ribbons, dot-matrix machines take a longer time to produce a color output. Each color or color combination requires a different pass of the printhead and that slows things down more than just a little bit. Also, since the separate dots never completely line up, it is possible that there will be gaps in the final printout and solid areas may end up incompletely filled. Finally, since dot-matrix machines must rely on ribbons and since ribbons tend to wear out fairly quickly, outputs produced later in the ribbon's lifetime will be lighter than those produced earlier.

In contrast, a color ink-jet printer uses a special four-color ink cartridge and applies the colors, or combinations of color, when called upon by the graphics programming in the microcomputer. Since it is capable of multi-color output, the time needed to create the final output is shortened considerably. Further, solid-color areas appear much more uniform in density because it is possible to overlap the ink dots. Also, since it is possible to mix the colors directly on the printout, the ink-jet printer is capable of printing many more color combinations and hues than a dot-matrix machine.

Because the printhead of the ink-jet machine is microprocessor-controlled, it is possible to have the printhead dither. When the printhead dithers, it mixes the ink droplets in different intensities, thus creating darker or lighter color intensities.
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Cost comparisons

In general, you will find that the cost of ink-jet printers has fallen markedly during the last year, as have the prices of just about all computer printers. Roughly a year ago, it wasn’t uncommon for a good reasonable-cost ink-jet printer to cost between $2,500 and $6,000, with some of the top-quality machines costing up to $50,000. Now, the cost of a good ink-jet printer is approaching that of some of the more capable dot-matrix machines on the market, about $895. Even top-quality machines have had price drops, too, to the $30,000 region. As for a good color ink-jet printer, you’ll still have to wait some time until the prices drop even further. Even though their prices have dipped in the recent months, you’ll still find them expensive pieces of equipment, ranging in price from $5,500 to nearly $12,000.

Laser printing

Although their cost puts them beyond the means of most personal computer owners, if you own a large business, or have need of offset-printer-quality output, you may be interested in some of the laser printers currently on the market.

One such machine is the Xerox (Printing Systems Division, 840 Apollo Street, El Segundo, CA 90245) 5700. That system can produce documents in a wide variety of type styles (up to 256 can be stored), and in type sizes ranging from 6 to 24 points. Graphics can also be accommodated. Printing can be done on both sides of a page, plain paper is used, and up to 43 pages a minute can be produced.

CAPABLE OF OFFSET-QUALITY PRINTING, this Xerox 5700 laser printer can produce documents with a wide variety of type styles and sizes.

The key to the printer is a laser-imaging system. That imaging system has a resolution of up to 90,000 dots-per-square-inch, which is why the system can produce copy that compares favorably with offset printing. The key to the machine’s versatility is the fact that the location of each dot on the page can be individually controlled. Thus almost any image can be reproduced. Once the image is created, the actual printing is done using Xerox’s xerographic (photocopy) process.

You may be wondering about the cost for all of this. Well, the basic 5700 system can be had for about $65,000.

Dot-matrix developments

Perhaps the key development in the dot-matrix printer realm during the last year is the increasing density of the printhead. Quite typically, printheads used to have dot densities of $5 \times 7$ or $7 \times 7$ and now they routinely feature $9 \times 7$ or $9 \times 9$ dot densities in standard (draft) mode, and as many as $18 \times 24 \times 7$ or 9 in the near-letter-quality mode.

The dot density of a printhead isn’t hard to determine. It merely means the number of pins the printhead contains in vertical and horizontal rows. For instance, if the density of a printhead is $7 \times 7$, it would have 49 little metal pins enclosed in the printhead in seven horizontal rows and seven vertical rows. If the density is $9 \times 7$, then there are nine vertical rows and seven horizontal ones.

The biggest criticism of the dot-matrix printer in the past has been its “computerish” hardcopy output. That means that the printout is made up of very noticeable dots, no true descenders, and is very hard to read. However, that criticism has been pretty much nullified by the near-letter-quality output of some dot-matrix printers.

Using overlapping vertical rows of dots, those printers actually lay down two slightly offset dots during its print run. Those dots give the hard-copy a more “typed” look when it is printed. The dot-matrix manufacturers are able to achieve this thanks to the fact that they are using printheads with finer wires, which permits greater density (18 or $24 \times 9$). Since those heads also usually feature two extra horizontal rows of pins, they are also capable of having true descenders on such letters as “g” or “y.”

At one time—about a year-and-a-half-ago, that type of output was available only on machines costing more than $1,200, but now it is available on dot-matrix printers costing little more than $495. And, even low-cost printers—$199 to $499—have printhead densities of $7 \times 7$ or $9 \times 7$, so that their output has a more professional quality.

One problem with new near-letter-quality dot-matrix printers is that they take away one of the dot-matrix printer’s biggest advantages—speed. That’s because generating the slightly offset dots needed to produce the nicer looking output requires that each letter be actually printed twice, slowing down the entire process. But printer manufacturers have found a way to let us “have our cake and eat it, too.” That is, all but the least expensive dot-matrix machines these days are dual-mode. They offer a high-quality but slow near-letter-quality mode as well as a less attractive looking, but much faster draft mode. Typically, the print speeds on those machines vary from 40 to 80 characters-per-second in the near-letter-quality mode and from 160 to 200 characters and more in the draft mode.

Dot-matrix printheads

Let’s look at the typical printhead. A dot-matrix printer is called an impact printer with good reason. Its printhead contains fine wires that are fired electrically into a ribbon, which strikes a piece of paper, thus producing the image.

The firing of the pins is controlled by solenoids that are activated by electrical pulses received from the character-generating ROM. That ROM contains the ASCII code for the characters and the pins corresponding to that code are all fired at the same time to produce the required letter.

As are ink-jet machines, dot-matrix printers are almost universally bidirectional printing units—they print on both passes across the paper—and they usually feature logic-seeking printheads. Logic-seeking printheads seek the shortest path between two printing points thus cutting printing time. Because they are logic-seeking and microprocessor-controlled, dot-matrix printheads are usually capable of graphics output. Typically, most of them have a special programmable graphics mode that is capable of laying down nearly 80 x 80 dots-per-inch, and, even more if special graphics software is used.

Since there are few moving parts in a dot-matrix printer, other than the finefeed motor and motor used to move the printhead, those units tend to be fairly reliable. Printheads last a long time, on the order of 200 million characters, although that isn’t as long as a typical ink-jet printer.

The biggest drawbacks of dot-matrix printers are their noise and the fact that ribbons wear out fairly quickly. Most dot-matrix machines emit noise in the 55- to 85-dB range, which makes them rather uncomfortable to be near for any length of time. Newer machines, however, tend to be a little quieter.
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Dot-matrix machines also seem to run through ribbons very quickly, especially if they are used a great deal. That means that early printouts are good quality, but later printouts tend to be lighter and harder to read. And, if those ribbons aren’t used quickly, they tend to dry out and also produce lighter printouts.

**Daisywheel developments**

The other type of impact printer on the market is the letter-quality or daisywheel printer and its variant, the thimble printer. Both rely on essentially the same technology, but, during the last year, their capabilities have been increased markedly.

At one time, the average low-cost daisywheel printer was a unidirectional, noisy, slow-speed affair. It did produce top-quality printing, but the tradeoff was that it took forever to complete a printout. Those units tended to operate very slowly—12 to 18 characters-per-second—tying up the computer for long periods as they slowly worked their way through documents. If you wanted higher-speed, bi-directionality, and microprocessor control in your daisywheel, you had to spend nearly $3,000.

But, the last year or so has seen a change in this, beginning with the Smith-Corona (65 Locust Ave., New Canaan, CT 06840) **TP-1**. That was the first low-cost, bidirectional daisywheel printer for personal computer use. It debuted at a price of under $800 and set the trend toward lower-priced home units, whose prices seemed to keep on dropping. Now, it seems most major printer manufacturers have a low-cost daisywheel available.

The key to the change in the daisywheel market was the introduction of microprocessors in those devices. That development allowed low-cost daisywheel printers to gain bidirectional and logic-seeking capability. It also enables the daisy-wheel to be used for something that was once the province of the dot-matrix printer—graphics. Because the printhead can now be controlled with computer precision, the low-cost daisywheel printer can be programmed for a minimal level of graphics. It can produce such things as charts, graphs, and some limited pictorial matter.

Let’s take a look at a daisywheel printhead. Where a dot-matrix machine uses solenoids and pins, the daisywheel uses a whirling disk with flexible petals and a small hammer. Each letter is formed on a petal of the printhead, which somewhat resembles a daisy, it’s from the printwheel that the machine gets its name.

As the printhead moves across the page, it receives the ASCII codes output from the character-generation ROM. However, instead of those pulses activating a series of wires, they cause the whirling disk to align the appropriate letter-petal with the ribbon. The petal is then struck by the hammer, which produces the letter.

The key drawbacks of this machine, again, involve noise and speed. Even at their quickest, they are only about one-quarter to one-half as fast as the slowest dot-matrix machines on the market. But, the quality of the print they produce, since the letters are fully formed, can’t be beeped. Also, those printers give you the capability of changing typefaces or type sizes easily, as the daisywheels themselves can be changed.

A variation of the daisywheel printer is the thimble printer. In those machines, rather than a daisywheel, the print element resembles an upside-down thimble with spokes. As with the daisywheel, each of the spokes contains a fully formed letter.

**Thermal printers**

Thermal printers are dot-matrix devices. However, rather than using ink to do the printing, they use special heat-sensitive paper and pass it over a series of heated pins to create the print out. Thermal printers have always been among the least expensive devices on the market, but have suffered from the fact that the required paper is expensive and their output is often of poor quality. On the plus side, those printers are fairly fast.

The picture for thermal printers has gotten much better of late. For one thing, many of the new machines are capable of using plain paper. That’s more, thermal printers capable of multi-color output have now reached the market. Those use plain paper and heat-sensitive dye. The paper is drawn over a heater bar after the dyes are laid down creating the image. The result is a fairly inexpensive color printer.

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**THE SMITH-CORONA 7P-1** was one of the first low-cost, bidirectional daisywheel printers for personal computer use.

**THE CHARACTERS on a daisywheel are located at the ends of the "petals," when a hammer strikes the petal, the character is printed.**

**ONE OF THE NEWEST** thermal printers, this unit from IBM (P.O. Box 2989, Delray Beach, FL 33444), is for use with the *PCiR*.!
**Herb Friedman**

**Gadgets and Gizmos**

A look at some genuinely useful devices that can make life with your computer a bit more pleasant.

With the possible exception of IBM—who learned quickly from the mistakes of others—most manufacturers of personal computers went out of their way to "marry" the user to one brand of hardware. Through the use of non-standard connectors and signal lines, unusual hardware both in the computer and disk drives, and in some instances off-the-wall software, the object was to preclude the purchase of third-party hardware and software.

Fortunately, as with all things, there was more intelligence outside the companies than inside, and so a vast third-party hardware and software marketplace was created by unaffiliated entrepreneurs who manufacture or sell all sorts of gadgets, gizmos, and accessories for personal computers. In some instances the third-party vendors are so successful they eventually force the original manufacturer into providing similar equipment.

In this article we are going to take a look at some of the interesting and useful products that are available. Some you might have read about, others will be new ideas; some were developed on a kitchen table, others by the largest manufacturers.

While we're going to discuss specific devices for specific hardware, bear in mind that similar equipment is usually available for other systems. For example, if we cover an accessory add-on clock for a Radio Shack computer, it pays to ask if there's one available for your Apple, because there is.

Whether the accessories come from someone's basement or garage, or the manufacturer of the computer hardware, they add a notable degree of performance to personal computing, particularly to the low cost computers or those no longer supported by a manufacturer.

**Standard I/O**

For example, Osborne sold many Osborne-1 computers before the company went bankrupt. To say that the computer had many quirks would be kind, but because there are so many users and because the computer is still being sold let's look at how third-party gadgets handle two of the machine's more prominent hassles. First, the remote video monitor output. The Osborne-1 has an itty-bitty built in screen, so for extended viewing an accessory external monitor is needed to avoid eye strain. The computer's video monitor output, however, isn't standard composite video: it was intended for an Osborne monitor never seen in this neck of the woods. The second difficulty is the modern interface—it used a circuit known only to Osborne. Again, the object was to force the user to purchase an Osborne peripheral—a modem.

Third-party vendors take care of both problems at reasonable prices. The Exmon panel plug-in adapter (no wiring changes) from JMM Enterprises, Inc. (115 Batterys Ave., Enumclaw, WA 98022) provides the Osborne-1 with a composite-video output, which allows any standard composite-video monitor to be used with the original 52-column screen computer. If the computer was upgraded to 80/104 columns the adapter still works in the 52-column mode. (It moderately "scrambles" an 80-column display.)

As for the modem port, that's handled by a device called an Osbreak from Image Sales (Box 200, 2442 N.W. Market St., Seattle, WA 98107). The device connects to the Osborne's 9-pin modem connector and creates a standard 25-pin DB-25 RS-232-C input/output as well as a "true break" signal. A small pushbutton switch on the Osbreak's cabinet produces the "true break" required by some time-share computer and database networks. The Osbreak also permits a serial printer to remain connected to the computer while using a modem because the modem and printer no longer have to share a single RS-232 connector on the front panel.

Speaking of RS-232 interfaces, if you're into using different
THERE ARE MANY double-density disk upgrades for the Model 1, including this one from Radio Shack itself.

As the Color-Computer blossomed from a basic instructional machine into a rather sophisticated but inexpensive professional quality computer (lots of dynamic software is now available, among them one of the very best word processors), the single expansion port proved too limiting even for Radio Shack, and their latest catalog lists a port expansion unit that will accommodate up to four program cartridges and/or disk drive controller.

Upgrading the Color Computer

One of the computers for which there is a seemingly endless list of gadgets is Radio Shack's Color Computer. No one can quite figure out what Radio Shack had in mind for the color computer because expansion possibilities appeared—at first glance—to be sharply limited. It received some bad press, was even rumored to be on the verge of being discontinued, but here it is full of life, due mostly to third-party gadgets.

Let's run through some of the gadgets that made the unit a real winner—you might find just the item you're looking for. First off, there's the calculator-keyboard of the pre-1983 model. No problem here: replacement with a keyboard having typewriter keys is a 15-minute job for anyone. The keyboard is from Spectrum Projects (93-15 86th Drive, Woodhaven, NY 11421). You open the cabinet, unplug the old keyboard, plug in the new keyboard, close the cover, and you're ready to type on real keys.

How about some “letter quality” word processing from a Color Computer using a daisywheel printer with a polyethylene ribbon, the same kind of ribbon used on IBM typewriters? That produce “camera ready” — (for offset printing) documents. There are some real cheap but excellent printers that can do this, such as the Smith-Corona TP-1 and the Brother HR-1 and HR-15. But how do you connect those Centronics-type parallel printers to the “mickey mouse” 600-baud serial output of the Color Computer? You do it with a Color-Computer-to-Centronics printer interface from Botek Instruments (4949 Hampshire, Uxica, MI 48087). Unlike other hardware of every kind, the Botek unit comes with every cable and connector you will need, there are no extras. Just plug it in the way you get it. (Will wonders never cease?) By the way, by changing the unit's Radio Shack compatible input connector for a DB-25 you can use the device to interface other serial-output computers with a Centronics-type printer.

Finally, before we leave the Color Computer, consider the expansion port, of which there is only one. You can plug in a ROM program cartridge or a disk-drive interface, but not both at the same time. At least that's the way it was designed. But one of the most successful add-ons for that computer is a six-slot ROM port extender that allows the user to keep up to six ROM or RAM cartridges and/or the disk controller plugged in and ready to go at the touch of a switch. The device is from J-Nor Industries, Inc.

(6272 W. North Ave., Chicago, IL 60639).

As the Color-Computer blossomed from a basic instructional machine into a rather sophisticated but inexpensive professional quality computer (lots of dynamic software is now available, among them one of the very best word processors), the single expansion port proved too limiting even for Radio Shack, and their latest catalog lists a port expansion unit that will accommodate up to four program cartridges and/or disk drive controller.

Updating older computers

Were you one of the original computer hobbyists who built the Heathkit H8 computer? The H8 remains a good, rugged computer, but its single density hard-sectored disk drives are now somewhat behind the times. In fact, it's often difficult just to locate hard-sectored disk media, not to forget up-to-the-minute modern software. But the plug-in FDC-H8 controller from C.D.R. Systems, Inc. (7210 Clairemont Mesa Blvd., San Diego, CA 92110) will upgrade your H8 to both hard and soft-sectored operation in double density. The unit allows use of both hard and soft-sectored 5¼-inch disks, 8-inch disks, and double-density. If you also use one of the Z80 upgrade cards available for the H8 you should be able to read or run just about any modern CP/M software.

Speaking of “Old Timers,” the grand-daddy of them all is the Radio Shack Model 1 computer. About 300,000 were sold, most of which appear to be still in use. (They are hard to come by in the used-equipment marketplace and command almost their original price.) A Model 1, with the expansion interface, has lots of I/O ports and busses sticking out and ready for use. Give a hobbyist an accessible I/O bus and he'll probably build something to use the connection. That's exactly what happened. Until the introduction of the IBM PC, there were more gadgets and gizmos for the Model 1 than for any other computer—perhaps more than for all other personal computers put together.

The Model 1 has never really gone out of style and there are some exceptionally useful gadgets and gizmos still being produced for that computer. The list is almost endless, but here are a few highlights you might find useful. First off, a disk-system double-density upgrade which more or less doubles the storage capacity of the disk. There are several upgrade kits available including Radio Shack's own (which must be installed by a Radio Shack service center). For many, the least troublesome installation will be the Percem Doubler from Percem Data (11220 Pagennill Rd., Dallas, TX 75243). Percem's upgrade is user installed; it simply plugs in. It is supplied with the Dosplus 3.4 operating system, a good system presently being used by many independent software houses because they can provide a full run-time program for the Model 1 using it. (Radio Shack does not usually permit independent software houses to provide a run-time TRSDOS.)

If you want to experiment with voice synthesis, but have a tight budget, the old Model 1 is the way to go. For under $100 Alpha Products (79-04 Jamaica Ave., Woodhaven, NY 11421) will provide you with the software and a voice synthesizer that plugs right into the side of a Model 1 computer, using the old screen printer port on the expansion interface. Voice synthesizers are also available for other computers, most notably those from Apple and IBM, but not at $70 including the software.

Other Model 1 gadgets also available from Alpha Products include a plug-in clock module with a battery backup that displays time and/or date, a selector switch for two printers that plugs into the printer port of the expansion interface, and even a plug-in joystick for games.

Getting away from the computer itself, do you find yourself connecting and disconnecting plugs and cables when you change peripherals? Does going on line to a database through a modem mean you must disconnect your serial printer? Does changing to a daisy-wheel printer require you to disconnect the high-speed line printer? Maybe you need something like the active serial port expander, from Bay Technical Associates, Inc.
(Highway 603, Bay St. Louis, MS 39520). An active port expander isn’t just a simple switch. It has separate UART’s, buffers, and handshaking, and each port can operate with a different configuration (i.e., baud rate, stop bits, and handshaking) so you can drive any attached device without taking peripherals apart to move internal DIP switches.

**Printer accessories**

While we’re on the subject of peripherals, one of the most commonly used printers is the Epson MX-80 (and the newer version, the RX-80). Unfortunately, the printer accommodates only tractor-feed paper, the kind with the holes punched along the edges. If you want to use single sheets such as letterheads you must insert the sheet in a special plastic carrier that must first be pushed through past the print head before it reaches the tractor mechanism, a procedure that has been known to cause more print head damage than anything else. A better way to handle single sheets such as letterheads is to retrofit the printer with a Micro-Grip Friction Feed from Bill Cole Enterprises, Inc. (Box 60, Wollaston, MA 02170-0060). That device provides a small friction feed area for single sheets, yet it doesn’t interfere when feeding tractor paper. While it isn’t exactly a factory modification it does work. The device requires only a screwdriver and the opening of an MX-80’s cabinet (no soldering). The same job can be done on an RX-80 without opening the cabinet.

For those with the opposite problem—that of continuous tractor feed paper or forms on a single-sheet daisywheel printer—the manufacturer usually has a tractor feed accessory, though they often cost in the hundreds of dollars. The popular Smith-Corona TP-1 and TP-2 printers used with budget priced computer systems also have a tractor feed option, whose selling price, however, bears no relationship to the list price of about $200. With some careful shopping you should be able to pick up TP-1 or TP-2 tractors for about $60. (It’s the same tractor for both.) They are not the easiest thing to install, but all it takes is a screwdriver, perhaps pliers, and a lot of patience.

One of the all-time award-winning gadgets for printers is Fingerprint from Dresselhauser Computer Products (837 East Alosta Ave., Glendora, CA 91740). Fingerprint installs inside Epson printers, including the versions of that printer from computer manufacturers such as IBM and Texas Instruments. It will also retrofit the Okidata Microline 82 printer. The device provides 8 to 10 functions that are normally under software control by just touching the printer’s on-line, off-line, and linefeed operating keys in the proper order. The extra functions include condensed printing, emphasized (double-strike), double-size characters, automatic 8-space left indent so you can punch binder holes without cutting into text, automatic perforation skip-over, even italic print. It’s a plug-in device and installation requires opening of the cabinet and a modest degree of dexterity. If you have ever plugged an integrated circuit having 20 or more pins into a socket, installation shouldn’t take you more than 15 minutes from beginning to end.

While on the subject of printers, don’t overlook some interesting interfaces that allow the use of standard printers with the Commodore and Atari computers, both of which have proprietary printer I/O’s for their own printers. If you want to connect one of the inexpensive daisy wheel printers to those computers, it normally can’t be done. But there are a number of printer interfaces that will allow you to use a centronics-compatible printer with those computers. Just about any retailer that carries Atari or Commodore accessories will stock one or more of those.

In closing we’ll cover what is rapidly becoming one of the most desired peripherals: the “printer buffer.” Basically, a printer buffer is a memory device connected between the computer and the printer. When you want to print, you dump the contents of the computer’s RAM to the printing buffer, which in turn feeds the printer. Within seconds your computer is free for use while the buffer takes minutes or even hours to feed your documents to the printer. Buffers are available with 16K to 256K of RAM; the bigger your documents the more RAM needed for a total dump. (This article’s manuscript was handled by a 16K buffer, and took almost 23 minutes to print on a rather slow daisywheel printer. But, instead of staring at a “dead” screen for 23 minutes, we were able to use the computer to process a mailing list.)

Printer buffers are usually available as stand alone devices—complete unto themselves. But several models can be integrated directly into the computer. The Microbuffer line from Practical Peripherals (31245 La Baya Drive, Westlake Village, CA 91363) has “bare” models that plug directly into the Apple II series of computers and the Epson family of printers. Orange Micro (1400 N. Lakeside Ave., Anaheim, CA 92804) has a buffer that “docks” directly onto their Grippler +, Epson APL, and Apple parallel interfaces.

The list of gadgets and gizmos available for personal computers is almost endless, ranging from super-colossal “professional” joysticks (whatever “professional” is supposed to mean) to disk emulators for the IBM that require a second mortgage on the old homestead. We have only attempted to look at accessories that provide greater computing power or convenience for the user with a low cost computer system.

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**R-E**
Working with Databases

One of the best uses for a computer is to organize your records. Here's a look at some software that can help make that task easy.

For example, if we wanted an electronic file of our property for insurance purposes we might use a program such as Hayden's Personal Property Inventory (Hayden Book Co., Rochelle Park, NJ 07662), which creates four electronic bins named item, description, serial number, and value. Each of the electronic bins is called a field. There is the "item" field, the "description" field, etc. In a sense, the word "field" is generic for "storage bin." You can put any kind of information in the bins. But when your files have different fields, each bin, or field, must contain the same kind of information.

For example, an item field is the storage bin for the name of the item. The description field stores the characteristics of the item. The serial number field holds the date the item was purchased. The value field stores the cost of the item.

To ensure you get the information out correctly, the computer relates the data in one field with the data in other fields, so that if you specify a search for data on a "widget," the screen would fill with all the information on the widget: the description, serial number, and value.

Depending on the particular software, the program might even create new field data from the other fields. For example, assume that we had stored five items, each having a value of $5. We might possibly create another field called total value whose data will be the sum of all the individual entries in the value field. In this case, if we asked for a report on the total value field, the screen would display total value = $25, representing five items of $5 each. If we added data on a sixth item whose value was $6, the total value field would contain the value $31.

Programs that simply file information that can be accessed at will are logically called "electronic files." Files that permit the data to be compared, mathematically processed, and whose data can be extracted in random bits and pieces presented in a final report in numerous configurations are called "database managers"—meaning the user can not only file but manipulate the stored data so it produces a report in a specific format.

Report software for an associated database can produce a report on anyone or anything. Push a button and the computer will print paychecks from the payroll records stored in the database. Push another button and it will not only tell how many widgets were sold for each minute of last week, but it will project how many widgets will be sold per minute in 1987; and will tell...
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CIRCLE 92 ON FREE INFORMATION CARD
the boss how many keys per minute each word processor operator types, and the length of everyone’s coffee break, and the exact second (not minute) the assembly line workers punched in.

While database managers have enormous power in the sense the user can virtually write the data-handling program itself, they often prove to be extremely complex and difficult to use. For example, dBase II from Ashton-Tate (9929 West Jefferson Boulevard, Culver City, CA 90230), the best known of the personal computer database managers, is usually difficult to learn. There is even a separate training course (tutorial) for dBase II, and yet another expensive program to interpret the user’s ideas into the dBase II “language.” While some users can get a grip on the program in a matter of weeks, there are others who spend better than a half year and still cannot create the database.

The problem with these super database-management programs is the myth that everyone needs one. In fact, when run on a small personal computer—meaning 64K of RAM or less and a 5½-inch disk system with a storage capacity of about 200K per side, the super database is often difficult to organize, time consuming to use, and relatively expensive. Most home-and-family and small-business users simply don’t need that much “sophistication”—here sophistication is a euphemism for complexity.

The truth is that many users can get by with discrete data filing software—meaning individual programs that perform one particular database function—rather than a super-database that can process every conceivable file and record. To help you understand the kind of programs available in dedicated software, we’ll take a look at some of the simple data-filing systems.

Let’s start off with something very simple but very convenient: a random-access information file—a computer simulation of a 3 x 5 file card. Such a file is a good way to organize the bits and pieces of information we would like to have at our fingertips. Such information might include who we’re supposed to meet for lunch next Thursday; where we hid Mom’s gold wedding band when we went on vacation; where we filed that issue of Radio-Electronics with the article on direct-broadcast satellites; how much we paid for our cameras and where we placed the original sales slips (for insurance); the name of the person who reinished the office desks, etc.

There are many so-called “filing systems” but none the equal of SeekEasy (Correlation Systems, 81 Rockinghorse Rd., Rancho Palos Verdes, CA 90274). SeekEasy is self-contained; it does not require a word processor for data entry. It is totally random for both entry and search, with the entered information treated as a single file. The user can enter up to two lines (160 characters) of anything in any order. One entry might be: “Lunch, Feb. 3, 2 PM, Joe Smith, Widgets, Inc.” while another entry might be: “IRA Account 1983, East Bank Of The Missouri. 145-5678.”

If on Feb. 3 the user simply enters “Lunch,” “Feb. 3,” “Joe,” “Smith,” “2 PM.” or any combination, the entire entry will be displayed. Similarly, entering any piece of information from the IRA entry will call up the entire entry.

Even if the user gets the spelling or numbers incorrect a random access file will display and/or print the nearest equivalent. Naturally, the more precise and detailed the search-data entries, the narrower the range of displayed file information.

Random access files such as SeekEasy have no fields, no definitions, no report structure, nothing except total search of every character. If the information is there it will find it. Unfortunately, some random access programs are slower than others, anywhere from a few seconds to almost an hour. Again, for conventional personal computers the fastest we have seen or used is SeekEasy, which will random access 2.5K per second. Under the most difficult search conditions—the least amount of descriptive information—the program takes only 10 seconds to locate one of 100 records on a 5½-inch double-density disk system.

We have gone into a little extra detail on SeekEasy so that as we cover other types of filing systems you can put them in the proper perspective in terms of complexity of data entry, search and reports, speed, and ease of use.

When you need it all!

One of the real heavyweights in database management that doesn’t require a college course in how to program to use is Intopstar from MicroSoft (10700 Northup Way, Bellevue, WA 98004). That program really consists of two separate programs Database, which is the filing system, and Reportstar, which creates screen and printed reports. The user can purchase either program separately, or the complete package. Database allows the user to create a specific screen layout for entering data by simply moving the cursor around the screen and then typing in both graphic and character prompts.

A typical Database screen might contain lines composed of dots, with each dot representing a possible character entry. The
screen can also have special automatic formatting for such things as telephone numbers or Social Security numbers. The program then "remembers" the screen. The nice part about Datastar is that it works on every conceivable level, from rank beginner to advanced programmer. Once the screen is created it can be used as-is, or each prompt can be keyed to accept only certain types of information, or even convert information. For example, a name field can be keyed to accept only alpha characters, no numerals, with all entries automatically converted to upper case letters. In addition, some fields might be designated numeric only, while still others can be derived from other fields. For example, if five fields have numerical entries, a sixth field, one that is perhaps called total, or sum will be the value of the sum of the five numerical fields, or a field might contain derived information within a specific range.

The major point is that you only use as much of Datastar as you can handle. The more you learn the more you use.

Same thing with Reportstar. You can create either screen or printout formats—even new report fields—from the information in the Datastar file. Again, you can limit your reports to only the features you can handle comfortably.

An extra value of the Infostar system—particularly for the small businessman whose filing requirements might be constantly changing—is that as the user gets greater skill with the program, he or she can usually upgrade the formats without having to redo the entire database.

Basic systems

SeekEasy and Infostar are rather expensive programs, even though they run on moderate cost 8-bit machines. Similar features, although they are not as convenient to use or as flexible, are available in budget priced software for the low-priced personal computers.

For example, there's Filewriter, from Dynateck MicroSoftware, Inc. (7847 North Caldwell Ave., Niles, IL 60648), for the Commodore 64. That is a "program generator," which means that you create the screen prompts you want and the software then writes a program in BASIC that will perform exactly the functions you indicated on the screen.

The created program will store your information, retrieve it, and allow you to make updates and deletions. You can even moderately customize the entry fields for alpha or numerics only, date only, etc. much as you would do when using Datastar. You don't get the flexibility of a "professional" filing system such as Datastar, and the entry for each field can be no longer than a single line, but you get a lot of performance at the lowest possible price in a system that can be handled by the newcomer to personal computing. Also, Filewriter comes with a very thin but excellent manual that's easily understood by the beginner. It's also an excellent training aid for those who want to learn something about database management.

If you can put up with a program that's relatively slow to load and relatively slow to run, and you know nothing about programming or database management but need somewhat extensive computerized files, consider one of the more sophisticated program generators. Among the better ones is The Producer (Software of the Future, Inc., PO Box 1245, Arlington, TX 76004-1245).

That program is particularly well suited for the beginner because it comes with unusually good cassette-based training tapes. It's more sophisticated, and requires more skill than Filewriter, but you can eventually end up with a full-featured database that will do just about anything you want—the trade-off is that it will do it quite a bit slower than the super-database management systems.

Basement bargains

Now that the youngsters who used to hang out at Radio Shack in the late 1970's have grown up and graduated as computer-science majors, we're getting some really excellent low-cost database software for the budget priced home-and-family computers. Even though the programs might be priced as cheaply as a discounted "arcade game," some of them are good enough to be considered for part-time or small business use. For example, consider the basic Radio Shack Color File program consisting of the computer and a cassette recorder (no disk). One of the most convenient filing systems you're likely to run across for any computer is the $25 ROM-cartridge Color File for that minimum system.

Color File's power is an almost unbelievable sorting facility for what is obviously a rock-bottom price. The screen comes up with eight field selections. Seven are data fields with the usual home-and-family database labels such as ADDRESSES, WARRANTIES, CAR MAINTENANCE, etc. The eighth selection permits the user to define seven fields of his own choosing, each field having a limit of up to 32 characters each including the prompt. Each field can accept as many different entries (words, descriptions, or numerals) as will fit on the line. For example, if one field is designated INSURANCE, the entries might read: LIABILITY, AUTO, EQUIPMENT.

Now here's where the super-sort feature of Color File comes in. Once the data is stored in memory, the user can then sort on any field, sort again on any of the data for that field, sort yet again, and so on, to sort up the record field that sort, pick a second field, sort once or more on the second field, and then repeat the whole procedure for the remaining five fields. Color File will even sort on partial data. For example, if a field contains, widgets, gizmos, and gadgets, Color File will locate the record if you sort the "wid." To do that with almost any top-of-the-line database-management system would take anyone other than an expert several weeks of effort, and that's assuming, of course, they had the programming skill to start with.

Color File does not create its own fields, nor will it sum fields, and its 32 character line length including screen prompts is somewhat limiting, but for filing and retrieving information it's hard to do better.

As you can see, there are sharp differences in the way ordinary data can be processed by a personal computer, not to overlook the fact that the software can range in price from almost pocket change to several hundred dollars. Also, the same type of sophisticated feature, such as a multi-field sort, really doesn't depend on price. Surprisingly enough, the lowest-cost software might very well have the exact data-handling feature most needed for your use. When it comes to shuffling data, don't look at the brand name, the price, nor even the myth. Quite often, the best data-handling software is designed to do only one specific job, but do it extremely well.
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GARY McCLELLAN

Part 2

Last time we started building a device that keeps unwanted telephone calls from reaching you. It’s time now to finish assembling the main board. Once that’s done, we’ll turn our attention to the second part of the project, the decoder board. Incidentally, the decoder board has fewer parts and is easier to build than the main board, so it shouldn’t take as long to complete.

Before we continue, an incorrect Radio Shack number was given in the Main Board Parts List for RY1; the correct number is 275-213. Now, picking up from where we left off last time, let’s turn to the diodes.

Be sure to observe the polarities of those devices. Install four IN4002 diodes at D8-D11, next to the fuse. Then go to SO1 install a 1N4148 diode at D7. Move over to IC5 and install four IN4002 diodes at D3-D6. Finish up by installing IN4002 diodes at D2 and D1 as shown.

The capacitors are installed next. Since there are many, they will be installed a few at a time. Be sure to push the capacitor bodies firmly against the board before soldering in place. Also, double-check the polarities before soldering the tantalum or electrolytic capacitors in place.

Start by installing a 0.01-µF disc at C2. Then install a 0.22-µF film at C1. Move to the right and install a 47-µF electrolytic at C3. Then install a 1-µF tantalum at C4. Make sure the capacitors are installed properly before continuing.

Continue by installing a 0.1-µF polyester at C5. Then a 1-µF tantalum at C6. (Be careful not to install it in the R5 or R7 positions.) Install another 1-µF tantalum at C7. And install a 0.1-µF disc capacitor at C8.

Continue by installing another 1-µF tantalum at C10. Then install a 0.1-µF polyester at C12. After that, install another 0.1-µF polyester at C11, just below IC5. Move over the IC4 socket and install a third 0.1-µF polyester at C9.

At this point, the remaining capacitors are installed. First install 0.1-µF discs at C16 and C17. Then install a 470-µF electrolytic at C15. Make sure it is installed properly before soldering in place. Finally, install 0.01-µF discs at C13 and C14, next to F1.

Now the transistors and two IC’s may be installed. Be sure to position the flat side of the transistor cases as shown in the parts-placement diagram. Start at the top of the board. Install a 2N2222 transistor at Q2. Then install the other 2N2222 at Q1 near RY1. Move on to the IC’s, install a 78L05A at IC7 and another 78L05A at IC6.

Some wire jumpers are required and they will be installed now. Use pieces of leftover resistor or capacitor leads for them. Note that there are four jumpers and that they are located around the IC3 and IC4 sockets. Start with the jumper above IC3. Bend a lead to fit, then install it as shown. Move to the right of IC3 and install another jumper as shown. Finally, move to SO1 and install two jumpers above it. Be careful not to put a jumper in place of R16. Two other jumpers, located on the left side of the board, will be installed later.

The resistors are installed next. Since there are so many, they will be installed a few at a time.

Start by installing a 10K potentiometer at R12. Then move to the left and install a 1K resistor at R1. Then install a 10K resistor at R13 and a 4.7K resistor at R4. Then install a 100K unit at R6.

www.americanradiohistory.com
Continue by installing a 33K resistor at R8 and a 22K resistor at R9. Move to the left, next to IC1, and install a 10K resistor at R2. Then install a 1K resistor at R3. Jump over the capacitors and install a 270K resistor at R5. Then install a 10K unit at R7.

The remaining resistors, which are grouped around the IC4 socket, are installed next. Install a 100K resistor at R16, a 10-megohm resistor at R14, and a 2.2K resistor at R20.

The next step is to install the two insulated wire jumpers on the foil side of the board. Simply cut to pieces of insulated wire to the appropriate length and carefully solder them in place.

Finish up the assembly by installing the IC’s. Install the M290 into the IC2 socket. Then install a CD4538 into the IC3 socket and a CD4093 into the IC4 socket.

The decoder board

Let’s discuss the circuitry briefly and then build the board. The decoder has one basic job; to detect tone pairs from Touch-Tone phones or detect pulses from rotary-dial phones. A desired code number is programmed into the board, and whenever that number is detected, the board produces an output.

Returning to the main board, an output from the decoder triggers a one-shot. The one-shot enables a 2 Hz oscillator. As a result, the project produces a distinctive beep-beep-beep sound for ten seconds. That is what tells you to answer the phone.

Figure 5 shows a simplified schematic diagram of the board; the complete schematic is shown in Fig. 6. Incoming dial pulses or tones from the phone line appear on the dial pin of PL1. The tones or pulses drive IC1-a, an analog comparator. That device provides gain and squares up all signals.

The output from IC1-a branches in two directions, to the tone-detector circuitry and to the dial-pulse counter. The tone-detector circuitry consists of two phase-locked tone-detectors, IC3 and IC4. Recall that pushbutton tone telephones produce two tones, low and high. (That’s why the system is known as DTMF or Dual-Tone Multi-Frequency.) The low tones have frequencies of less than 1 kHz, while the high tones have frequencies that are above 1 kHz. At any rate, when the appropriate low and high tones are present, IC3 and IC4 produce logic-low outputs. Gate IC5 detects that condition and produces a logic-high output. The output from IC5 goes to a timer circuit that will be discussed shortly.

Note that the tone detectors are adjusted to respond to the number “7”. That means that the low-tone detector, IC3, is adjusted for 842 Hz and the high-tone detector, IC4, for 1209 Hz.

The dial-pulse circuitry consists of three parts—a pulse discriminator, a one-second reset, and a dial-pulse counter. Comparators are used for everything except for the dial-pulse counter.

The purpose of the pulse discriminator is to prevent tones from pushbutton phones, as well as any other stray audio, from clocking the dial-pulse counter. In effect, that circuit works as a low-pass filter.

In operation, input signals cause the output of IC1-a to pulse high. If the frequency is too high, diode D2 prevents capacitor C8 from charging. As a result, comparator IC1-b never triggers, and no output goes to the counter. But if the frequency is low, C8 has time to charge through resistor R10. The comparator then triggers and each pulse clocks the dial-pulse counter. Note that the values of R10 and C8 are set for 45 milliseconds, or half the pulse width of a standard rotary-dial phone.

The purpose of the one-second reset circuitry is to reset the dial-pulse counter on each pulse. That way, the circuitry will be ready for the next call. In operation, input signals cause the output of IC1-a to pulse high. That causes comparator C9 to charge through diode D1. At the same time comparator IC1-c triggers, removing the reset from the dial-pulse counter so that the counter is free to count pulses. About one second after the pulses stop, C9 is discharged through resistor R9. Thus, comparator IC1-c is untriggered and resets the dial-pulse counter.

The purpose of the dial-pulse counter, IC2, is to count pulses from rotary-dial type phones. It has eight decoded outputs and each output represents the number dialed. Note that there are two other outputs, but they are reserved for housekeeping purposes. Also note that the desired output, “7”, is jumpered to the 0.7-second timer circuitry. Note that for simplicity, only the “7” output is shown in Fig. 6.

The remaining portion of circuitry on this board is a 0.7-second timer. The purpose of that circuit is to prevent false triggering, mainly by the tone detectors, which can sometimes be tricked by human speech. For that circuit to produce an output, either the decoded tones or the dial pulse must be present for at least 0.7 second. For times less that that, the circuit will not produce an output.

In operation, a good pair of tones makes the output of IC5 high. That causes capacitor C17 to charge through resistor R19 and diode D5. If the tones last over 0.7 second, comparator IC1-d triggers and produces a high output. That triggers the decoder circuitry on the main board through the TRIG output of PL1. In the case of a rotary-dial phone, a good number makes the jumpered output of IC2 high. So capacitor C17 charges through resistor R20 and diode D6.

Note that after the tones or dial pulses disappear, resistor R21 discharges capacitor C17, untriggering the comparator. So the two output goes low and the circuitry is ready for the next call.

That completes the theory—on to assembly!

Assembly

Start by referring to the Parts List for the decoder board and obtaining all of the parts. Here are a few suggestions that may be helpful as you shop.

The IC’s are all industry standard, and many manufacturers make them. For example, the National LM567CN is also made by Signetics (NE-567N) and Exar (XR-567CP).

The only capacitor that might cause problems is C17—a 1μF tantalum type. A low-leakage electrolytic may be substituted for that capacitor if needed.

As for the resistors, R14 and R17 may require some searching. To make things easier, a supplier and part number is given in the Parts List. Also, two odd-value resistor types are used, 6.2 kilohms and 180 kilohms. If you can’t get the 6.2-kilohm units, simply parallel a 6.8-kilohm resi-
tor with a 68-kilohm unit. As for the 180-kilohm unit, simply parallel a 220-kilohm resistor with a 1-megohm unit.

You'll also need a PC board. If desired, order the set from the supplier given in the Parts List. Otherwise, you can make your own using the pattern shown in Fig. 7.

Once you have the parts, assembly can begin. Refer to Fig. 8, the parts-placement diagram, and position the board as shown.

Start with the IC sockets. Install a 14-pin socket at IC1 and solder in place. Then install another 14-pin IC socket at IC5. After that, install a 16-pin unit at IC2. Finish up the IC sockets by installing 8-pin units at IC3 and IC4.

Continue assembly with the two LED's. Be sure to look at the plastic cases carefully; one side should be flattened. And the lead closest to the flattened side should be shorter than the other. Install each LED with the flattened side (and short lead) to your right. Install LED2 first, near the top of the board. Then install LED1 in the same manner.

Continue assembly by installing the capacitors. Since there are so many, they will be installed a few at a time. Be sure to install the polarized capacitors with the + sign as shown in the figure, and double-check your work after soldering.

Install a 1-µF tantalum capacitor at C17 along the top of the board. Then move to your left and install a 0.1-µF disc capaci-
tor at C14. Move to the left some more and install a 47-µF electrolytic capacitor at C7. And after that, install a 0.1-µF polyester capacitor at C9.

Move to the bottom of the board and continue. Install a 1-µF electrolytic capacitor at C1. Then move up and install a 0.01-µF polyester capacitor at C2. Next, install a 0.1-µF polyester unit at C8.

Install another 47-µF electrolytic capacitor at C3. Then move up and install 0.1-µF polyester units at C4 and C10. Back up and install a 2.2-µF electrolytic capacitor at C5. Then above it, install another 0.1-µF electrolytic unit at C6.

Move up and install a 0.1-µF disc capacitor at C16. Be careful not to install it at R15 by mistake. Then install another 2.2-µF electrolytic capacitor at C12. After that, install another 1-µF electrolytic capacitor at C13. Finish up the capacitors by installing 0.1-µF polyester units at C11 and C15.

Continue with the four component-side jumpers. Use short pieces of leftover capacitor leads for those. Install the first jumper next to C14, along the left-hand side of the board. Then move to the bottom left side and install another jumper. Move to the center of the board and install the two remaining jumpers between the LED's.

Next, install jumper JU1. When that jumper is installed as shown the pulse-dial circuitry will respond to a damped 7. The remaining pads in that area are provided to allow you to select a different code number and are normally unused.

Continue assembly with the resistors. Since there are so many, they will be installed a few at a time. Start at the top of the board by installing a 1-megohm unit at R21. Then install 180K units at R20 and R19 on either side of the IC5 socket. After that, move down and install 100K units at R12 and R11, adjacent to the IC2 socket.

Install a 100-ohm resistor at R7, below R11. Be careful not to place that resistor in the D1 position. Then move to the right and install a 4.7K resistor at R8. Move to the lower lefthand corner of the board and install a 10-megohm resistor at R9. After that, move to the right and install another 4.7K resistor at R4.

Install two more 100K resistors at R5 and R3. Then move up and install a 22-ohm unit at R2. Move to the right and install a 47K resistor at R10. After that, install another 4.7K resistor at R6. Next, install a 2.2K resistor at R11. Bend the leads to size first, then install.

Move to the top of the board and install a 6.2K resistor at R18. After that, install a 20K potentiometer at R17. Be sure to push the body of the potentiometer firmly against the board before soldering it in place. After that, install another 2.2K resistor at R16.

Install another 6.2K resistor at R15. Then install another 20K potentiometer at R14. Push the body firmly against the board before soldering. Finish up by installing another 2.2K unit at R13.

Continue assembly by installing three short pieces of wire at the pads marked TP1-TP3. Use short pieces of leftover wire, cut to a length of 1/8-inch for that. Install two of the wires at the holes above R18. Then install the remaining one next to R15.

Next, we turn to the diodes. When installing the diodes, be sure to position them as shown. Double-check your installation after soldering. Note that all diodes are 1N4148's.

Install a diode at D5 as shown. Then install a diode at D6 to the left of it. Move down to the IC1 socket and install diode DI next to it. Then install diode D2 to the right of it. Move to the IC3 socket and install diode D3 next to it. And finally, move to the IC4 socket and install diode D4 next to it.

Continue by installing two insulated foil-side wire jumpers. Note that they are shown as dashed lines in Fig. 8.

**PARTS LIST—MAIN BOARD**

All resistors 1/4-watt, 5% unless otherwise noted

<table>
<thead>
<tr>
<th>Resistor Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, R3-1000 ohms</td>
<td>Metal film</td>
</tr>
<tr>
<td>R2, R7, R11, R13-10,000 ohms</td>
<td>Metal film</td>
</tr>
<tr>
<td>R4-4700 ohms</td>
<td>Metal film</td>
</tr>
<tr>
<td>R5-270,000 ohms</td>
<td>Metal film</td>
</tr>
<tr>
<td>R6, R16-100,000 ohms</td>
<td>Metal film</td>
</tr>
<tr>
<td>R8-33,000 ohms</td>
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<tr>
<td>R9-22,000 ohms</td>
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<tr>
<td>R10, R14, R15, R19-10 megohms</td>
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<tr>
<td>R12-10,000 ohms, potentiometer, linear taper, PC-board mount (Radio Shack 271-218)</td>
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<tr>
<td>R17-330 ohms</td>
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<tr>
<td>R18-470 ohms</td>
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<tr>
<td>R20-2200 ohms</td>
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**Capacitors**

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<td>C5-47 µF, 16 volts, radial leads, electrolytic</td>
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<td>C15-470 µF, 25 volts, radial leads, electrolytic</td>
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**Semiconductors**

IC1-TIL119 optoisolator (Texas Instruments) | Texas Instruments |
| IC6-M290 ring-detector subsystem (Mendakota—see below) | Mendakota |
| IC3-CD4558 CMOS one-shot (RCA) | RCA |
| IC4-CD4093BE CMOS Schmitt trigger | CMOS |
| IC5-MOC5010 optoisolator (Motorola) | Motorola |
| IC6, IC7-78L05ACP 5-volt, 100-mA regulator (Motorola) | Motorola |
| Q1, Q2-2N2222 NPN transistor | NPN transistor |
| D1-D6, D8-D11-1N4002 diodes | NPN diodes |
| D7-1N4148 diode | PNP diode |
| F1-0.25 amp, 3AG fuse | 3AG fuse |
| PL1-6 pin male PC-header (GC Electronics 41-046 or similar) | GC Electronics |
| RP1-12-volt DC coil (Radio Shack 275-213 or equivalent) | Radio Shack |
| PB1-Piezoelectric buzzer (Radio Shack 273-060 or equivalent) | Radio Shack |
| SJ1-SPST momentary pushbutton switch (Radio Shack 275-618 or equivalent) | Radio Shack |

**Miscellaneous**

PC board, solder, wire, 2 PC-mount fuse clips (Littlefuse 122087), IC sockets, etc. | Small parts |

The following is available from Mendakota Products, Ltd., PO Box 20HC, 1920 W. Commonwealth Ave., Fullerton, CA 92633: A set of three PC boards and the M290 ring detector IC (order part No. M290). The cost is $28.00 plus 5% sales tax. Sor-ry, no C.O.D.'s or credit-card orders.
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R-E
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We are the U.S. LIST PROTECTION COMPANY and we protect mailing list owners from having their valuable list of customers stolen or used without authorization. In addition, at the same time, we monitor the delivery of the United States Postal Service. This is a very important service for a mailing list owner to have. He has to protect his mailing list because in many cases, it cost him hundreds of thousands of dollars to compile. If a mailing list is stolen and left undetected, it could very well put the list owner out of business.

Here is where you come in and how we protect our clients from having their mailing lists used without authorization. We have thousands of mailing list owners who allow many authorized mailings on their list each year. Each time an unauthorized mailing is made, they are vulnerable to having their list stolen. Therefore, we supply the mailing list owners with a secret list of “decoy” names and addresses. He inserts these “decoys” into his mailing list without making anybody aware of it. Then if an unauthorized mailing is made on the list, the “decoys” will receive more mail than they are supposed to. A mailing list owner will have solid evidence of any unauthorized mailings and can pursue legal action on that basis.

You, as a Mailing List Protection Agent, will have your address and a code name used as a decoy. For example, if your name is Robert Smith, you may give yourself the code name of James Smith. This way you can distinguish your personal mail from the decoy mail. Now, when you get your daily mail, you will open the coded mail from the personal mail and put the date on the face of the envelopes of the coded mail. Each week you will take all of your coded mail and put it in a special package that we will supply. Then you will forward it to us for payment. What could be easier?

What Happens Next?

When your package of coded dated mail arrives at our office, we will count the number of pieces in the package and send you a check the same day along with another special package for your next group of coded dated mail. We then match the mail you sent us and forward it to the proper list owner for his use.

When you receive the next correspondence from us, it will include the following:
1) A payment of $30 for each coded dated piece of mail inside.
2) A payment for the postage money you spent to send us the previous package.
3) Another special package for the next group of mail.

Examples: Suppose various packages contained the following quantities of coded dated mail on different occasions. Here’s how much money you would receive:
- Group One contains 384 pieces in the package you forwarded us. WE PAY YOU $115.20 plus the postage money you spent to send us the package!
- Group Two contains 671 pieces in the package you forwarded us. WE PAY YOU $201.30 plus the postage money you spent to send us the package!
- Group Three contains 917 pieces in the package you forwarded us. WE PAY YOU $275.10 plus the postage money you spent to send us the package!

We want you because we have a current need for agents with decoy addresses all over the United States. Our address is so well known that it could never be used as an effective decoy. Let’s mention, many of our list owner clients are involved in regional mailings, thus we need decoys in all 50 states. Consequently, it doesn’t matter where you live, you can become a Mailing List Protection Agent as long as you have an address in the United States or Canada.

How You Can Get Started So You Can Make Extra Money As A Mailing List Protection Agent

In order to get officially registered as a Mailing List Protection Agent, you must pay a one time fee as indicated on the LIFETIME REGISTRATION CERTIFICATE. The fee covers all the computer costs of getting your code name and address integrated into the system, setting up your file for payment in our office, and start-up kit we will send you as soon as you register.

Your start-up kit consists of easy-to-follow instructions, an easy-to-complete form you must fill out once for our files, and your first special package to forward coded dated mailing pieces back to us for payment.

Imagine making extra money as a Mailing List Protection Agent. There isn’t an easier way to make an honest income. And the best part is that you can make a substantial second income and spend only a few short minutes each week doing it.

The amount of openings we have for Mailing List Security Agents is severely limited. We only need a few honest dependable individuals in each area. Therefore, you must register within the next two weeks to qualify. You have 14 days to forward us the LIFETIME REGISTRATION CERTIFICATE along with your payment. If you send your registration in after that time, we reserve the right to refuse your request and, of course, immediately return your remittance, if you’re rejected because you didn’t meet the deadline.

Now is your chance to get in on the easiest way of accumulating extra money that has never been made available. For the next 14 days, you have the chance to join others who are reaping the financial rewards by acting as a Mailing List Protection Agent. Don’t lose out on this opportunity to cash in. Say "YES" and ACT NOW before time runs out and it is too late!

Offer good in Canada - U.S. funds only.

Sincerely,

Susan Williams, U.S. List Protection Co.

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☑ YES, I accept your invitation to become a Mailing List Protection Agent.

☑ Enclosed is $25.00

☐ Cash

☐ Money Order

☐ Check

☐ Payment for my lifetime registration and start-up kit

☐ Postage service guaranteed (if you pay by cash or by money order)

☐ I’m in a hurry to make money! Enclosed is an extra $2.00. Please rush my start-up kit by first class mail

(PLEASE PRINT)

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Designing with Linear IC's

This month we inaugurate our new back-to-school series. This time around we'll be looking at linear IC's, and how you can use them in your own designs.

JOSEPH J. CARR

INTEGRATED-CIRCUIT TECHNOLOGY has made the job of circuit design much simpler. That's because those devices have progressed to the point that very few external components are needed to form a fully functional circuit. Consider, for instance, an operational amplifier: when setting the gain of those devices, the design simply entails picking the ratio of two resistors.

That's not to say, however, that working with linear IC's does not present its own unique problems. The purpose of this article, and the ones that will follow, is to introduce you to the various types of linear IC's. In the coming months we'll be looking at how those devices work, and how to use them successfully in your circuit designs.

IC construction

As you can see in Fig. 1-a, an IC is made up of layers of p-type and n-type semiconductor material. The bottommost layer of the IC is called the substrate. The substrate is about 6 mils thick and its area can measure from 50 x 50 to 160 x 160. In our example, the substrate is p-type material. In other IC's it could just as easily be n-type; it all depends on the design of the particular device.

The IC is fashioned by stacking alternating layers of p-type and n-type semiconductor material on the substrate as shown in Fig. 1-a. Each layer measures about 5- to 30-micrometers thick.

That brings us to one of the most basic design considerations that must be remembered when designing IC circuits. The p-type substrate and n-type next layer form a PN "diode" junction that must be reverse biased under normal conditions. The circuit designer must keep that constraint in mind. Although some clever designers are able to use forward bias for that junction, accidental reverse bias can destroy the device. In general, then, the substrate should be connected to either ground or to the case if it is made of metal.

Incidentally, the circuit formed by the IC is shown in Fig. 1-b.

Differential amplifiers

The heart of most linear IC amplifiers is the transistor differential amplifier shown in Fig. 2. A differential amplifier is designed to produce an output signal that is proportional to the difference between two input signals.

Transistors Q1 and Q2 form a differential pair because their emitters are tied together and their emitter currents are determined by a common constant-current source. Since the current, I1, from the constant-current source can not vary, it can neither increase nor decrease in response to changes in load. Since the sum of the transistor's emitter currents, I1 + I2, is equal to I1, we may conclude that keeping the sum constant, because I1 is constant, requires one of the currents to decrease if the other increases. In other words: if I1 increases, then I2 will decrease, and if I1 decreases, then I2 will increase. Those relationships are critical to understanding the operation of the differential amplifier circuit.

For purposes of this discussion, we will assume that the collector and emitter currents of the transistors are identical. (In fact, however, those currents differ by the amount of the base current.) We will therefore assume further that I1 and I2 are also the collector currents of Q1 and Q2 respectively.

The voltage appearing at the collector of Q2 is our output signal V0. The base of Q2 is designated the inverting input (symbolized by a - sign), while the base of Q1 is the noninverting input (symbolized by a + sign). By definition, those two inputs produce equal but opposite effects on the output signal. That means the two inputs will produce out-of-phase outputs. The output signal produced by the noninverting input is in phase with the input signal; the output signal produced by the inverting input is out of phase with the input signal. A consequence of that action is that identical voltages applied to both inputs will cancel each other and produce zero output.

Let's first examine the operation of the inverting input—the base of Q2. When both V1 and V2 are zero, then V0 is at a quiescent value, or zero. If V2 is made positive, current I2 will increase (Q2 is
The voltage drop across R3 will also increase, so \( V_O \) will go down. In other words, a positive-going input signal produces a negative-going output; the input is an inverting input.

The noninverting input is the base of Q2. When \( V_I \) is made positive, current \( I_2 \) will increase. Since the sum \( I_1 + I_2 \) is constant, current \( I_2 \) must therefore decrease. With \( I_2 \) decreased, the voltage across R3 is less, so \( V_O \) increases. In that case, a positive-going input signal creates a positive-going output signal: thus the base of Q1 is truly a noninverting input.

### Operational amplifiers

By far the most popular IC linear amplifier is the operational amplifier, whose schematic symbol is shown in Fig. 3. The typical IC op-amp consists of a differential input amplifier followed by a high-gain amplifier chain. The output stage must be bipolar, meaning that it can go either positive or negative.

Let's examine the pinout of an op-amp for a moment. First, what is not present in the device shown in Fig. 3-a? The answer to that is that no ground or common terminal is used! There are two power-supply terminals \((V_+ \text{ and } V_-)\), but no ground. Rest with that mystery for a bit; we'll explain it shortly.

Finishing up with the pinout, the two inputs, inverting and noninverting, are the same as discussed previously. The output terminal is self-explanatory.

The ideal op-amp has the following properties: Infinite open-loop gain, infinite input impedance, zero output impedance, zero noise contribution, infinite bandwidth, and, finally, inputs that “stick together.”

Open-loop gain means the gain with no feedback, and for the ideal op-amp it is infinite. The open-loop gain for real op-amps is not infinite, but it is very, very high (20,000 for inexpensive devices, over 1,000,000 for premium-grade op-amps). Infinite input impedance implies that the ideal op-amp input will neither sink nor source current. Again, real op-amps differ from the ideal. The input impedance is not infinite, but is very, very high (1 megohm to over 1012 ohms).

The output impedance of real op-amps is not zero, but is very low (usually under 100 ohms). That property makes it a nearly ideal voltage source to drive any following stages.

Zero noise contribution means the op-amp supplies no noise of its own to the output signal. That ideal is rarely met, however, and one must use premium-grade “low noise” devices if noise is a factor.

What about infinite bandwidth? Few op-amps have gain-bandwidth products over 2–3 MHz, and frequency-compensated types (e.g., 741) will provide substantial gain only to 10 kHz.

What does “inputs that stick together” mean? It means we must treat both inputs the same. If we apply a voltage to one input, then we must treat the other as if the same voltage were applied to it also! And that is not just some theorician’s mumbo-jumbo. If you apply 2 volts to the inverting input, you will measure 2 volts on the noninverting one as well! That property will be very important when we analyze op-amp circuits in the months to come. In fact, you may have already been exposed to that concept, but under the confusing heading of “virtual ground.” A virtual ground occurs when the noninverting input is grounded. In that case, we must treat the inverting input as if it were also grounded! Hence, the inverting input is said to be at “virtual” ground.

Designing circuits around the operational amplifier is made a lot easier by the fact that gain is set simply by the ratio of feedback and input resistors. We can tailor frequency response with simple R-C networks, or even just a capacitor in parallel with the feedback resistor.

The operational amplifier also simplifies the design of electronic integrators, differentiators, and logarithmic amplifiers. In fact, it was in those kinds of circuits that the op-amp was first used. The name “operational” amplifier came about because that type of amplifier could perform mathematical operations in analog computer circuits.

The power supply for operational amplifiers, and many other linear IC’s, is shown in Fig. 4. Although batteries are shown here, electronic regulated power supplies may be substituted. The typical op-amp will operate at any voltages between ±4.5 volts and ±18 volts, with some operating at ±22 volts.

There are actually two separate supplies used: +V and −V. The +V power supply is positive with respect to ground, while −V is negative with respect to ground. There is no ground terminal on the op-amp. The signal common is the ground terminal of the power supply. The inverting and non-inverting input signals, and the output signal, are referenced to the power-supply common.

Power-supply decoupling capacitors are not always needed, but it is a good idea to include them. Generally those decoupling capacitors are placed close to the body of the op-amp, rather than at the power supply. For frequency-compensated devices such as the 741, you might be able to get away with no decoupling at all. But for all uncompensated types use 0.1-μF capacitors to ground both the +V and −V inputs. It is also wise to use 1-μF tantalum capacitors in parallel with the 0.1-μF units in order to take care of low-frequency decoupling.

Power-supply specifications for op-amps can be a little confusing. We have two basic problems: supply-rail limit and maximum allowable voltages.

The supply-rail limit refers to the minimum difference between the power-supply potential and the maximum output signal voltage. For common 741-type devices, that potential might be 3.5 volts. The maximum output signal potential, therefore, is 3.5 volts below the power-supply voltage.

How does that affect the designer? Suppose you are designing the input signal amplifier for a 10-volt A/D converter. You want the maximum signal amplitude to be 10 volts, obviously. The DC power-supply potential must be 10 + 3.5, or 13.5 volts DC. If you had planned to use ±12-volt DC supplies then your signal would clip at 11.5 volts! For 12 volt DC supplies, the maximum output signal would be 12 - 3.5, or 8.5 volts!

Some op-amps have small supply-rail limits. The BiMOS devices, for example, can come within 0.5 volt of the supply rail. The usual way of guessing that limit (if it isn’t published) is to count the number of PN junctions (base-emitter or base-collector) in the transistors between the output terminal and either power supply terminal. Then multiply by 0.6 volt. The positive (+V) and negative (−V) supply limits may be different on some op-amps.

The problem of maximum supply potential comes about only when trying to operate the device at maximum, and not thoroughly reading the spec sheet. The VMAX ratings might be ±18-volts DC, leading one to believe that +V and −V may both be 18-volts DC. That’s not always true! Look for the specified termi-
nal-to-terminal maximum voltage, that is, the maximum voltage that may safely be applied between +V and −V terminals of the op-amp.

Let’s look at a “tor instance!” The 741 device has maximums for −V and +V of ±18-volts DC, but a terminal-to-terminal maximum of only 30 volts. If we applied 18-volts DC to both +V and −V, the potential would be +V − −V = 18 − (−18) = 36 volts. That potential exceeds the 30-volt limit. If we apply maximum potential to one terminal, then the other must be derated to stay within the specification. For example, in the case above let’s assume +V is 18-volts DC. The maximum allowable for −V is 30 − 18, or 12 volts DC. In that case, we would set +V = 18 volts DC and −V = 12 volts DC.

We also sometimes see a related problem that causes op-amp burn-out at strange times. If the supply voltages rise unevenly at turn-on, or decay unevenly at turn-off, it is possible that some op-amps will burn out. Such problems occur mostly when one supply has a lot more capacitance than the other, or when one supply is a lot more heavily loaded than the other.

A similar problem occurs if the input voltage is allowed to rise higher than a supply voltage. The result can be an incorrectly biased substrate and burn-out of the device. That problem usually occurs only when there is some energy-storage device, such as a large capacitor, at the input terminal. In that case, the input voltage may decay at a slow enough rate that some voltage remains at the inputs after power to the device has been removed.

Current-difference amplifiers

The operational amplifier is only one form of linear IC. There are, of course, dozens of others. Many of them are special-function devices (e.g., cassette-tape recorder pre-amplifiers, etc.), but at least two devices have quite a bit in common with the op-amp.

One of those devices is the current-difference amplifier (CDA); that device is also called the Norton amplifier. In essence, the CDA is a current-input/voltage-output device, so it can be called a trans-resistance amplifier.

The CDA is particularly useful in automotive applications, or other cases where a single monopolar power supply is used. Although the CDA never caught on like the op-amp, it is nonetheless very useful. We will examine the CDA in detail in a future article.

The OTA

The other device that has a lot in common with an op-amp is the OTA (Operational Transconductance Amplifier). Figure 5 is a circuit model for that device. The input is modeled as a simple resistance, much like an ordinary operational amplifier. The output, however, is modeled as a current source, where the magnitude of the current is equal to $G_{M}V_{IN}$; the “gain,” therefore is the transconductance ($G_{M}$).

The transconductance operational amplifier will also be discussed in full in a future article.

In the next part of this series we will get down to brass tracks with the op-amp. Discussed will be the inverting-follower circuit configuration, how to set gain, and how to determine minimum input resistances. We will also introduce you to certain op-amp problems—and their solutions.

R-E

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![Save the clouds.](image)

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**One-Stop Component Center**

- Quality Components
- Over 680 Items Available From Our 600 Authorized JIM-PAK Distributors
- Competitive Prices
- Distributors Welcome
- For information call (415) 595-5936 Telex #176043

**CONNECTORS AND ACCESSORIES**

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**GENDER CHANGERS**

Used to connect 2 cables which have the same gender.

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<td>JRSF-M</td>
<td>Connects 2 male (DB25P) cables</td>
</tr>
<tr>
<td>JRSF-F</td>
<td>Connects 2 female (DB25S) cables</td>
</tr>
</tbody>
</table>

**D-SUB CONNECTORS**

**SOLDER-TYPE CONTACTS**

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>DE9P</td>
<td>9 pin Plug</td>
</tr>
<tr>
<td>DE9S</td>
<td>9 pin Socket</td>
</tr>
<tr>
<td>DE9H</td>
<td>Hood for DE9 Series Connectors</td>
</tr>
<tr>
<td>DA15P</td>
<td>15 pin Plug</td>
</tr>
<tr>
<td>DA15S</td>
<td>15 pin Socket</td>
</tr>
<tr>
<td>DA15H</td>
<td>Hood for DA15 Series Connectors</td>
</tr>
<tr>
<td>DB25P</td>
<td>25 pin Plug (Meets RS232)</td>
</tr>
<tr>
<td>DB25S</td>
<td>25 pin Socket (Meets RS232)</td>
</tr>
<tr>
<td>DC37P</td>
<td>37 pin Plug</td>
</tr>
<tr>
<td>DC37S</td>
<td>37 pin Socket</td>
</tr>
<tr>
<td>DC37H</td>
<td>Hood for DC37 Series Connectors</td>
</tr>
<tr>
<td>DD50P</td>
<td>50 pin Plug</td>
</tr>
<tr>
<td>DD50S</td>
<td>50 pin Socket</td>
</tr>
<tr>
<td>DD50H</td>
<td>Hood for DD50 Series Connectors</td>
</tr>
</tbody>
</table>

**MICRO CHARTS**

**Instant Data on the Most Popular Computer and Microprocessor Parts**

- Fully decoded data
- Compact 8½” x 11” size
- Durable credit card plastic
- Clear and concise two-sided tables for full instruction set, disassembly, ASCII, base conversion, pinout & much more...

**Part No.**

| ML280  | Z80 CPU |
| ML6502 | 6502 (65XX) |
| ML7400 | 7400/7400 TTL Pinouts |
| ML8080A | 8080A/8085A |

**CARD-EDGE CONNECTORS**

**JE750 4-Digit Fluorescent Alarm Clock Kit**

The JE750 Alarm Clock Kit is a versatile 12-hour digital clock with 24-hour alarm. The clock has a bright 0.5” high blue-green fluorescent display. The display will automatically dim with changing light conditions. The 24-hour alarm allows the user to disable the alarm and immediately re-enable the alarm to activate 24 hours later. The kit includes all documentation, case and wall transformer. Other features: flashing你看下这个表格。
The I/O
The RS-232 port is really part of I/O system, which we'll be discussing in a future installment of this article. However, we must introduce it now because it is required for any operator I/O. It also must be used to confirm proper operation of the basic system.

The RS-232 port can be implemented in two distinctly different manners. The first and easiest is to use a UART (Universal Serial Asynchronous Receiver Transmitter) IC. The UART constantly waits for an incoming character, receives it according to whatever protocol has been programmed, and stores the character in a holding register until the microprocessor requires it. Transmission is simply a matter of writing the character to the UART's transmit register.

The other alternative—the one that we'll use—is to use one input and one output of the board to send and receive the serial data. That method requires the microprocessor to assume control of the entire process of data reception and transmission. However, it eliminates the requirement for a large and expensive component. The principal limitation of this approach is that the microprocessor must know when to expect a character and must be executing its input routine before the character is sent to the board. That's not a problem for most applications. In the case of BASIC, it means that all console commands and program INPUT statements are handled easily. However, there can be no INKEY$ statement.

The eighth output and eighth input of the bit-addressable I/O port will be used to implement the RS-232 port. The requirement for a negative voltage supply for the RS-232 link can be avoided if a bit of foxy circuit design. The incoming RS-232 signal is normally at the “mark” or negative level. Every character transmission ends with a stop bit designed to return the line to the negative level. We can generate our level from the incoming RS-232 line. That approach works fine for cables of less than 10 feet long. If longer cables are used, a negative supply between -5 and -12 volts DC should be used. Such a supply is available from the power-supply board, which—as we mentioned previously—we'll discuss in a future installment.

When examining serial asynchronous waveforms, remember that a logic one is less than -3 volts DC and a logic zero is greater than +3 volts DC. The line is held in the mark or one state when not active. The transmission always begins with a start bit = 1 and ends with a stop bit = 1. The stop bit returns the line to the mark state.

Full duplex serial operation that means separate wires carry data to and from the control computer (at terminal). Pin 2 of the RS-232 connector is transmitted data to the computer. Pin 3 is received data from the computer. At the terminal, these two pins are reversed so that pin 2 is an output and pin 3 an input. If you are using a personal computer as a terminal, you must determine if the RS-232 port of your computer is configured as a terminal or as a computer. Whatever the case may be, connect the board's input to the terminal's output and vice versa.

### PARTS LIST—COMPUTER BOARD

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Resistors</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1-C13, C15</td>
<td>R1, R2, R3</td>
</tr>
<tr>
<td>C14, C16</td>
<td>R4, R5, R7, R11, R12</td>
</tr>
<tr>
<td>C17, C18</td>
<td>R8, R9</td>
</tr>
<tr>
<td>C19, C20</td>
<td>R10, R12</td>
</tr>
</tbody>
</table>

Note: All resistors are ±1 percent.

### PARTS LIST—POWER-SUPPLY/BSR LINK BOARD

<table>
<thead>
<tr>
<th>Capacitors</th>
<th>Resistors</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1, C2</td>
<td>R1, R2</td>
</tr>
<tr>
<td>C3-C6</td>
<td>R3, R4, R6</td>
</tr>
</tbody>
</table>

Note: All resistors are ±1 percent.
Building the control computer

The actual assembly of the assembly of the controller requires no special techniques. You can use a printed-circuit board (we showed the foil patterns for the double-sided board in Figs. 2 and 3) or you can wire-wrap the project. You are probably better off with the PC board. Troubleshooting will be easier, and assembly will be quicker—about an hour. Assuming you already have the board. (If you are not able to make your own board, see the Parts List for a supplier). Wirewrapping the project will take about 16 hours. One note on wire-wrapping: Do not give into the temptation of wire-wrapping directly to the leads of the discrete components. The integrity of a wire-wrap joint depends on the square corners of the post.

If you have the printed-circuit board, simply follow the parts-placement diagram in Fig. 4. Be careful not to create solder bridges, and when you are finished, wash the board in flux solvent. That will remove any flux residues left on the board. Don't forget that we've showed the foil and parts-placement diagrams for only the computer board. The power supply and BSR-type controller will be located on a separate board of the same size. We'll discuss that single-sided board next time, and we'll give you some more hints on the control computer's construction.

Troubleshooting

After you install all the parts, carefully inspect your board. You should check that all IC's are in the correct sockets and that they are correctly oriented. Transistors and diodes should also be checked. Then measure the power-supply voltages. Although we have not yet discussed the board for the power supply and BSR-type controller, you can test the computer board if you have a +5-volt DC regulated supply.

Regardless of what supply you use, ensure that it is the correct voltage, and be sure to orient it correctly. Reversing the power-supply polarity is like reversing an IC, only it's more efficient—it will burn out all of the IC's. The BASIC operating system should be inserted into the system ROM socket (IC9). The first memory socket (IC12) should contain a 2016 RAM IC. Do not insert additional memory yet. Also, unneeded I/O should be removed. Get your terminal to the proper protocol (4800 baud, no parity, 8 data bits, full duplex, caps lock on) and connect it to the board. Apply +5 volts DC. If the BASIC prompt (>) appears, we can assume that the basic microprocessor circuits are correct. (If you use the BASIC II operating system, then you do not have to set your terminal to 4800 baud. Simply hit the space bar within 7 seconds after the board is turned on or reset.)

If the BASIC prompt does not appear, then we have some troubleshooting to do. Unfortunately, though, we've run out of room to talk about it this month. But it's the first thing we'll deal with next time.

Along with the troubleshooting hints, we'll look at the power supply, remote controller, and also the I/O capabilities of the computer.
Testing transistors
EARL (DOC) SAVAGE, K4SDS, HOBBY EDITOR

IN THE FEBRUARY 1984 "HOBBY CORNER" we discussed how to make realistic battery tests. Well, this month we’ll turn to another testing problem. Glen Gartner (PA) asked a question about how to test bipolar transistors. He needs a procedure that uses minimal equipment—such as only a multimeter. Since that topic is sure to interest many of you, we’ll spend some time on it. We’ll start with a look at some transistor basics.

Essentially, a transistor is a couple of diodes that share a common element. That sharing causes one diode to be affected by what happens in the other. Of course, that is an over-simplification—you could not make a transistor using two discrete diodes—but that model does generate a mental picture that is helpful to us.

Current flow in a transistor
You know that a diode is a two-terminal device that passes current in one direction, but has a very high resistance to current flowing in the opposite direction. Conventional current flows freely from the diode’s anode to cathode. Figure 1 shows the schematic symbol for a diode—current flows in the direction of the arrow.

Now let’s get back to the transistor. You know that there are two bipolar types: PNP and NPN. The symbol for the PNP transistor is shown in Fig. 2-a. Figure 2-b shows how you can think of the PNP transistor. In effect, there are two diodes with a common cathode (the base). From our discussion of diodes, it is clear that the PNP transistor has low resistance to current flow from emitter to base and also from the collector to base.

Now that we know how to think of the transistors, we can go about testing them. But first we have to be able to identify the leads. Figure 4 shows some common transistor-package types along with their pinouts.

The next task is to determine the polarity of your multimeter probes when it is in the resistance-reading mode. Do not assume that the black one is negative! You can test the polarity by tracing the internal wiring of the meter or by using a second meter. Of course, you can use a marked diode and measure its resistance in both directions—the resistance will be greater when the negative probe is on the anode. Once you determine the probe polarities, mark your meter permanently so that you won’t have to check it again.

Now you’re finally ready to find out whether the transistor is a PNP or NPN type. Before I tell you, think about the information we’ve gone over so far. You have everything you need to make the test. Can you figure it out?

Connect one meter probe (in the high-resistance range) to the base of the transistor. Measure the resistance to the emitter and, again, to the collector. Then connect the other probe to the base and repeat the measurements. Both of the first two readings will be higher than both of the second set of readings. If not, you either have a defective transistor or you have identified the three leads incorrectly.

Assuming that both readings in one set are greater than both in the other set, apply this rule: If the readings are higher when the negative probe is on the base, the transistor is an NPN type. Otherwise, it is a PNP transistor. Once you get the hang of making this measurement, you can test transistors quickly—at least in less time than it takes to explain it!

Is it good?
Now you have the leads identified and you know the transistor type. However, you still do not know if the transistor works! There are several ways to test a transistor. First you can substitute a transistor known to be good for a suspect one in a circuit. If the circuit then functions, the original transistor is bad. On the other hand, if it doesn’t function, you cannot be
sure of the transistor—either it or another component could be bad.

You can also test many transistors with a multimeter. In this procedure, start with the highest resistance scale each time and move down as necessary. Here are the steps:

1. Connect the probes to the base and collector.
2. Reverse the probes and note the resistance.
3. Connect the probes in the direction of the highest resistance.
4. Short the emitter to the base if the transistor is good, the reading will decrease.
5. Change the base probe to the emitter.
6. Short the emitter to the base. If the transistor is good, the reading will increase.

A simpler and more reliable way to test a transistor is to put it in a test circuit. The simple audio oscillator shown in Fig. 5 will keep softly with every good bipolar transistor that you plug into it. The resistors and capacitor values are not critical—almost anything in the ballpark will work. In addition, the voltage is so low that the transistor won’t be damaged if you plug the leads in wrong or if the switch is in the wrong position. For convenience, you can build this little tester in a small utility box, so that it will be on hand whenever you need it.

There is, of course, a fourth way to test transistors. I have admitted my laziness to you in the past, so it will come as no surprise that I use a handy-dandy commercial transistor checker. You, too, might take a look at Radio Shack’s 22-025. It’s small, versatile, and costs less than $15. It will check transistors both in-circuit and out-of-circuit, and will even give a relative beta measurement. You can also use it as a continuity checker or as an audio oscillator. Like the checker circuit we built, the tester is safe—you can plug transistors in backward and not damage them.

All right, Glen, you and other readers can surely find one suitable way to do your

continued on page 113
Making true RMS measurements

ROBERT F. SCOTT, SEMICONDUCTOR EDITOR

The accuracy of measured RMS values of AC voltages has always been questionable. That’s because the shape of the AC wave being measured can drastically affect the readings of many voltmeters. In most multimeters and AC panel meters, the AC wave is rectified to develop a DC voltage that is proportional to the RMS value. For example: two popular analog multimeters specify their AC voltage accuracy as 5% of full-scale value when measuring a 60-Hz sine wave. Accuracy “goes out the window” if the input signal’s shape is nonsymmetrical or if the signal approaches a triangle or pulsed waveform.

Semiconductor manufacturers have developed monolithic RMS-to-DC converters that permit AC voltages to be measured with maximum errors that are a small fraction of one percent. A recent addition to this category of devices is the AD637 from Analog Devices (One Technology Way, PO Box 280, Norwood, MA 02062).

That IC is a monolithic, high-accuracy RMS-to-DC converter that can be used to compute the true RMS value of any complex AC waveform. In addition, the device computes the square, mean-square, and absolute values of complex AC or AC superimposed on DC input waveforms. Its circuit features a wide bandwidth: 8 MHz when the input is 2 volts RMS or above, and 600 kHz with a 100-millivolt RMS input. The circuit includes built-in compensation for crest factor and handles signals with crest factors of up to 10 with less than a 1% increase in error. Crest factor, CF, is the ratio of a signal’s peak amplitude to its RMS value: $CF = \frac{V_{peak}}{V_{RMS}}$. Sine and triangle waves have low crest factors that do not exceed 2. Pulse trains with low duty-cycles have much higher crest factors. For example, a rectangular pulse series with a 1% duty cycle has a crest factor of 10.

A voltage equal to the logarithm of the RMS output signal is brought out to a separate pin on the AD637 so that the user can make direct measurements in decibels. The 0-dB measurement range is 60 dB; the 0-dB voltage-reference level can be set to between 0.1 volt and 2.0 volts RMS by providing an external reference current.

How the circuit functions

The only external component required for RMS-to-DC conversion is a capacitor that controls the averaging-time period and determines the low-frequency accuracy, ripple level, and settling time. Figure 1 is a functional diagram of the IC. We can think of it as being made up of 4 main sections. The first is an absolute-value circuit (active rectifier) made up of A1, A2, and their associated components. The second is a square/divider made up of A3 and Q1-Q5. Third is a filter/amplifier. A4, and fourth is buffer/amplifier A5. (The buffer amplifier can be used either as an input buffer or in an active filter configuration: it is a user option.)

The input voltage, $V_{in}$, is rectified by active rectifier A1-A2 to produce a unipolar current $I_1$. That current drives input to the squarer/divider which has the transfer function: $I_2 = I_1/2^{\text{CF}}$

The output current of the squarer/divider, $I_2$, drives A4 which, along with the external averaging capacitor connected to pin 9, forms a lowpass filter. If we make the time constant of the filter much longer than the longest period of the input signal, A4’s output will be proportional to the average value of $I_2$. The output is taken back to A3 to provide current $I_3$, the denominator of the transfer-function equation above. See the standard RMS conversion circuit in Fig. 2. Current $I_3$ equals the average value of $I_2$ and is returned to the squarer/divider to complete the operation: $I_4 = \text{Avg}[I_1] = I_{\text{RMS}}$ and $V_{out} = V_{in} \times I_{\text{RMS}}$.

The averaging time constant

The AD637 can handle both DC and AC input voltages. Its DC output will track exactly the absolute value of a DC input and will approach the true RMS value of an AC input. The deviation from the true RMS value is the averaging error caused by AC ripples riding on the DC output signal. That is a factor of the input signal’s frequency and the averaging time constant, $\tau = (25 \text{ ms} \times C_1 \times C_2)$. It is defined as the peak value of the AC ripple component plus the DC error. That is illustrated in Fig. 3.
The peak value of the AC ripple as a percentage of the output signal is

\[
50/6.3\sqrt{2}\text{f, where } f\text{ is the signal frequency. The DC error is also frequency dependent; it varies as the percentage of the reading by } 1/(0.16 + 6.4/\sqrt{2}). \text{ The magnitude of ripple decreases the accuracy of the measurements being made. The amount of error can be reduced by increasing the value of the averaging capacitor } C_{AV}. \text{ However, that has two disadvantages: 1) The capacitance of } C_{AV} \text{ can become extremely high. 2) The settling time of the AD637 increases in direct proportion to the value of the averaging capacitor. Settling time } T_S \text{ equals } 115 \text{ ms/} \mu \text{F} \times C_{AV}.
\]

A preferred method of reducing ripple is to add a one- or two-pole filter network connected between output terminal pin 9 and the buffer amplifier input, pin 14. A single-pole filter, such as the R1–C1 network in Fig. 2, provides the best compromise between ripple and settling time.

When C1 is made 3.3 times CAV, the magnitudes of the AC and DC errors are equal at 50 Hz. If we set CAV to 1 μF and C1 to 3.3 μF, we reduce the ripple for a 60-Hz input signal from 5.3% (when CAV is used alone) to 0.15% and settling time increases by not more than three times.

The AD637 is available with two accuracy ranges (types J and K) for a 0 to +70°C temperature range. A type S is available with a operating-temperature range of −55°C to +125°C. All devices are packaged in ceramic 14-pin DIP’s. For additional information, write to Analog Devices, PO Box 280, Norwood, MA 02062. Ask for a copy of the booklet High Precision Wide-Band RMS-DC Converter: the AD637.

New Darlington power transistors

RCA recently introduced a family of six 2-amp Darlington power transistors. The six complementry devices, three NPN and three PNP, are housed in TO-220AB packages. The TIP110, TIP111, and TIP112 are NPN devices and are rated for a collector-to-emitter breakdown voltage (VCEO) of 60, 80, and 100 volts, respectively. The TIP115, TIP116, and TIP117 PNP devices have the same VCEO ratings, respectively.
MICROPROCESSORS HAVE BEEN INCORPORATED INTO ALMOST EVERY TYPE OF ELECTRONIC DEVICE IN USE TODAY. FOR INSTANCE, IN MANY STEREO AND TV SETS, THEY ARE OFTEN USED ALONG WITH SENSORS TO CONTROL THE AFC (AUTOMATIC FREQUENCY CONTROL) SO THAT IF THE TUNED FREQUENCY BEGINS TO DRIFT, THE MICROPROCESSOR CAN AUTOMATICALLY COMPENSATE FOR THAT CHANGE. BUT THAT'S NOT THE ONLY THING THAT THEY CAN BE USED FOR; VCR'S USE THEM TO STOP OR START OPERATIONS ACCORDING TO THE CONDITION OF THE SYSTEM. FOR EXAMPLE, RCA'S VJP900 VCR USES A COMPLEX SYSTEM OF SENSORS AND MICROPROCESSORS TO MONITOR THE OPERATION OF THE SYSTEM. OTHER MICROPROCESSORS CONTROL SUCH THINGS AS THE TUNING PROCESS, THE TIME-DELAYED RECORDING, AND THE REMOTE CONTROL FUNCTIONS. THIS MONTH WE'LL SEE HOW SOME OF THOSE MICROPROCESSORS ARE USED TO CONTROL THE TUNING AND SENSING OPERATIONS OF THAT VCR. WE'LL START WITH THE SENSING CIRCUIT.

SENSING CIRCUIT

TAKE A LOOK AT FIG. 1; IT SHOWS A DIAGRAM OF THE TROUBLE-SENSING CIRCUITRY FOUND ON THE SYSTEM-CONTROL BOARD. THAT BOARD CONTAINS TWO IC'S AND VARIOUS SENSING DEVICES THAT ARE USED TO DETECT SUCH THINGS AS MOISTURE, END OF THE TAPE, AND THE ROTATION OF THE TAKE-UP REEL. THE TWO IC'S, IC802 (SYSTEM-CONTROL MICROPROCESSOR-B—ONE OF FIVE MICROPROCESSORS IN THE UNIT) AND IC806 (A QUAD COMPARATOR) ARE USED TO MONITOR THE OUTPUT OF THE SENSORS AND ACT ACCORDING TO THE SIGNALS THEY RECEIVE.

THE TROUBLE SENSOR IS A MOISTURE-SENSITIVE RESISTIVE-SEMICONDUCTOR DEVICE THAT IS USED TO TELL THE MICROPROCESSOR WHEN THE MOISTURE LEVEL IN THE SYSTEM OFFERS A THREAT TO THE OPERATION OF THE UNIT. WITH ALL THE DELICATE ELECTRONICS IN A VCR—TO SAY NOTHING OF ITS INTRICATE MACHINERY—EXCESS MOISTURE COULD DAMAGE THE MACHINE. THE TROUBLE SENSOR, A SMALL FLAT DEVICE ABOUT AN INCH SQUARE, IS MOUNTED NEAR THE MIDDLE OF THE "WORKS" IN MOST VCR'S. IN FIG. 1, THAT DEVICE IS CONNECTED TO THE NON-INVERTING INPUT (PIN 9) OF ONE OF THE OP-AMPS CONTAINED IN IC806. DURING NORMAL OPERATION (WHEN THERE IS LITTLE OR NO MOISTURE DETECTED), THE RESISTANCE OF THE TROUBLE SENSOR IS HIGH—AROUND 80,000 OHMS. THAT CAUSES A LOGIC HIGH TO BE DEVELOPED AT PIN 9 OF IC806. (ANY VOLTAGE BELOW 1.2 VOLTS IS A LOGIC LOW; ANYTHING ELSE IS A LOGIC HIGH.) WHEN THAT HAPPENS, A HIGH IS PASSED ON TO THE SYSTEM-CONTROL MICROPROCESSOR (IC802) AT PIN 6. THAT INPUT SIGNAL TELLS IC802 THAT THE MOISTURE LEVEL IS SAFE. ON THE OTHER HAND, WHEN THE TROUBLE SENSOR DETECTS AN EXCESSIVE AMOUNT OF MOISTURE, ITS RESISTANCE DECREASES, WHICH CAUSES A LOGIC LOW TO BE APPLIED TO THE COMPARATOR. THAT, IN TURN, CAUSES THE COMPARATOR TO OUTPUT A LOGIC LOW TO IC802, AND THE MICROPROCESSOR PLACES THE VCR IN THE STOP MODE.


The cassette-up switch, connected to pin 5 of IC802, is used to tell the microprocessor when the cassette basket is loaded and in the down position. With the basket in that position, switch S902 is closed and a high signal is input to IC802. That signal causes the system-control microprocessor to enable the VCR. On the other hand, if the cassette is placed in the basket but the basket isn’t pushed down, the cassette-up switch opens and the VCR stops.

The last sensor operation that we’ll look at is the cylinder-lock detector. The cylinder-lock signal is supplied by cylinder-servo circuit IC502 (not shown) and is input to the microprocessor at pin 4. During normal operation the cylinder servo generates a logic low signal. If the cylinder’s motor speed were to decrease, a logic high would be generated by the servo IC. That signal is then passed to the microprocessor, which will shut down the VCR upon receiving that signal.

Service tips

If the VCR does not go into the play mode, check the outputs of all the trouble sensors. The dew sensor should have less than 1.5 volts at its input. If the correct voltage is present, check the output of the end-of-reel sensors (rewind and forward) at PG805 pins 3 and 4. Both outputs should be less than 0.15 volt. Also, confirm that there is a logic high input at pin 5 of the system-control microprocessor. If any of those voltage levels are incorrect, service the appropriate sensing section. In addition, if the VCR makes no attempt to load the tape from the cassette, the problem can most likely be found in the reel-rotation or the cylinder-lock detectors. Those two sensors will turn on the system only after the tape-loading sequence has been completed.

If, after loading the cassette in the basket, the VCR immediately ejects (unloads) the tape, check to make sure that there is a 1-volt peak-to-peak squarewave during the time of load completion. If that’s missing you may have a bad rotation-detector (Q905) or capstan servo problems. If it’s normal, check the cylinder-lock signal; it should be a logic high before the loading sequence is completed. At the end of that sequence it should go to a logic low. If not, you could have a problem in either the cylinder-servo circuitry or the drive IC.

Tuning section

As we said earlier, there are many microprocessors in the VJP900. Almost as many as Presidential candidates! And they’re like politicians in more ways than one. When the VCR is turned on they all “shake hands” with one another. (We’re not kidding; there are lines labelled hand-shake lines, which are separated into two parts: one is VDI (ready) and the other is acknowledge). Those lines are shared by the timer and remote-control microprocessors. When one of the microprocessors is ready to send data, it pulls the VDI line on the receiving microprocessor low. The receiving microprocessor, in turn, outputs a high on the ACK line, meaning “ready when you are.” The sending microprocessor then transmits a 16-bit word. Each bit of the data confirms the ready status of the receiving microprocessor. Note that you cannot see these signals on a conventional oscilloscope. However, you can usually monitor the receiver by reading the logic level at the input.

The remote-control microprocessor monitors the status of the whole unit by checking the microprocessor on the sensor board. If anything is wrong with any one of the five microprocessors, the VCR will be shut down. Also, if the tab on the cassette is missing you cannot record; the VCR shuts down and will not start.

The VJP900 also has a PLL (Phase-Locked Loop) electronic tuner that is controlled by the PLL microprocessor. That microprocessor also keeps track of the remote-control microprocessor. This continues on page 107.

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105
RF power measurements
HERB FREIDMAN, COMMUNICATIONS EDITOR

As any electronics engineer or technician, radio amateur, or CB'er can tell you, RF power measurements can be a real headache. As an example, consider the problem we ran into recently.

We were involved in a project that called for the upgrading of an existing two-transmitter setup where one transmitter was the backup for the other. All that was really being done was replacing one of the older transmitters with a new one. The completed installation was to resemble the one shown in Fig. 1: a rather simple circuit that switches either transmitter to the transmission line. (For simplicity, the dummy load, safety interlocks, etc. are not shown.)

Note the location of the output-power meter. It's really part of a combination power VSWR metering panel: in effect, two meters in one. One of the meters was for VSWR calibration and measurement: the other was calibrated directly in watts for RF output power.

The problem

Now, let's look at the problem. With both transmitters working into a dummy load, a 6-kW output was measured. But when switched to the transmission line, the original transmitter produced a meter indication of almost 6 kW, while the new one produced a meter reading of only 4.2 kW. What was the cause of the apparent loss of nearly 2 kW when operating into the transmission line? In reality, there was no loss of any kind. The problem was simply an incorrect reading caused by standing waves.

If you think about it for a moment, you'll realize that an RF-power meter is simply a forward-power VSWR indicator, with its own calibration adjustment and an RF-watts scale. Consider how such a device works. A sample of RF energy is picked off the center conductor of the transmission line by a probe that is inserted under the coaxial shield. It is then rectified and the resulting DC is passed through a calibration potentiometer to the meter indicator. If the meter's indication is to serve as the calibration for a VSWR meter, then the meter scale simply has a calibration mark and the calibration potentiometer is adjusted so the forward power causes the meter pointer to fall on that mark. If the same meter has a scale calibrated in RF watts, the potentiometer is adjusted until the meter indicates either the calculated output, or the value indicated by a precision wattmeter when the transmitter is working into a dummy load. (Obviously, that is not intended to be a precision measurement, but a relatively accurate guide for a technician.)

Now we are ready to tackle the question of what caused the apparent loss of power when the second transmitter was switched in. In reality, there was no loss; it was simply an incorrect meter reading caused by the standing waves on the transmission line. The RF power that was sensed by the meter was affected by the standing waves at the location of the probe.

Let's look at what we mean by that. If the line is flat with almost a 1:1 VSWR, the current and voltage at any probe location along the line will be equal to any other location (excluding normal copper losses). So that, regardless of where the probe is located, it will always sense the same amount of RF and the meter calibration would be valid anywhere along the line. But if there is any amount of mismatch, standing waves will be produced along the line and the RF sensed by the VSWR probe will depend on the magnitude of the standing wave at the location of the probe. That's why there is a potentiometer for forward power calibration.

But why wasn't the location or magnitude of the standing wave the same when the transmitters were switched? Actually, in the old transmitter installation they were constant regardless of which transmitter was used. That's because the designers of the original installation used exactly one wavelength of transmission line between the transmitters and the coaxial selector-switch. Regardless of which transmitter was switched in, the transmission line length remained the same. By now you should have figured out the problem. If not, think about what happens if there is any change in the length of the transmission line? Correct—the relative magnitude, and possibly the position, of the standing waves can change. The probe, which formerly might have been located at a node, might now be on the peak of the standing wave, so that the RF sensed by the probe will not be the same and it will be necessary to re-adjust the calibration potentiometer for the correct power reading.

Because of the new location of one transmitter, a low ceiling, and other such irreversible considerations, it was impossible to maintain equal lengths of transmission line (or multiples) between the transmitters and the selector switch, so the physical length of the line depended on the particular transmitter in use. That, in turn, affected the amount of RF sensed by the VSWR probe. Hence, the RF output power indication was incorrect when the transmitters were switched unless the meter was recalibrated.

Now it might be logical to assume that there's real big trouble with the antenna system if a change in transmission line length can produce a variation of almost 33% in output power measurement. Actually, the system was very good—the measured VSWR being a shade over 1:1.

Keep all of this in mind for the next
Let's Try Again
When I disconnect the yoke on this Sony KV 9000 color TV, the sound comes on and the vertical sweep returns. Several things were suggested by you in the last letter but none helped. Could you try polishing up the crystal ball again for me because I am up against a wall on this one.—J.A.H., Colorado Springs, CO

Let's try it again. You know, this may be a silly question to ask, but did you completely overhaul the possibility of an intermittent short in the yoke winding? Shorted turns in the horizontal windings would load down the 17- and 20-volt supplies, which are scan derived. Those voltage sources are used to power the audio and also vertical circuitry. A simple resis-

SERVICE QUESTIONS

continued from page 101

processor as well as the system-control microprocessor to make sure all systems are go. If no fault is detected in any of the sub-systems, you can go ahead with the recording; if not, something happens. A microprocessor is like a politician in many ways; however, you can trust them for one thing. They won’t shake your hand and then go back to Washington and raise your taxes!

R-E

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HELPFUL HINT

I never miss "Service Clinic" and have found your articles very helpful in my work. I also appreciate your printing of tips from readers. Here's one I discovered.

Last fall, the video-detector diode in our old RCA CTC-17 went out. Not being able to find another, I ended up installing a new Schottky-barrier UHF diode which was available at a local Radio Shack store (catalog No. 5082-2835).

With the new diode in place, the picture came on with extremely high contrast and, although the PIV rating of the device is only 5 volts, a VTVM measured 18 volts across the detector output. Also, when the AGC was adjusted to obtain the normal contrast range, the picture showed improved sharpness and saturation.

I have tried that on other sets and their owners have remarked how much better their picture looked. Also, I have yet to have any callbacks in regards to making that substitution.

PICTURE SLIPS

On a Zenith 12CB122X the problem is that the picture slips sideways. The horizontal tubes check good on a tube tester. I tried replacing Q404 (sync separator) and Q407 (the horizontal-phase detector) without success. The voltage measurements around Q407 are: 10.6 volts at the collector; 9.42 volts at the base, and 1.04 volts at the emitter—R.S., Oklahoma City, OK.

The first thing I would do is change the 6L8N. That failing, I would want to know why the voltages around Q407 are so far out of the ballpark. My schematic calls for 0.82 volts on the collector. The base is likewise far off. Resistance readings from the collector and base to ground should be 47K and 10K respectively.

TUNER DRIFTS

The tuner in my 13JC10 Zenith seems to drift and then go into a snowy picture. By switching the channel selector back and forth, you can lock the picture back in. The trouble is intermittent. I replaced the tuner twice, but the problem still exists.—B.G., Shawnee, KS.

If one is available, a tuner subber could help a great deal on this one. If the picture is still unreliable, you should then look for an intermittent condition in the IF strip. If the problem disappears when you use the substitute tuner, you can focus on the tuner teeds. Monitor the B+, AGC, and AFC terminals on the set's tuner and look for changes. If you're still unsure, you can substitute these different teeds with appropriate external voltages.

FAULTY TUNER

I have a Sylvania E46 to repair. I think the tuner is bad. I can get channel 7 (some of the time) but no others. The channel-indicator readout works only sometimes, but even then, the numbers are wrong. I think the memory module will have to be replaced, but I know it's expensive. Can I tune the set to Channel 3 and use the cable box? How about using a solid state tuner from a discarded TV set?—S.M., W. Palm Beach, FL.

A new memory module would no doubt solve all your problems, but you do have alternatives. If you inject a small variable voltage into the tuning voltage input to the tuner you should be able to scan through and stop at Channel 3. You can then measure the voltage and duplicate it with a fixed voltage. Your readout will be inaccurate but as you state in the rest of your letter, that doesn't matter. As for using an external tuner, sure. I made my own tuner subber with one I pulled out of a scrap set. The only factor that has to be watched carefully is the B+. AGC requirements are fairly standard.

R-E
The inputs are connected via the same 34 pin edge connector and consist of the audio input, three sync inputs for gen-locking, and nine RGB digital video inputs. The audio input is used only for the RF-modulated output and can replace the generator’s internal 1500-Hz oscillator.

There are various ways you might gen-lock the unit using the three sync inputs. The vertical and horizontal reset can be driven separately (you must use pulses of less than 800 ns duration). If you do that with the vertical-reset control high (or not connected) then the vertical timing is reset to the beginning of each field. If the vertical-reset control is “low” then the vertical timing is reset to the fifth vertical separation pulse. That allows it to act like a conventional integrated sync-separator circuit.

Another possibility is to use a circuit such as shown in Fig. 13. That allows gen-locking from a source of composite sync at LS-TTL levels. It should be noted that those schemes will lock the scanning timing but not the chrominance oscillator. Color can still be produced, however.

One of the more intriguing capabilities of the test generator is its ability to accept digital RGB data, format the data with the proper sync signals, and then output the data in the correct format and timing pulses.
data. The possibilities range from the creation of other simple test patterns, to interfacing with a microcomputer for the projection of dynamic video color imagery for computer games, interactive learning, etc.

Table 3 lists the digital inputs that can be used to produce blank rasters for several colors. Note that each primary color (red, green, and blue) has three inputs, and thus, $2^3 = 8$ input levels. Other colors (a total of 512) are possible.

As a simple example, suppose you wish to have the signal generator provide a solid red raster (perhaps for adjusting receiver purity). Simply connect the three red inputs (RLSB, R, RMSB) high, and the six green and blue inputs low. Now when the generator is in the 101 mode, it supplies a composite-video signal with a constant red image.

For complicated applications involving computer control you must choose between two general approaches. In the first method, the signal generator acts as the master timing source and the computer software synchronizes to the vertical- and horizontal-drive signals. In the second approach, the computer is the master clock and provides sync and reset signals to the signal generator in addition to the RGB data.

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and since it's the last output in the chain, we're connecting it back to the data input of the IC. Remember that we have to make sure that the incoming data at the clock input is constantly recirculated around and around the daisy-chained flip-flops in the 4018. Any change in the input data to the IC has to be fed into it at the clock input and not the data input. All that we're using the data input for is to make sure that whatever we feed into the 4018 stays there.

Losing the \( Q_3 \) output means that we can't use it to generate the sinewave but we still need it to recirculate the data. The result of eliminating that output is shown in Fig. 3. There have been two changes, the one we expected and one that's just one of those lucky breaks. The most obvious change is the flattening at the top of the waveform. That's what we expected and isn't really any great surprise. We've overlaid the output waveform with a sinewave again and you can see that it is a better fit than we got earlier in Fig. 2-b. Even though the drawing of the sinewave is crude, you can see that it's going to be a much better fit.

The second change isn't quite as obvious because the drawings aren't exactly to scale. Since we've lost one of the outputs (the one that produced the top of the output waveform) the top only remains for two incoming clock periods instead of three, as it did in Fig. 2-b. That not only helps us fit the crest of the sinewave but gives the rise and fall on either side a better shape making the fit even better. Of course, as we've seen over and over again, you can't get something for nothing and we're paying a price here as well. Let's not forget that while we may have an easier time fitting the curve, we've lost one of the outputs and consequently our resolution has suffered. But, as with so many other things, trade-offs are the name of the game in electronics as well.

Picking the ideal resistor values to give us the best approximation of a sinewave involves a lot of math. The principle behind the whole thing, however, isn't really that hard to visualize. Figure 4 gives us a graphic representation of the problem. What we're looking at is the first 180 degrees of the sinewave. The generating of the sinewave means that all of the outputs are going to come into play during each half of the full-cycle. Take another look at Fig. 1, you'll see that the sequential rise and fall of the flip-flop outputs determine the shape of the summed waveform. Because each of the outputs is out of phase (or delayed) by exactly one incoming clock pulse, each of the outputs controls the amplitude of the output waveform at 45 degree (or 180/4) intervals. (We're dividing by four instead of five because the \( Q_3 \) output is not being used. Even though we're allowing for the time it takes to change state, it adds nothing to the amplitude of the output waveform.)

Finding the correct resistor values, therefore, means a bit of trigonometry and some more analysis. Don't be put off by the math; it's not all that difficult and understanding it only involves common sense and curiosity—two very important tools for anyone who wants to be involved in electronics.

transistor checking. I recommend the methods in this order: 1) commercial tester/test circuit; 2) substitution; 3) multimeter. The multimeter method should be considered only as an emergency measure—that's because it does not work with all transistors.

Cat-birds

Leroy Jack (NE) needs some ideas on how to protect birds from his cats. It seems that they particularly relish wrens and Leroy wants to give the birds more of an even chance. He says that he has tried attaching bells to the cat's collars but that has produced only limited success. He wonders about putting a small audio oscillator on those collars.

Sure, you could do that, Leroy, but battery weight could be a problem if the oscillator is to operate very long. We would be more inclined to use a little 3909 IC—usually referred to as an "LED flasher."

If you put the 3909 in the circuit shown in Fig. 6, you can get sound with a low current requirement. We're not sure as to what kind of sound will be most effective in this application. Probably an occasional "click" will work as well as anything else. That is what you will get from the circuit shown. Other frequencies can be generated by varying the value of potentiometer and the capacitor.

That's all we have room for this time. Hang in there—your question may be coming up next month.

By the way, you may be wondering how the questions are chosen for answering here in the column. What I try to do is to select those questions that will be of the greatest interest to the greatest number of readers. That depends on the subject to the question and the range of the possible applications of the answer.

I am sure that you know that your questions are appreciated by all of us. Keep them coming. Oh yes, you don't have to wait until you have a question before you write—I'll be glad to see your comments and suggestions, too.
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<tr>
<th>Component</th>
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**HANDY Sockets and Buss Strips**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Socket Strips</th>
<th>Buss Strips</th>
<th>Ground Plate</th>
<th>Tie Points</th>
<th>14 pin I.C.'s</th>
<th>Price</th>
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<td>HB-0100</td>
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**HANDY Breadboard Assemblies**

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<th>Part Number</th>
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</table>

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### SOUND CHIPS

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<td>LM3232K</td>
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<td>LM723</td>
<td>0 to 40 VDC</td>
<td>276-1740</td>
<td>1.59</td>
</tr>
<tr>
<td>LM3177</td>
<td>2 to 16 VDC</td>
<td>276-1776</td>
<td>2.78</td>
</tr>
</tbody>
</table>

Type | Fixed Output | Cat. No. | Each |
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>7805</td>
<td>+5 VDC</td>
<td>276-1770</td>
<td>1.59</td>
</tr>
<tr>
<td>7812</td>
<td>+12 VDC</td>
<td>276-1771</td>
<td>1.59</td>
</tr>
<tr>
<td>7815</td>
<td>+15 VDC</td>
<td>276-1772</td>
<td>1.59</td>
</tr>
<tr>
<td>7905</td>
<td>-5 VDC</td>
<td>276-1773</td>
<td>1.59</td>
</tr>
<tr>
<td>7912</td>
<td>-12 VDC</td>
<td>276-1774</td>
<td>1.59</td>
</tr>
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**Audio Power Amplifiers**

- **Low As $39^c**

Type | Cat. No. | Each |
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>LM398</td>
<td>276-703</td>
<td>3.19</td>
</tr>
<tr>
<td>LM386</td>
<td>276-1731</td>
<td>1.09</td>
</tr>
<tr>
<td>TA2050AP</td>
<td>276-705</td>
<td>2.99</td>
</tr>
<tr>
<td>LM380</td>
<td>276-706</td>
<td>1.59</td>
</tr>
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**Ceramic Disc Capacitors**

Type | Cat. No. | Each |
<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>47</td>
<td>272-120</td>
<td>0.001 272-126</td>
</tr>
<tr>
<td>47</td>
<td>272-121</td>
<td>0.005 272-130</td>
</tr>
<tr>
<td>10</td>
<td>272-122</td>
<td>0.01 272-131</td>
</tr>
<tr>
<td>47</td>
<td>272-123</td>
<td>0.05 272-134</td>
</tr>
<tr>
<td>47</td>
<td>272-124</td>
<td>1.0 272-135</td>
</tr>
</tbody>
</table>

**4000-Series CMOS ICs**

Type | Cat. No. | Each |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7400</td>
<td>276-1801</td>
<td>59</td>
</tr>
<tr>
<td>7404</td>
<td>276-1802</td>
<td>79</td>
</tr>
<tr>
<td>7408</td>
<td>276-1822</td>
<td>79</td>
</tr>
<tr>
<td>7447</td>
<td>276-1805</td>
<td>1.19</td>
</tr>
<tr>
<td>7490</td>
<td>276-1808</td>
<td>89</td>
</tr>
</tbody>
</table>

**Electrolytic Capacitors**

- **Aid Leads**

Type | Cat. No. | Each |
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>4.7</td>
<td>272-1012</td>
<td>49</td>
</tr>
<tr>
<td>10</td>
<td>272-1013</td>
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<tr>
<td>22</td>
<td>272-1014</td>
<td>69</td>
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<tr>
<td>47</td>
<td>272-1015</td>
<td>69</td>
</tr>
<tr>
<td>100</td>
<td>272-1016</td>
<td>79</td>
</tr>
<tr>
<td>220</td>
<td>272-1017</td>
<td>89</td>
</tr>
<tr>
<td>470</td>
<td>272-1018</td>
<td>99</td>
</tr>
<tr>
<td>1000</td>
<td>272-1019</td>
<td>1.59</td>
</tr>
<tr>
<td>2200</td>
<td>272-1020</td>
<td>2.49</td>
</tr>
<tr>
<td>3300</td>
<td>272-1021</td>
<td>2.99</td>
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<tr>
<td>4700</td>
<td>272-1022</td>
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<td>470</td>
<td>272-1046</td>
<td>1.59</td>
</tr>
<tr>
<td>1000</td>
<td>272-1047</td>
<td>1.99</td>
</tr>
<tr>
<td>2200</td>
<td>272-1048</td>
<td>3.49</td>
</tr>
</tbody>
</table>

**TTL Digital ICs**

Type | Cat. No. | Each |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>7400</td>
<td>276-1801</td>
<td>59</td>
</tr>
<tr>
<td>7404</td>
<td>276-1802</td>
<td>79</td>
</tr>
<tr>
<td>7408</td>
<td>276-1822</td>
<td>79</td>
</tr>
<tr>
<td>7447</td>
<td>276-1805</td>
<td>1.19</td>
</tr>
<tr>
<td>7490</td>
<td>276-1808</td>
<td>89</td>
</tr>
</tbody>
</table>

**Replacement Transistors**

Type | Cat. No. | Each |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2N1305</td>
<td>PNP 276-2007</td>
<td>1.19</td>
</tr>
<tr>
<td>MPS2002</td>
<td>NPN 276-2009</td>
<td>70</td>
</tr>
<tr>
<td>2N2222</td>
<td>PNP 276-2010</td>
<td>89</td>
</tr>
<tr>
<td>MPS3904</td>
<td>NPN 276-2016</td>
<td>69</td>
</tr>
<tr>
<td>TIP31</td>
<td>NPN 276-2197</td>
<td>99</td>
</tr>
<tr>
<td>2N3904</td>
<td>PNP 276-2020</td>
<td>1.59</td>
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<tr>
<td>MPS2907</td>
<td>NPN 276-2023</td>
<td>79</td>
</tr>
<tr>
<td>MJE344</td>
<td>NPN 276-2024</td>
<td>49</td>
</tr>
<tr>
<td>2N3053</td>
<td>PNP 276-2030</td>
<td>89</td>
</tr>
<tr>
<td>MPS3368</td>
<td>NPN 276-2032</td>
<td>79</td>
</tr>
<tr>
<td>TIP120</td>
<td>NPN 276-2068</td>
<td>1.29</td>
</tr>
<tr>
<td>2N3055</td>
<td>PNP 276-2041</td>
<td>1.99</td>
</tr>
<tr>
<td>M2995</td>
<td>PNP 276-2042</td>
<td>2.19</td>
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<tr>
<td>2N1244</td>
<td>NPN 276-2057</td>
<td>59</td>
</tr>
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<td>PNP 276-2058</td>
<td>59</td>
</tr>
<tr>
<td>MPSA66</td>
<td>NPN 276-2059</td>
<td>59</td>
</tr>
<tr>
<td>MPSA13</td>
<td>PNP 276-2060</td>
<td>59</td>
</tr>
<tr>
<td>MPSA42</td>
<td>PNP 276-2061</td>
<td>69</td>
</tr>
<tr>
<td>MJE4911</td>
<td>NPN 276-2062</td>
<td>99</td>
</tr>
</tbody>
</table>

- **Compact SPST Reed Relays**

Type | Cat. No. | Each |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5 VDC, 20 milliamps</td>
<td>275-232</td>
<td></td>
</tr>
<tr>
<td>12 VDC, 11 milliamps</td>
<td>275-233</td>
<td></td>
</tr>
</tbody>
</table>

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2798 33.95
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22 pin ST .26 .26
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28 pin ST .39 .31
40 pin ST .48 .38
64 pin ST 4.20 call

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14 pin WW .68 .51
16 pin WW .68 .57
16 pin WW .98 .89
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22 pin WW 1.34 1.25
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5.088 3.90
5.185 3.90
5.7143 3.90
6.0 3.90
6.144 3.90
6.5536 3.90
8.0 3.90
10.0 4.35
10.736835 3.90
13.5188 3.90
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16.0 3.90
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18.0 3.90
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20.0 3.90
22.184 3.90
30.0 3.90

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R6,R23,R37—3300 ohms
R7,R15,R48—4700 ohms
R8—75 ohms
R9,R10—220 ohms
R11—100 ohms
R34,R47—470 ohms
R16—27,000 ohms
R17—2200 ohms
R19,R20—22, R24—R27, R29—R31, R33,R43,R45,R50,R51—R54,R66
R63,R65—9,000 ohms
R28—1 megohm
R29,R62—47,000 ohms
R34—10,000 ohms, trimming potentiometer
R35—68,000 ohms
R44—50,000 ohms, trimming potentiometer
R46,R61,R66—100,000 ohms
R49,R67,R68—15,000 ohms
R57,R58,R60,R64—33,000 ohms
R59—22,000 ohms

Capacitors
C1—0.002 μF, ceramic disc
C2,C4—0.001 μF, ceramic disc
C5—75 pF, mica
C6,C8—C24—C26—C29—0.1 μF, ceramic disc
C6,C7—47 pF, ceramic disc
C9,C10,C15,C16—C32—100 pF, ceramic disc
C11,C28,C30—C34—C37—C42—0.1 μF, ceramic disc
C12—C31—C41—C43—1 μF, 16 volts, tantalum
C13—0.2 μF, ceramic disc
C14—330 pF, ceramic disc
C17,C33—22 pF, ceramic disc
C18,C19,C21—10 pF, ceramic disc
C20—470 pF, ceramic disc

PARTS LIST

C22—5—40 pF, trimmer capacitor
C23—10 pF, ceramic disc
C27—5 pF, ceramic disc
C36,C39—4700 μF, 16 volts, electrolytic
C40—1000 μF, 16 volts, electrolytic

Semiconductors
IC1—LH0002CN current amplifier (National)
IC2—IC21, IC27—4066 quad bilateral switch
IC3—LM1889 TV video modulator
IC4—LM1886 TV video matrix D/A converter
IC5—74LS32 quad or gates
IC6—74LS03 quad NAND gates
IC7—IC15—74LS151 one-of-eight selector/multiplexer
IC16, IC23, IC24—74LS161 synchronous 4-bit counter
IC17—74LS00 quad NAND gates
IC18—74LS20 dual 4-input NAND gate
IC19, IC28, IC30, IC42—4049 hex inverting buffer
IC20—74LS191 synchronous up/down counter
IC22—74LS73 dual J-K flip-flop
IC25—74LS174 D-type flip-flop
IC26, IC39—74LS123 dual retriggerable monostable multivibrator
IC29, IC31—74C00 quad NAND gates
IC32—74LS38 8-input NAND gates
IC33—74LS02 quad NOR gate
IC34—74LS169 4-bit synchronous up/down counter
IC35—7473 dual J-K flip-flop
IC36—MM5321 TV camera sync generator (National)
IC37—74LS365 hex bus driver
IC38—74LS93 4-bit binary counter
IC40—LM318 op-amp
IC41—74LS08 quad AND gate
IC43—LM340T5 5-volt regulator, 10-220 case
IC44—LM340K5 5-volt regulator, 10-3 case
IC45—LM340T12 12-volt regulator, TO-220 case
IC46—LM320T12 12-volt negative regulator, TO-220 case
Q1—Q4—2N2222A
Q2,Q3—MPS918
Q5—MPSAOS
D1,D3—D18—1N914 or 4148
D2—IN746A
S1—7-position rotary switch (Allied 7471001 or similar)
S2—pushbutton switch, normally closed
S3—SPDT toggle switch
S4—SPST toggle switch
LED1—standard red
T1—Transformer (Triad F-166XP or similar), primary: 117 volts; secondary: 24 volts, center-tapped, 125 volts, 9 volts, center-tapped, 5 volts
BR1,BR2—bridge rectifier, 1.5 amps
L1—0.071—0.082 mH adjustable coil (J.W. Miller 48A778MPC or similar)
L2—7—12 μH adjustable coil (J.W. Miller 23A105RPC or similar)
XTAL1—14.31818 MHz crystal
F1—Fuse, 1 amp, pigtail leads
J1—BNC jack
J2—Type N jack
J3—J5—Standard tip jacks

Miscellaneous—Heat sinks, cabinet (Pactec CM86-225), power cord, strain relief, TO-3 mounting kit, IC sockets, etc.

The following are available from Jengco, 3323 San Mateo, Suite 75, Albuquerque, NM, 87110: Complete kit including PC boards, all components, cabinet (no IC sockets), $295; Etched, drilled, and silk-screened PC boards (boards A and B), $49.50; Complete test generator, assembled and tested, $395. Please add 5% for postage and handling, New Mexico residents add 4.25% sales tax, allow 6—8 weeks for delivery.

color-bars signal can also be used to check chroma demodulators.

Interfacing the generator
A standard 34-pin card edge is available at the back of the unit. Refer to Table 2 for the pinout configuration. Numerous sync-family signals are provided as TTL level outputs (horizontal drive, vertical drive, composite sync, composite blanking, and colorburst gate). Those signals are useful in a variety of applications such as driving switches. The vertical-drive and horizontal-drive signals are handy for driving two or three video cameras (for example: in a security system), thereby synchronizing them for input to a simple switcher or VCR. That avoids the loss of sync which usually causes picture roll. A composite sync at video levels can also be derived from the generator by using the gray-level signal adjusted for blanking (gray level = 0) and taking the output from the front-panel BNC video output connector.

continued on page 109
## CPU's & Support Chips

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<tr>
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### Register Chipsets

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## Tally Controllers

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## Electronic Kits from Hal-Tronix

2304 MHz Down Converter Tuned in Channels 2 to 7 on your own home TV has frequency range from 2000 MHz to 2500 MHz, very easy to convert to Commercial TV, includes Case and Control Panel. $39.95.

2304 MOD 1 (Basic Kit) $19.95

2304 MOD 2 (Basic-Pre-amp) $30.95

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Power supply for either model above is available in Kit, Board and Parts, $89.95. Complete unit $129.95, (the above units are ideal for recorders, counters, etc.)

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16-Bit Touch Tone Decoder Kit with PC Board and Parts $69.95

### Encoder Kit

16 Encoder Kit, complete with Case, Pad and Components $39.95

### 16 Encoder Kit Complete with Case, Pad and Components $29.95

## Contact Information

- **Solid State Sales**: P.O. Box 74D, Somerville, MA 02143
- **Tel**: (617) 547-7053
- **Email**: SSSales@manasquan.com
- **Fax**: 508-469-0240

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- Simple Do It Yourself Installation In Minutes
- Works With All TV Models and Compatible With All Cable Systems
- Guaranteed One Year By More Than 300 General Instrument Warranty Stations

B. JERROLD LCC-58
- Remote Control Lets You Change TV Channels From the Comfort of Your Chair
- Turn Your TV Set On and Off Without Touching the Dial
- 58 Channel Capacity
- Lighted Digital Display On the Converter Indicates the Channel
- Simple Do It Yourself Installation In Minutes
- Works With All TV Models and Compatible With All Cable Systems
- Guaranteed One Year By More Than 300 General Instrument Warranty Stations

C. JERROLD #JRX-3
- 37 Channel Capability
- Cord Type Remote Control
- Remote Channel Selection
- Remote-Fine Tuning

D. JERROLD #JSX-3
- 37 Channel Converter
- Set-Top Model

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<th>Address</th>
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<td>800-645-4808</td>
<td>(516) 270-3850</td>
<td>FREE SOLDERING WICK</td>
<td>N.Y. State residents and appropriate sales tax.</td>
<td>Send for our FREE 1994 catalog of electronic components, kits, IC's, computer software, computer peripherals and unique items.</td>
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<td><a href="http://www.americanradiohistory.com">www.americanradiohistory.com</a></td>
<td>462-9529</td>
<td>FREE 1984 catalog of electronic components, kits, IC's, computer software, computer peripherals and unique items.</td>
<td>N.Y. State residents and appropriate sales tax.</td>
<td><a href="http://www.americanradiohistory.com">www.americanradiohistory.com</a></td>
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</tbody>
</table>
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