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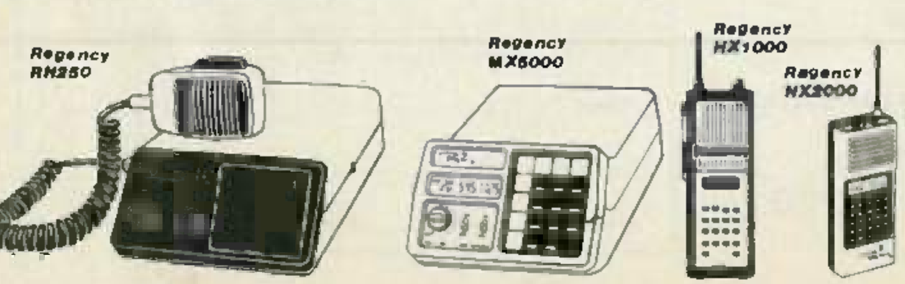

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COVER 1

You might think that building a computer is not too easy. That may be true if you start from scratch. But if you build it by interconnecting subassemblies, nothing could be easier. For example, the computer shown on our cover can be assembled in about an hour using nothing but a screwdriver!

While that may bother some of the electronics-construction purists among our readers, let us point out that there are several real advantages to buying your computer in subassemblies. First, you can save money. Second, you don't have to buy your system all at once—you can add to it as cash flow permits. If you want, you can even buy a bare motherboard and really assemble your computer piece-by-piece. Either way, you end up with an IBM-compatible computer without paying for the name.

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Hooking up your VCR can get rather complex as you add more equipment, cable service, etc. We'll show you how to do it the right way!

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We'll examine in detail an often-neglected but very important part of your TV.

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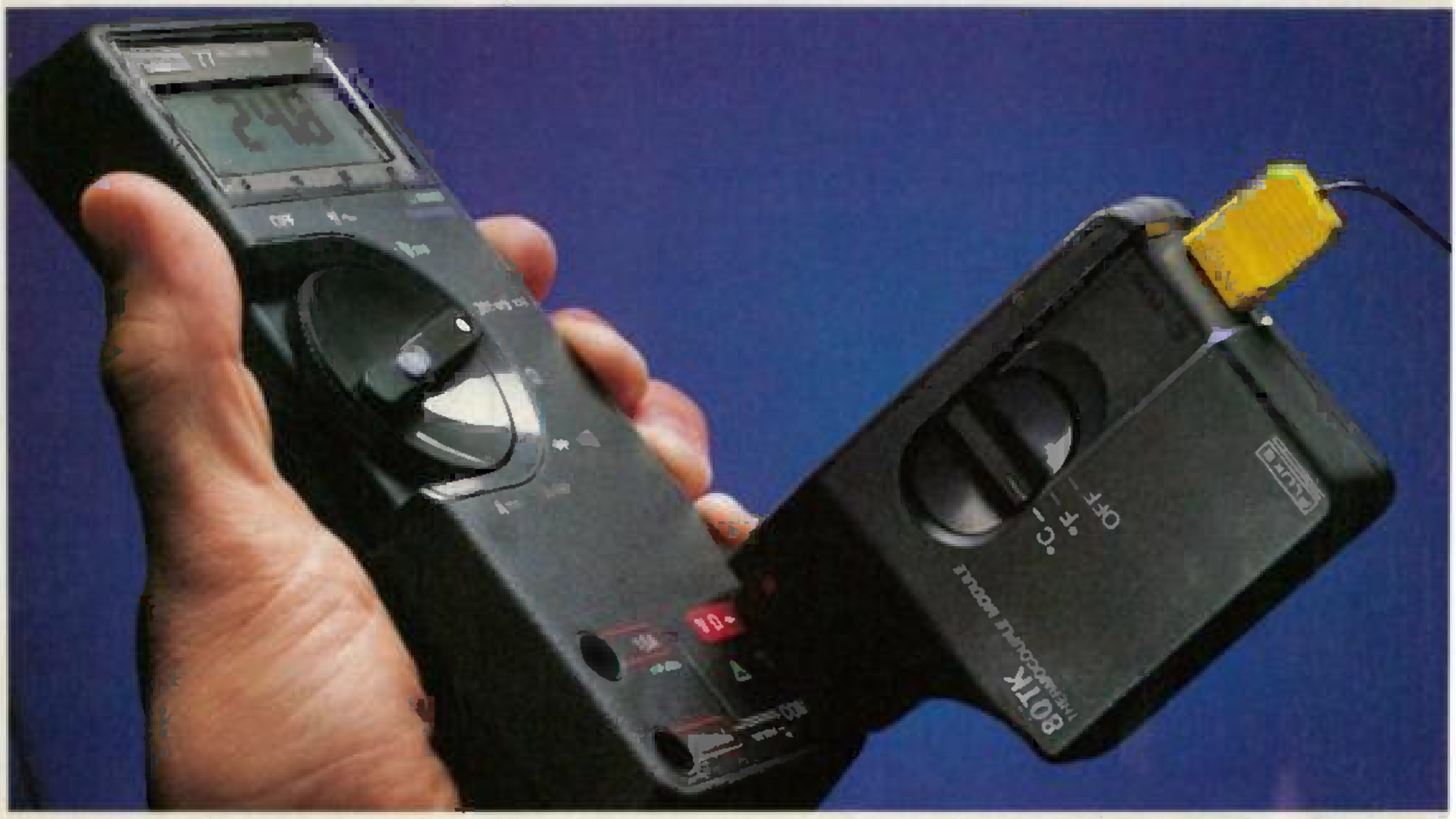

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CIRCLE 259 ON FREE INFORMATION CARD

WHAT'S NEWS

Jack Wayman inducted into Electronics Industry Hall of Fame

Jack Wayman, senior vice president of the Electronic Industries Association (EIA) was inducted into the Electronics Industry Hall of Fame at the Winter Consumers Show in Las Vegas last January. Mr. Wayman has been involved in the electronics industry for more than 35 years—22 of those years as an officer of EIA.

The Electronics Industry Hall of Fame was established in 1967 by the National Electronics Association to recognize individuals who have made outstanding contributions to the science and industry of electronics. It is organized in four major categories: inventor/scientist, industrialist/manufacturer, communications, and organization leaders.

Hall of Fame members include scientist/inventors Guglielmo Marconi, Nikola Tesla, and John Bardeen; manufacturer/industrialists David Sarnoff, George Westinghouse, and Morris L. Finneburgh, Jr., and in the communications category, Howard W. Sams, Hugo Gernsback, and John F. Rider.

In presenting the honor, Larry Steckler, president of the Hall of Fame and publisher of Radio-Electronics Magazine, said: "For more than 20 years, Jack has spearheaded the success and growth of the consumer electronics industry. His tireless energy helped to build a strong Consumer Electronics Group within the EIA and devleop the summer and winter Consumer Electronics Shows into the nation's largest trade exhibitions."

Peter McCloskey, EIA president, stated: "We at EIA are proud of Jack, not only for this major personal recognition but for his numerous achievements on behalf of the consumer electronics industry."

JACK WAYMAN, ELECTRONICS INDUSTRY HALL OF FAME'S NEWEST MEMBER, receives his certification from Larry Steckler (center) President of the Hall of Fame and publisher of *Radio-Electronics*, and Peter McCloskey (right) President of the Electronics Industries Association.

New speech-processing IC produces natural sound

Scott Instruments Corp of Denton, TX, has introduced the *Corretechs* signal processor, the first, they say, designed specifically for processing speech. With this announcement, Scott joins the ranks of such companies as TI, NEC, and General Instrument in producing a high-speed signal processor for speech processing applications.

Unlike earlier devices, Scott's signal processor is capable of pitch-synchronous waveform analysis, is noise resistant, and yields strong acoustic clues for phonetic segmentation. The processor outputs information for pitch extraction, speech compression and speech resynthesis. The resulting speech, says Scott, is natural sounding with speaker identity and inflection preserved.

New database handbook for high technology

A new scientific and technical database handbook put out by Technical Insights Inc., of Fort Lee, NJ, is a directory to more than 500 key scientific and technical databases scattered throughout the world. It is intended to make immediately available sources that the high technology professional otherwise could waste much time searching for.

It includes, says the publisher, virtually all the important machine-readable science and technology databases—whether available online or on tapes—from both U.S. and foreign sources.

Designed for high-technology professionals, corporate managers, scientists, and engineers, the *R&D Database Handbook* is available from Technical Insights, Inc., P.O. Box 1304, Fort Lee, NJ 07024. R-E

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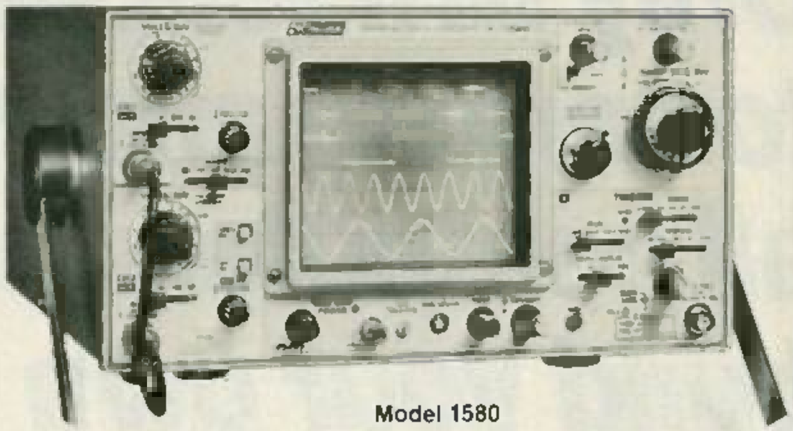

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You next assemble the power supply into the main unit of the computer. Using the digital multimeter, you check all keyboard connections and circuits.

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As you build the Sanyo from the keyboard up, you'll perform demonstrations and experiments that will give you a total mastery of computer operations and servicing techniques. You'll do programming in BASIC language. You'll prepare interfaces for peripherals such as printers and joysticks. Using utility programs, you'll check out 8088 functioning. NRI's easy step-by-step instructions will guide you all the way right into one of today's fastest growing fields as a computer

service technician. And the entire system, including all the bundled software and extensive data manuals, is yours to keep as part of your training.

How the pro computer critics rate the Sanyo 550:

"Sanyo BASIC is definitely superior to IBM Microsoft . . . lets you use two or three keystrokes for entering BASIC commands."

—MICROCOMPUTING Magazine

". . . compares favorably with the IBM PC, even surpassing it in computational speed . . ."

—COMPUTERS & ELECTRONICS Magazine

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—Bill Sudbrink, BYTE Magazine

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VIDEO NEWS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

• **8mm vs. Everything Else.** The big battle raging in the VCR world now is for the place of the new 8mm format in the scheme of things. With all of the original Beta group adding VHS-format recorders—Sanyo, Toshiba. NEC, Zenith, Marantz—only the inventor of Beta, Sony. has not gone over to the enemy camp. And Sony obviously is staking its future on 8mm.

In Japan, Sony has introduced an attractive camera-recorder combination (camcorder) in the 8mm format. Although it's a one-piece unit, its construction reveals that it probably is the forerunner of a home deck, since the recorder part of the unit seems designed to be produced as a separate part. There's further evidence of that in the PAL version just introduced in England. It has a two-speed switch, to permit playing at half speed. Thus, the "two-hour" cassettes due this summer could permit four-hour playing. Four hours is enough for most movies, and movies mean home decks—not necessarily camcorders.

Behind the scenes, there are reports that Sony is planning a full line of 8mm products—camcorders, home decks, and completely new recorder items. There's a persistent rumor of a very tiny deck or camcorder in the works, far smaller than the current Japanese product, which already is quite small. Sony officials in the past have talked of the possibility of equipping future TV sets with a drawer or slot into which a tiny deck may be inserted, and easily removed for portable use.

And remember that Sony started the entire Walkman craze. Is there lurking, perhaps, in the future a Video Walkman—a tiny, compact pocket VCR with an 8mm cassette and LCD or flat-tube color screen that would let commuters watch their favorite movies on the way to work?

• **Beta's Future.** Much concern is expressed that Sony and its partners may drop Beta. We don't think that that is likely. Beta was the first format, and still is the home-VCR format for many pioneers and purists. So if 8mm should become Sony's "people's format" of the future, it's reasonable to assume that Beta will continue as the deluxe format for those who appreciate quality. Sony is in the process of introducing Super-Beta, a new version of Betamax with high-band color, excellent for dubbing and with a picture that can be appreciated by an electronics connoisseur. It is extremely likely that Beta will move from its place as today's low-end format to tomorrow's aritocratic high-end format—hi-fi and high-band, a semi-pro setup for those who really appreciate quality in home videotaping. Evidence of that trend is shown in Sony's newest deck in Japan. It's hi-fi stereo and high-band, of course, and it has a special professional-type crank-dial for variable slow and fast motion in both directions. And it's called the "Beta Pro."

• **Stereo TV Sound.** Although very little stereo programming for TV is currently available—indeed, two of the three commercial networks aren't well-equipped to distribute it to most of their affiliates—the concept of multchannel TV sound (MTS) must already be considered a success. In early April, some 32 stations were already equipped to broadcast in stereo. They were mostly in major markets, and could be received in 34,000,000 TV homes, or 40 percent of all TV homes in the continental U.S. The raw material for stereo TV listening now exists. All that is needed now is programming. In the meantime, most equipped stations are broadcasting in synthesized stereo.

• **Sony and Others.** Sony is pursuing a new tack by helping prime the pump for other manufacturers. In the past, almost all products emanating from the Sony factories bore the Sony brand name. (An exception was the Beta VCR line that Sony made for Zenith; Zenith showed its gratitude by switching to VHS models made by JVC.) Now, however, Sony is making 8mm camcorders for sale under various brand names, including Fuji, Pioneer, and Yashica. **R-E**

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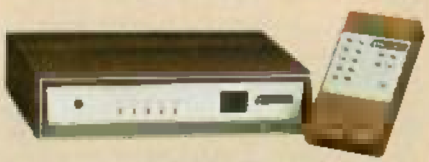

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LETTERS

WRITE TO:

LETTERS
Radio-Electronics
200 Park Ave South
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OOOOOPS!

In our article "Computer-Controlled Robot Arm" in the May 1985 issue, we let a rather embarrising error get into print. Notice that the power and ground lines are shorted together at each motor. Also note that the inputs and outputs of IC3 are reversed. Shown here is a section of the circuit as it should be. Figure 2 in the May issue also shows the correct configuration.

We're sorry those errors got past us, and we hope that they did not cause too many problems.—*Editor*

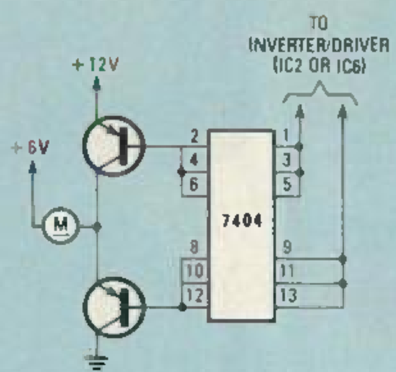

FIG. 1

VIDEO CAMERAS

I thank you for the article about lightweight video cameras. It was refreshing to see that topic covered. One thing I expect from **Radio-Electronics**, however, is accurate reporting, especially regarding the technical aspects of a subject. While most of the details discussed in the article were correct, one glaring error and a few omissions were present, and I'd like to clear those up.

First of all, horizontal resolution does not refer to the number of horizontal scanning lines in the picture, as stated in the article. All

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NTSC-type video signals (which all those cameras produce) are composed of 525 horizontal scanning lines, interlaced 2:1 each field (263.5 lines per field times 2 fields per frame). Therefore, the number of horizontal scanning lines is determined by the number of vertical picture elements. In tube cameras, all 525 are present, but CCD cameras omit a few (the Sony has 491), because they are lost to TV overscan anyway.

Horizontal resolution refers to the number of dots that can be placed next to each other on a line before they blur together. It is primarily a function of a camera's high-frequency response. When taken over the entire picture, those dots form (you guessed it), vertical lines, and are called TV lines. The more dots possible, the sharper the picture, as it can contain more pixels per image. (Remember, the number of vertical picture elements is always limited to 525 anyway).

What about the quality of the various cameras? There is certainly more to video quality than minimum illumination and resolution! While I realize that you are not in the ratings business, I feel that anyone who had actually tried any of those cameras would have had a few things to say. For example, the Panasonic *PK-410* and *PK-450* do make excellent pictures in very low light, but the diagonal striped color filter is somewhat visible on bright vertical-picture elements (such as a window edge) in any light, but especially in low light. Also, the Konica *CV-301* is especially susceptible to green streaking on moving dim-picture elements. Furthermore, that camera uses a tube called a Cosvicon (see page 51 for a picture of the camera), not a "Cosvision" as stated in the article. The camera is also available from Sharp (they make it for Konica) and they call their tube a Newvicon.

The wording to describe features is inconsistent, making comparison difficult. One camera is said to have "15mm-75mm zoom lens", while another has "6× zoom". Also, some features are mentioned on some cameras, but omitted on others. For instance, what is the resolution of the Panasonic cameras? It isn't mentioned. Also, the *PK-450* has built-in time and date display. That isn't mentioned either.

For that matter, some manufacturers are omitted altogether. Why go into detail in describing Quasar cameras, when they are identical to those from Panasonic (both are made by Matsushita, which owns both companies), yet omit Toshiba altogether? What about Sharp?

I expect more from **Radio-Electronics** than a simple trotting out of manufacturers' literature, and I usually get it. Please continue to be a *technical* magazine. Don't stoop to shallow consumer "overview" articles with too-little substance.

MICHAEL JAY GEIER
Allston, MA

MORE TROUBLESHOOTING NEEDED

Mr. Steckler answers his own question ("Letters", **Radio-Elec-**

continued on page 22

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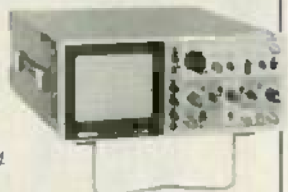

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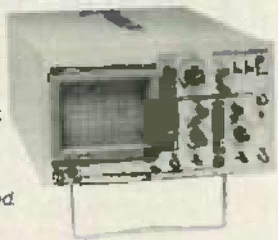

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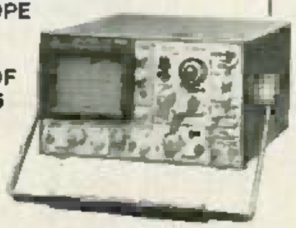

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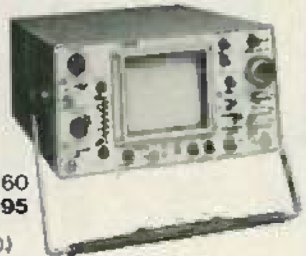

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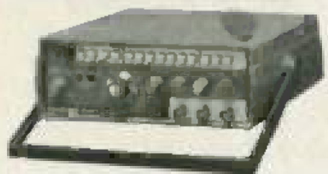

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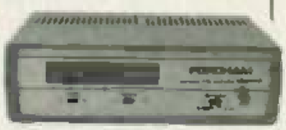

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LETTERS

continued from page 16

tronics, December 1984), when he tells us that he deplores replacing a $500.00 module for the sake of a 25-cent part. I'll bet he wouldn't throw away his $500.00 VCR without spending an appropriate amount of time, money, or both on its repair either. Naturally, with the electronics-value content of automobiles rising greatly, and since we are electronics people, we're the ones who want to explore the inner workings of new technology for a number of reasons ranging from simple curiosity to profit seeking.

The marketplace, not the manufacturer, is the only real determinate of value in general and the marketplace will also ultimately determine what is or is not repairable—including plug in modules.

I'm sure most **Radio-Electronics** readers own an automobile that represents a substantial investment. Near universal ownership of items such as autos, and clothes dryers, make for general reader interest. We all want to be sure we're getting a good value electronics-wise when we make that big purchase and I'm sure many readers will also want to know about troubleshooting and repair—especially when the difference between repair and replacement is a couple of C-notes or more.

DONALD J. SABO
Peekskill, NY

MANUAL NEEDED

I would appreciate your help with this matter: I have acquired a portable tube tester. The only problem is that I don't have the instruction manual and the unit is useless without it. I have been told that the company that manufactured the unit is probably out of business. The tube tester is a model 85, made by the Superior Instrument Company.

If you, or one of your readers, could find out any information on where I might get the instruction manual, I would greatly appreciate it.

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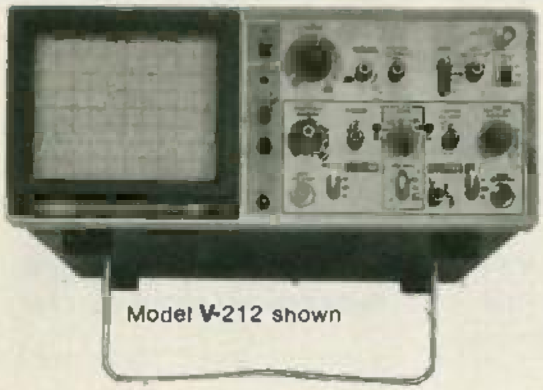
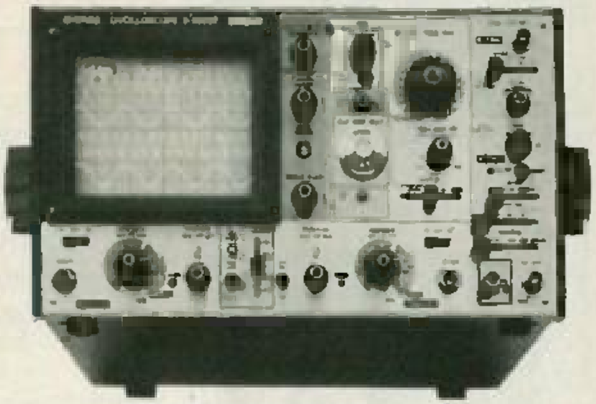


Model V-212 shown



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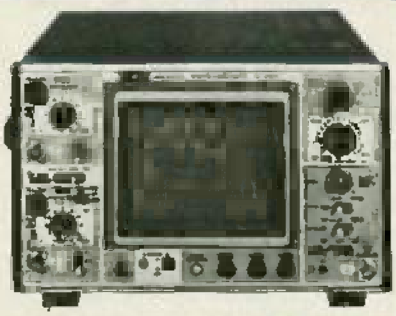

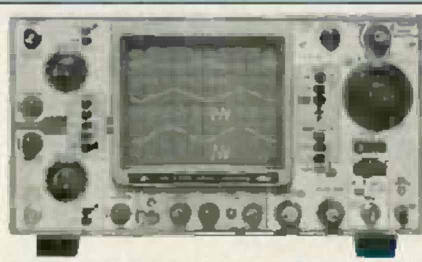

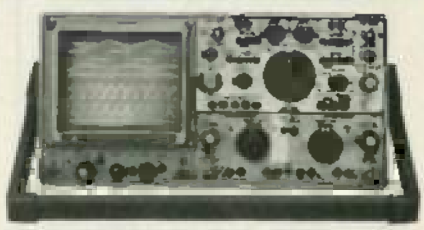

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CIRCLE 5 ON FREE INFORMATION CARD

IT USED TO BE THAT THE WORD "VIDEO" meant nothing more than TV to most people. But, since the advent of VCR, all that has changed. And with those changes has come a change in what we are willing to accept in terms of video quality.

These days, very few are content to "just accept" the video quality provided by our home set-ups. Instead, we are always seeking ways to improve the image that is displayed on our monitors or receivers. One way to achieve a noticeable improvement is with a video amplifier or enhancer. Those units increase picture detail and sharpness by boosting or amplifying the higher frequencies in a video signal. The high frequencies is where much of the fine detail of a video picture is located.

We recently looked at the *Detailer III*—one of the newest video enhancers from Vidicraft (0704 S.W. Bancroft St., Portland, OR 97201).

The *Detailer III*

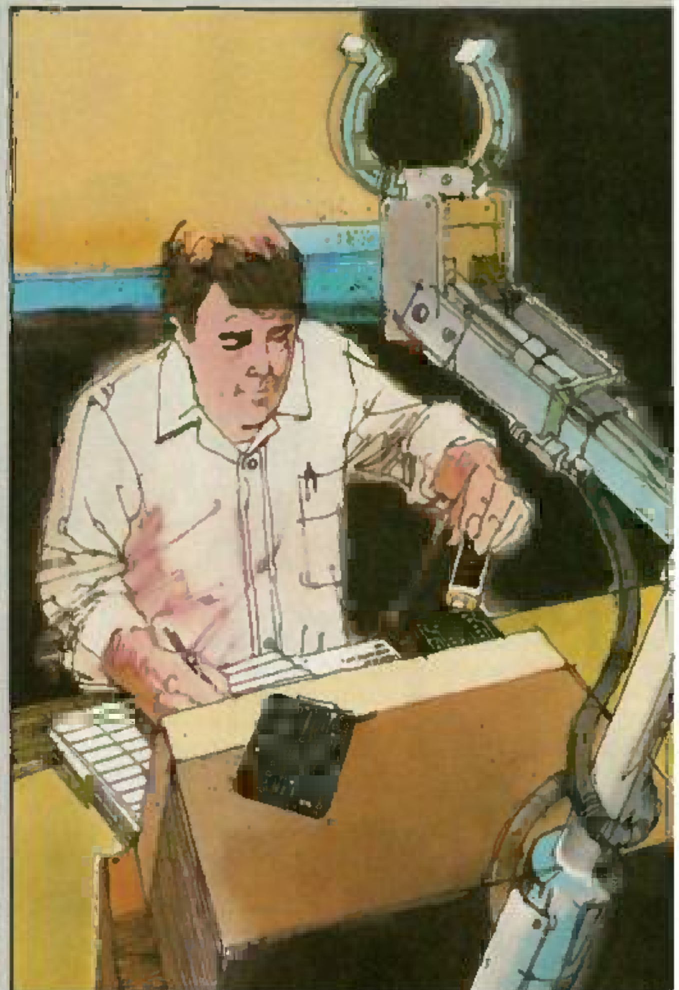
The *Detailer III* is a video enhancer that is designed to improve the performance of VCR's, videocameras, and videodisc players. As with all other such units, this enhancer's performance is greatly influenced by the quality of the material with which it used. In other words: The better the source, the better the results. When, for instance, the unit is used to enhance a tape of a quality over-the-air signal, dramatic increases in picture quality will result. On the other hand, use with a third-generation VHS tape recorded at the machine's slowest speed will produce minimal results.

One reason that the law of diminishing returns holds so strongly when it comes to video is that the same high frequencies that hold so much of the picture detail also contain much of the interference that is commonly called snow. Thus, when you enhance detail, you also enhance snow. In order to minimize that increase in snow, most video enhancers are equipped with some sort of noise-reduction system. The one contained in the *Detailer III* is two-fold.

One part of the noise-reduction system in this unit is Vidicraft's *VNX* circuit. That noise-reduction circuit supresses certain low-amplitude, high-frequency enhancements. As such, it seems to perform the exact opposite of the unit's enhancement function. But the *VNX* system uses a different set of thresholds. The result is a reduction of snow at the expense of some of the increased detail, but the overall result is an improved picture.

The second noise-reduction system is "black noise reduction". That system reduces the level of

continued on page 32



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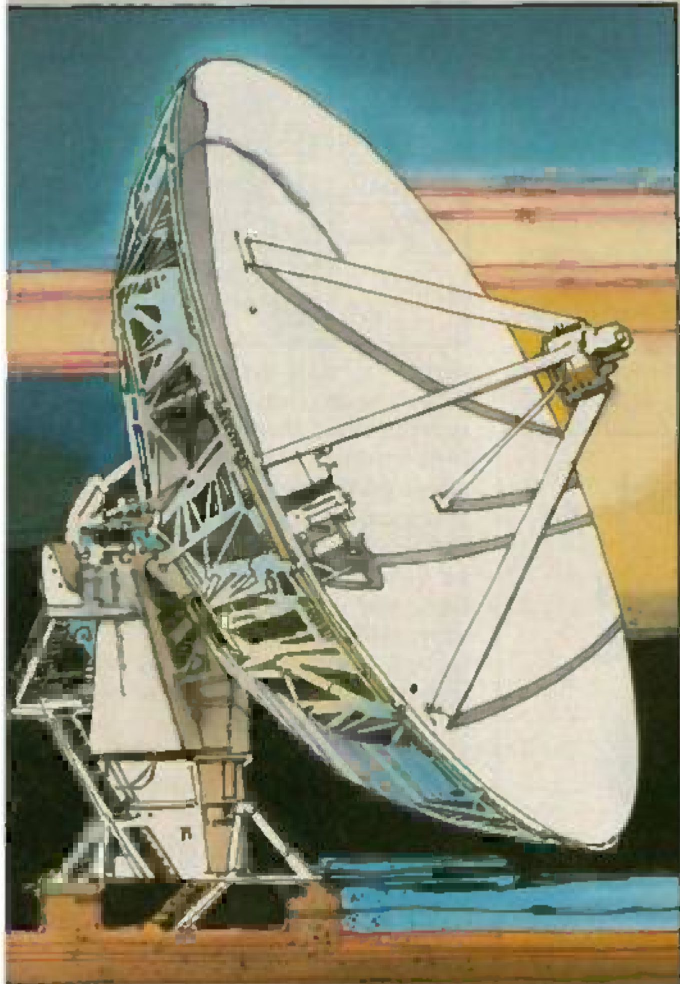

with electronics? anything.

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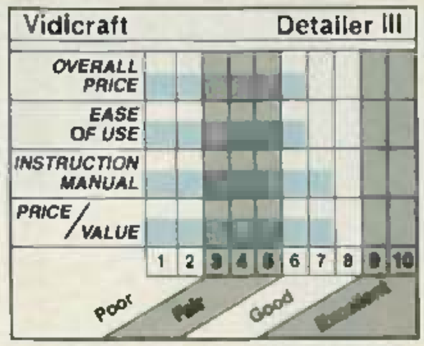
EQUIPMENT REPORTS

continued from page 26

enhancement in the dark areas of the picture. In those areas, increases in detail are not particularly noticeable, but increases in snow are.

One interesting feature of the *Detailer III's* enhancement system is the SPLIT SCREEN function. That allows you to use a front-panel control to split the picture into enhanced and unenhanced regions. That allows you to easily examine the effect of the enhancer on the video signal.

Other features of the unit include a four-input switching system and a distribution amplifier. Both features are capable of handling stereo audio as well as video. The unit's input and output connectors are all located on the rear panel. Included among those are four video inputs, four stereo (or mono) audio inputs, four video



outputs, and four stereo (or mono) audio outputs. Also on the rear panel are three accessory loop input/output connectors. Those allow additional video and audio accessories, such as a video processor or a stereo synthesizer, to be easily interfaced with the system. Any accessory placed in the loop will process any input selected. Input selection is done from the front panel. The selected input is indicated by a front-panel LED.

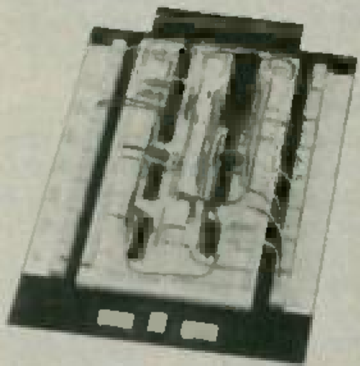
The *Detailer III* is an extremely versatile device. One indication of that is the number of interconnection schemes presented in the unit's manual. Set-ups with as many as eight permanently connect VCR's are outlined.

Speaking of the manual, it does an excellent job of showing you how to get the most out of the unit. All of the numerous hook-up schemes are illustrated in painstaking detail, and front-panel settings are both described and shown. Newcomers to video have not been forgotten by the manufacturer; sections covering such basic topics as the differences between the various types of connectors used in video set-ups have been included. Unfortunately, as is the case with many similar pieces of equipment, those more technically inclined have been overlooked; no technical details (theory of operation, schematic, etc) on the unit are provided. Additionally, only rudimentary troubleshooting information is provided.

On the whole, we are very pleased with the *Detailer III*. Its flexibility and performance should put it at the top of any serious video hobbyist's shopping list. The unit, which is covered by a twoyear warranty, has a suggested retail price of $349. **R-E**

Sabadia Export Corporation eZ Board

Solderless breadboard system for use with your personal computer



CIRCLE 8 ON FREE INFORMATION CARD

MANY PERSONAL-COMPUTER MANufacturers have provided for future expansion of their machines by supplying some type of expansion slot. At that slot, all of the signals to and from the microprocessor are made available. And many enterprising manufacturers have taken advantage of the availability of those expansion slots to devise add-on accessories to expand a computer's capabilities.

But you are not necessarily limited to the add-on circuitry developed for you by others. As long as you have access to those lines, there are an almost unlimited number of circuits that you can build. There is, however, a difference between having access to those lines, and having *easy* access to them.

But having easy access to those lines has now become much, well, easier, thanks to the Sabadia Export Corporation's (PO Box 1132, Yorba Linda, CA 92686) *eZ Board*. That product is a solderless breadboarding system that allows you to develop and build your own circuits, and interface them with your computer via its expansion slot.

The *eZ Board*

eZ Boards are available for three different computer systems. Those are the Apple *IIe* (and *II* and *II+*), IBM *PC*, and Commodore computers. The unit we examined was for use with the Apple *IIe*, and that is the one that we'll describe here.

The *eZ Board* system for the Apple is made up of three parts. Of course, there is the main breadboard unit, which contains the solderless breadboarding strips. Also provided is a system-bus interface card, which is inserted into one of the Apple's expansion slots. The third component is a length of flat ribbon cable that is used to connect the two.

The system-bus interface card is made up of a connector for the ribbon cable and a gold-plated card-edge connector.

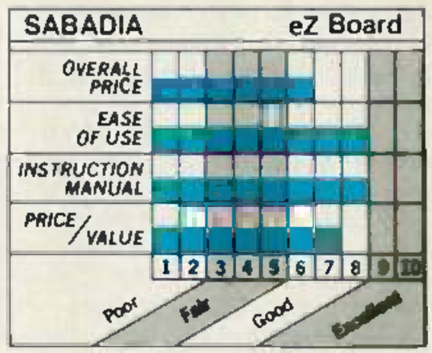
The main breadboard, or development board, contains a connector for the ribbon cable, tie points for all of the expansion-bus signals and supply voltages, four bus strips, and three solderless breadboard strips. The breadboard strips can accommodate up to 24, 14-pin DIP IC's. Also located on the development board is a DIP switch with 4 SPST switches.

The supplied 50-conductor ribbon cable is 18 inches long, which allows you at least some degree of freedom in positioning the development board. The connectors on the ribbon cable mate with those on the development board and system-bus interface card to assure error-free connections between the board and the computer.

Options

For greater flexibility, the manufacturer offers two valuable options for the *eZ Board*. Use of those options will help you get the most out of your unit.

One of those is a buffer/decoder board. That board provides buffers for the address and data lines, as well an address-decode/chip-enable line to the circuitry on the development board. Having such



a circuit between the computer and the *eZ Board* is important, as it greatly minimizes the chances of harming your computer with your experiments.

If the buffer/decoder board is not purchased, a buffer/decoder circuit should be incorporated into your design. But, while the circuit for the buffer/decoder is simple, and is provided in the unit's excellent instruction manual (more on that later), it does take up room on the development board. Using the buffer/decoder board frees that otherwise occupied space up for your circuitry. If it is purchased, the buffer/decoder board takes the place of the system-bus interface board.

The other option is an expansion breadboard module. It uses the same solderless breadboarding strips as found on the development board, and allows larger circuits to be accommodated. That allows for the construction of very large circuits since as many additional modules as needed for that circuit may be used.

The manual supplied with the unit is not fancy, but it gets the job done nicely. In addition to some basic information about the board, the manual goes into a bit of detail about the Apple computer and the 6502 microprocessor that it uses. (We examined the Apple version.)

Also included in the manual are two basic circuits to get you started using the *eZ Board*. Those are a parallel port and a joystick interface. Both circuits are thoroughly explained, and schematics, parts lists, theory of operation sections, testing procedures, and software listings are provided to make building and using the circuits easier.

Like the manual, the unit itself is not fancy, but it gets the job done. Our only complaint was that while all of the power and signal lines are clearly identified on the development board, that identification is merely printed on strips of paper that are glued to the board. It would have been nice to see a more permanent method used.

As to prices, the *eZ Board*, which is available directly from the manufacturer, sells for $124.95, the buffer/decoder board for $49.95, and the expansion modules for $19.95 each. In addition, there is a $5.00 shipping and handling charge on all orders. **R-E**

"I can't believe it—a whole trunk full of radio parts, but not a single piece of wire."

NEW PRODUCTS

CIRCLE 11 ON FREE INFORMATION CARD

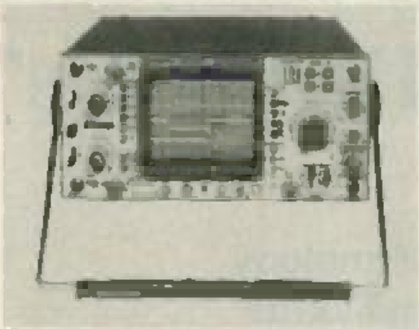
PORTABLE RADIO, model *RF-B600,* is a digital-frequency communications receiver. Ten-key direct-access tuning makes finding a station as easy as pressing the numbered buttons corresponding to the desired frequency's number. (To tune to 95.7 on the FM band, for example, just press the "9," "5," decimal point, and "7" buttons.) The nine-memory, scan/seek function stops at every station in either frequency direction for approximately five seconds before continuing. The seek function automatically searches for the strong-signal stations, remaining there until the function's button is pushed again.

Other features include a five-digit fluorescent digital readout, RF gain control, a 3½" PM dynamic speaker, universal voltage adaptor, and AC power cord. The system operates on eight "D"-size batteries (not included), and three "AA"-size batteries (not included) for memory backup.

The model RF-*B600* has a suggested price of $549.95.—**Panasonic, One Panasonic Way, Secaucus, NJ 07094.**

DIGITAL STORAGE OSCILLOSCOPE, model *LBO-5825,* is a 2-channel model that and has a 2K-word memory, a 5-MHz maximum sampling rate, and pre-trigger view capability. X-Y recorder output terminals are provided for use with a plotter, and simultaneous display of real time and stored waveforms are possible. Other features include roll function, memory protect, external clock provision, and automatic chop/alternate model select.

The model *LBO-5825* is designed for such applications as



CIRCLE 12 ON FREE INFORMATION CARD

stress analysis, shock and vibration testing, power-line transient monitoring, and computer glitch problems. It may also be used for production-line environments, because a stored reference waveform can be compared to an alignment waveform, expediting final adjustment of equipment by the technician.

The model *LBO-5825* is priced at $3,850.00.—**Leader Instruments Corporation, 380 Oser Avenue, Hauppage, NY 11788.**

AUDIO ISOLATION TRANSFORMER, the *AUD-IT*, is intended for use in 600 ohm, line level applications where the user needs to isolate an audio input/output signal, or remove power-line hum caused by ground loops. The

CIRCLE 13 ON FREE INFORMATION CARD

AUD-IT features two isolated RCA connectors for quick termination, compact size (2" × 2" × 1.25"), a color-coded metal enclosure, and built-in mounting tabs. It is priced at $39.95.—**V.A.M.P. Inc., PO Box 411, Los Angeles, CA 90028.**

BENCH MATS, *StopSlip Pads*, are durable, flexible plastic, green in color, with a high co-efficient of friction against other dry materials. They can withstand rough handling, are highly noise-absorbing, and protect work surfaces from scratching. They also prevent parts of any shape from rolling, sliding, or creeping, regardless of the force exerted on them. The friction characteristic of the material never diminishes, and you will find that keeping them clean is a simple matter. Just use mild soap and water; that is all that is necessary.

StopSlip Pads are available in precut sizes one foot square and up, or in rolls ready to cut with scissors for the user's own require-

CIRCLE 14 ON FREE INFORMATION CARD

ments. Retail prices start at $9.90 for a 10-inch square.—**Solder Absorbing Technology, Inc., South End Bridge Circle, Agawam, MA 01001.**

R-E

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If you've been wondering if you can obtain IBM compatibility for a reasonable price, the answer is that you can. We'll show you how.

ELLIOTT S. KANTER

FOR BETTER OR FOR WORSE, THE IBM PC HAS BECOME THE *DE FACTO* standard personal computer. Of course, like all computers, the PC has its shortcomings. But its most serious problem is its expense. There is a way around that problem, however, and **Radio-Electronics** will show you that way. We'll show you how you can put together a PC-compatible computer using parts available from HiTech International. We'll explain how the computer works, and we'll review its performance.

HiTech International, whose computer we'll be assembling, is a supplier of IBM PC XT-compatible motherboards (system boards) and other accessories. The best part about the HiTech computer is that even a novice at electronics construction can assemble his own computer at considerably less cost than IBM's offering.

PC Compatible Computer

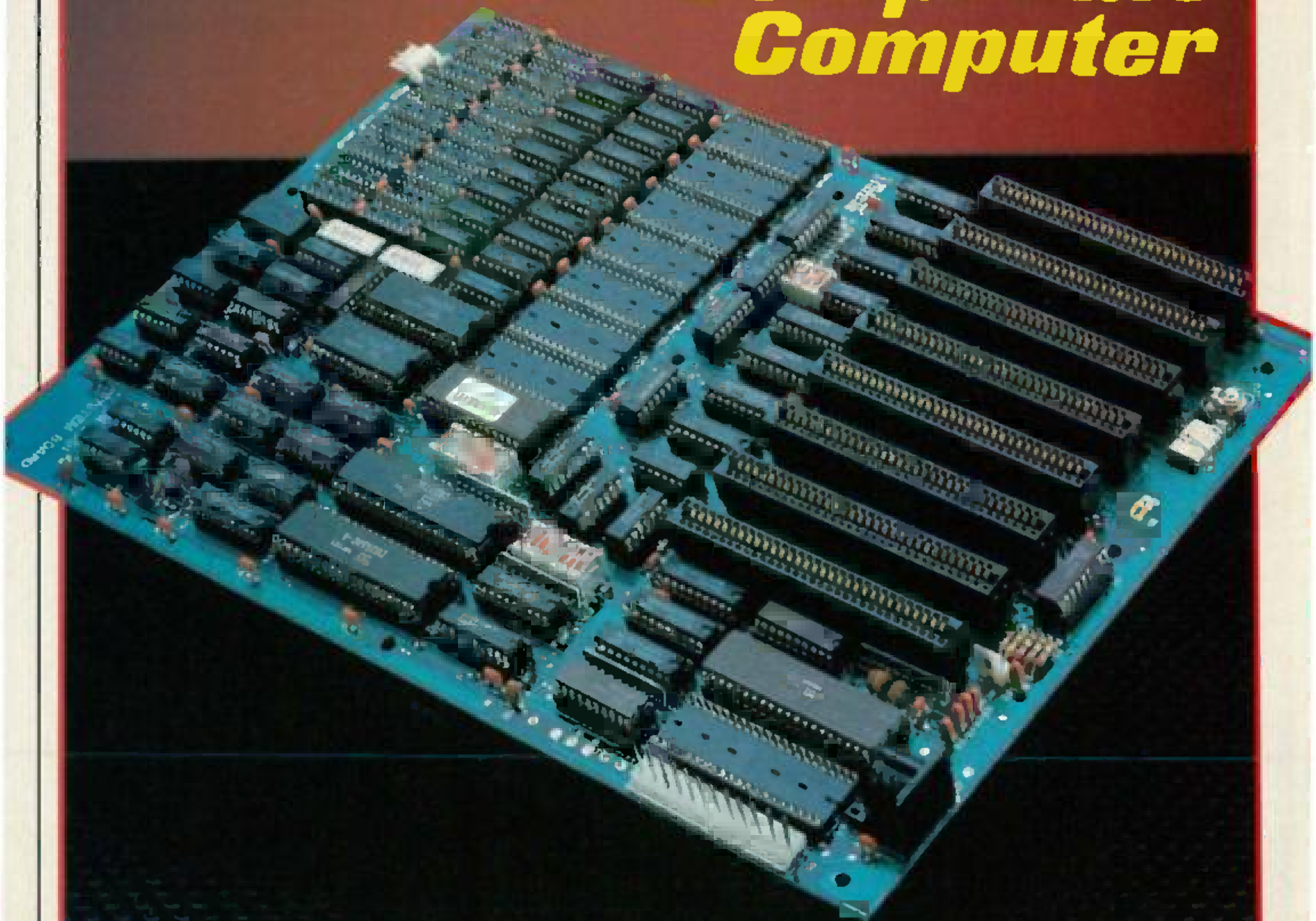

TABLE 1
IBM PC XT SPECIFICATIONS

Microprocessor:	Intel 8088 (4.77 MHz) with socket for addition of an 8087 math co-processor.
Memory:	ROM: 40K. Includes BASIC interpreter. RAM: Either 128K or 256K onboard, expandable up to 640 KB with a memory- expansion card
Keyboard:	83-keys with 10 function keys, numeric/cursor keypad, adjustable typing angle, and detachable 6-foot coiled cable
Mass Storage:	10 MB fixed hard disk. 360 KB double-sided/double density 5¼-inch disk drive
Expansion:	Eight expansion slots
Software:	Diagnostics, *Microsoft* cassette BASIC interpreter in ROM
Operating System:	PC DOS 2.1 (with advanced disk BASIC)
Size: 5½ × 20 × 16 inches	
Weight:	32 pounds
Cost:	$3895
Warranty:	90 Days.

TABLE 2.

BASIC IBM PC XT

Part No.	Item	Price
8529254	PC XT motherboard with 128K RAM	$750.00
8529247	130-watt power supply	$390.00
8529161	Base Assy (case bottom)	$ 86.00
852963	Bezel Assy (case front)	$ 41.50
8529209	Top Cover (case)	$ 50.50
	Keyboard assembly (complete)	$270.00
	64K memory modules (2 required)	$200.00(2)
	TOTAL:	$1788.00

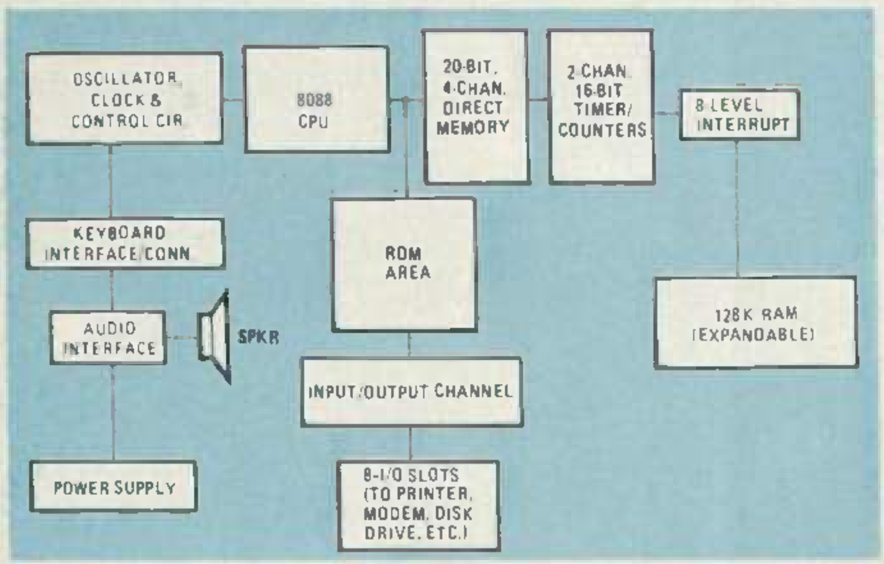

FIG. 1—A BLOCK DIAGRAM of the IBM PC XT shows the "musts" for a personal/business computer. The HiTech PC also has the same block diagram.

Many of HiTech's customers are service centers who buy the system or motherboard to use as running spares for PC XT's brought in for repair. The boards are the same size as IBM's, and—with the exception of the lack of BASIC in ROM—have the same form and function as that of the PC XT board. The basic IBM PC XT can not tell the difference between an IBM board or a HiTech board. And, unless you run the *Advanced Diagnostics Program Diskette* from IBM, neither will you. The discernible difference between the two boards appears as an error message which translates to "Hey, there's no BASIC in the ROM..."

Building by subassembly

In this article, we won't show you how to put together a computer piece-by-piece. (For example, the motherboard is regarded as a single component.) Instead, we'll show you how to build it subassembly-by-subassembly. We'll build the system in stages so that it can be expanded when the need for more functions makes it necessary (or when the cash flow permits). But we're getting a little bit ahead of ourselves. Let's talk more about the IBM PC before we talk about how to assemble a PC-compatible computer.

A brief history of the PC

For many years, the terms "personal computer" and "PC" have been applied to small, limited-use microcomputers which, because of their limited power, have been relegated to home rather than business use. That changed when computer-giant IBM unleashed a small multifunction microcomputer that has become the *de facto* definition for PC. Some three years ago, the IBM PC was introduced to the marketplace and the public's perception of computers changed. More computers were found in small and large offices and in the home. While there were already a number of "business-quality" microcomputers or PC's available, the magic letters IBM tended to make then more acceptable.

There were many other fine companies producing computers. But when the sales figures for any given period are compared, it's obvious that, by numbers alone, IBM was literally taking over the market. Even so, the new entry to the scene was not without its detractors. The most common complaint was (and still is) about the keyboard. The company that pioneered a standard in typewriter keyboards with the *Selectric* really missed the boat with the PC. Some keys are located in illogical positions, and the feel is not comfortable (although you *can* get used to it). Others complained that IBM could have gone with a more advanced microprocessor, and that the machine was too slow. Despite those, and other, complaints, the sales of PC's continued.

In the business world, if a product sells it's a success! And success breeds imitation and—as the PC imitations came to be known—clones. The buzz words "IBM compatible" became a company's ticket to bigger sales. Many manufacturers did

TABLE 3.
BASIC PC XT HITECH INTERNATIONAL

PC XT motherboard with 128K RAM	$525.00
Power supply, 130 watts	$175.00
Case (complete)	$150.00
Keyboard (complete)	$150.00
RAM Each 64K 2 required(3)	$ 50.00
Total:	$1050.00

TABLE 4
HITECH PC XT SPECIFICATIONS

Microprocessor:	Intel 8088 (4.77 MHz) with socket for addition of an 8087 math co-processor.
Memory:	ROM: 8K implemented (can be expanded by user to 40K) RAM: Either 128K or 256K onboard, expandable up to 640K with a memory-expansion card
Keyboard:	Enhanced Key Tronic 5150 PC. 83-keys with 10 function keys, numeric cursor keypad, adjustable typing angle and detachable 6-foot coiled cable
Mass Storage:	10 MB fixed hard disk. 360 KB double sided double density 5¼-inch disk drive
Expansion:	Eight expansion slots
Software:	Diagnostics, supports DISK BASIC
Operating System:	PC DOS 2.1 (with advanced disk BASIC)
Size:	5½ × 20 × 16 inches
Weight	32 pounds
Cost:	$2,454.00
Warranty:	1 Year.

TABLE 5
HITECH PC XT+ PARTS LIST

Part No.	Description	Price
RE-PCB W/IC	Motherboard with 128K RAM	$525.00
RE-PS-130	130-watt power supply	175.00
RE-ROM	BIOS ROM	35.00
RE-CASE	Case (complete)	150.00
RE-5150	enhanced keyboard	150.00
RE-MON/DIS	RGB video card	175.00
RE-DISK DR.	Teac 360K disk drive	125.00
RE-CTRL-A	Disk controller/parallel port	175.00
RE-HARD DISK	10 megabyte drive with controller	650.00
RE-YAD	Y Adapter (to attatch two drives)	5.00
	Total:	2165.00

everything and anything they could to make their offering the same in form and function as the IBM PC. A few companies made such perfect duplicates that they found themselves in legal difficulties with IBM. Others modified their product and qualified their "compatiblity" by stating it would "...run *most* of the vast library of business applications packages." That approach was perhaps the most prudent for the company which did not want to earn the attention of the lawyers in residence at IBM. There even were a few computers that *did* achieve compatibility without paying the price of legal hassles and the like. The system from HiTech International, which we are examining in this article, is one of them.

While achieving compatibility is important for the computer company, the bottom line is: Can the average small-business person afford the end product? While the IBM PC appeared on the surface to offer quite a "bang for the buck," closer examination revealed that the options necessary to make the computer a viable tool raised the price upward significantly. Naturally, those companies making "clones" were quick to point that out. The display card, and other absolutely necessary "options" cost extra, as did sufficient memory, mass storage, printer outputs, etc.

Early in the game, IBM noted the limitations of their original PC and offered first an upgrade of disk drives to dual density, double sided—effectively doubling the available storage capacity on each drive. That wasn't enough. The industry was getting storage-hungry and demanded more and more storage, causing both IBM to turn to a hard-disk drive (often called a "Winchester"), which could bring the mass-storage capacity up to 10 megabytes in the same space as a floppy.

As the consumer was becoming memory-hungry, the computer was rapidly becoming power-poor. The PC's power supply was not capable of supplying the demands that the hard disk placed on it. So IBM was forced to offer a hard-disk storage expansion option together with a heftier supply. But that wasn't all bad; the expansion also added extra I/O slots. (The PC's five slots would be fully populated even in a minimal configuration.) The bad part about the expansion unit was that it cost almost $3000.

IBM finally determined what the customer wanted and needed: adequate memory, and more mass storage. Thus, the PC XT was introduced. The letters "XT" were chosen to give the feeling that the computer really had something "extra." (But is it really extra, or is it the minimal configuration that the PC should have been sold in from the start?)

A real computer

The basics "musts" for a personal/business computer are shown in Fig. 1, a block diagram of the motherboard or system board of the IBM PC XT. A listing of the basic specifications of the PC XT is shown in Table 1.

In that PC XT, three of the eight expansion slots are occupied by asynchronous communications, floppy-disk drive and fixed-disk adapter cards. The price shown ($3895) includes those cards, and 256K RAM. The operating system, PC-DOS 2.10 is optional, and sells for $65.00. The price shown in Table 1 does *not* include any graphics or video-output card.

No matter how you might look at it, when you take into account the operating system, display adapter card, and printer port, it will cost you in the neighborhood of $5000 before you have a meaningful computer. That kind of price makes a lot of people wonder just what they're paying for. Is it a premium for the IBM logo, or is it the real value or cost of the computer (known in the trades as MOL or manufacturing overhead and labor). Well, in order to answer that question, let's see what it would cost to put together a basic IBM PC using IBM parts. Then we'll do the same using parts from HiTech.

FIG. 2—THE KEY TRONIC keyboard features a more comfortable feel and layout.

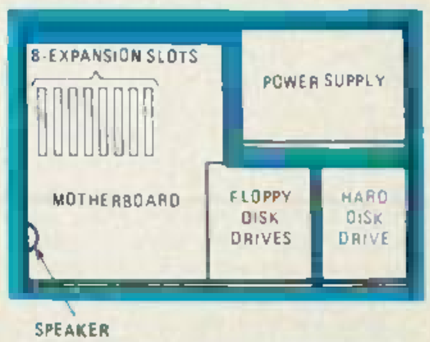

FIG. 3—THE BASIC INTERNAL ARRANGEMENT of the HiTech PC. Note that the 8 slots will accept full-size boards—an advantage over the IBM machine.

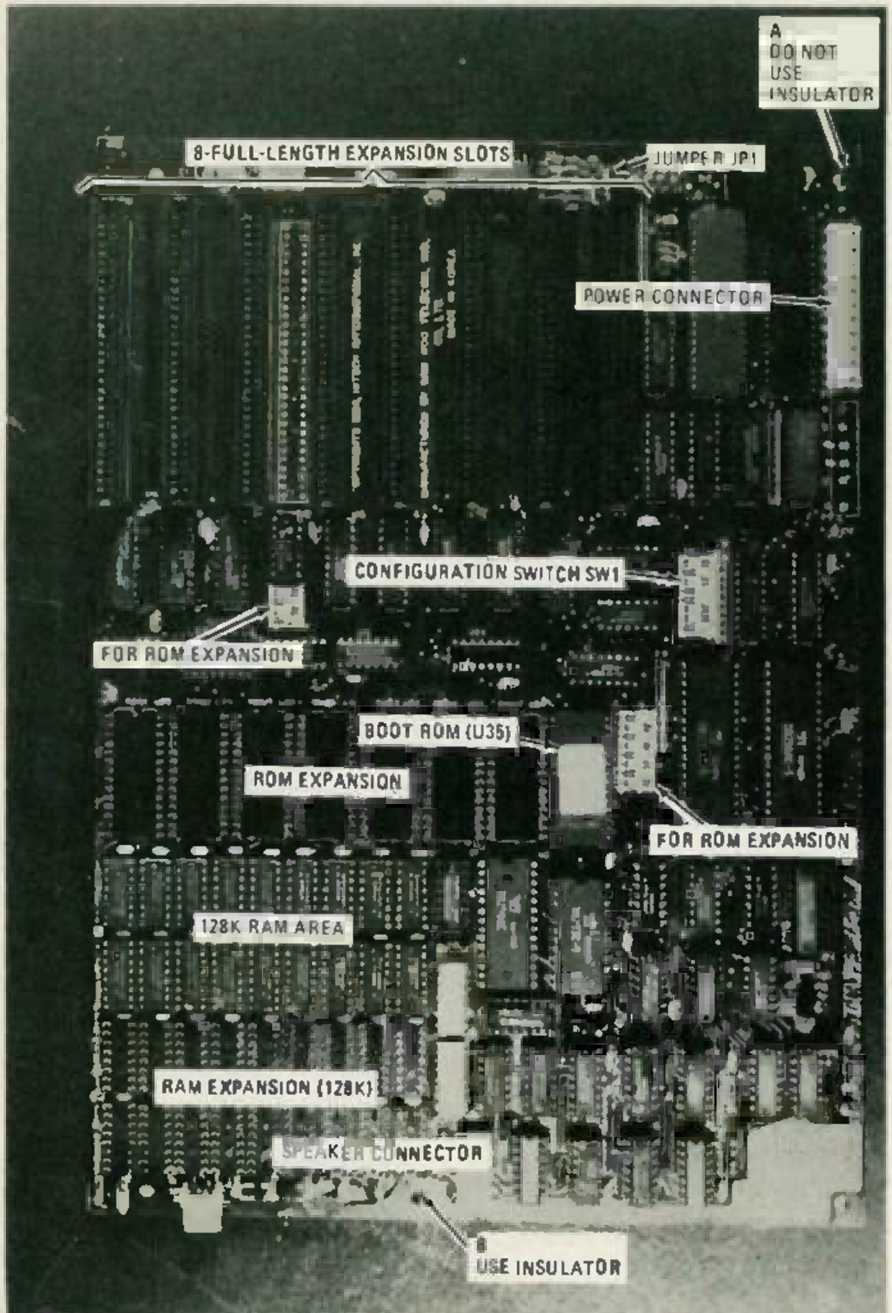

FIG. 4—THE HITECH MOTHERBOARD and some of the features you'll have to be familiar with.

Table 2 shows some pricing data from IBM's Part's Center. (When quoted those prices we were told that "...these prices are firm for today only and may change at any time...") Reduced to its basic building-block level (system board, case, power supply, and keyboard assembly) we see that we could put together a PC with 128K RAM but no disk drives for just under $1800. (Note that parts numbers are listed shown in Table 2 with the exception of the Keyboard, which is made up of many separate items—at the manufacturing stage—and will be lumped together with the total cost.)

What would be the cost for the same system using parts from HiTech? Are there any real savings and are there any differences? Table 3 shows the prices for HiTech's basic PC. As you can see, the price is about $1050—a saving of about $700. What do you lose? IBM BASIC, which is contained in ROM in the PC. But disk BASIC is supported.

Do you get anything extra? We should note that the keyboard that's furnished by HiTech is the Key Tronic model *5150*, shown in Fig. 2. It's fully IBM-compatible but features a "corrected" keyboard layout with a feel not unlike the IBM Selectric typewriter.

Now that we've looked at the savings you can hope for with the basic model, let's look at a more fully equipped model. Table 4 lists the specifications for HiTech's version of the XT, which you can compare to Table 1. We should note that two of the eight expansion slots are occupied by a combination printer/floppy-drive controller and the hard-disk controller. In a similar configuration, an IBM PC XT would have two long and one short expansion slots filled. We should also note that the HiTech expansion slots will accommodate eight full-sized adapter boards as opposed to the IBM's capacity for 5 long and 3 short boards. The price shown does not include a video or graphics adapter card. We should also note that the price shown is for a user-assembled system.

As with the IBM, the operating system (PC-DOS 2.10) is optional and has a suggested retail price of $65.00. If the standard IBM PC DOS Version 2.10 is used the system will not support BASICA. If the COMPAQ PC DOS Version 2.10 is used, all disk BASIC functions will be supported.

Building the Computer

Now that we've introduced you to the HiTech PC-compatible, it's time to put it together. Assembling your system really is easy and anyone can do it. HiTech seems to have set a standard for simplicity of assembly. The only tool you'll need is a common 1/4-inch flat-bladed screwdriver. And you'll need only about one hour. So we'll assume that if you can turn a screw, you will build your own PC-compatible computer.

Before we go any further, we should point out that a bare board is available from HiTech for $95. So if you really want to assemble your computer piece-by-piece, you can. Whether you can really save any money depends on how well you can shop for bargains on IC's, connectors, etc. Be advised, however, that because HiTech cannot control how you put your board together, they cannot issue any warranty for a bare board.

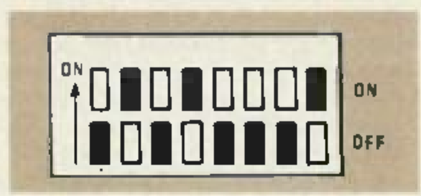

FIG. 5—THE PROPER SETTING of the configuration switch for our system.

So, assuming that you'll start with a ready-assembled mother board, let's run down the features and components your computer will have:

- Systemboard with 128K RAM
- Single 360KB floppy disk drive
- 10 megabyte hard-disk drive
- 130-watt power supply
- Key Tronic 5150 keyboard
- Parallel printer port
- Applicable controller cards
- Color graphics/monochrome display adapter

continued on page 82

Know Before you Buy

Here are some things to think about before you buy that TVRO system.

BOB COOPER, JR.*
SATELLITE TV EDITOR

Part 2 AS WE SAW LAST TIME, THE LEVEL OF PICTURE quality is determined by two factors. Two of those are the size of the dish, and the sensitivity and gain of the LNA.

Finally, the third factor is receiver IF bandwidth, a parameter that has a direct bearing on the quality of the pictures you receive. Take a look at Fig. 2-*a*. It shows how the energy of a typical satellite TV signal is concentrated. Note that the majority (about 90%) of the energy is concentrated in the center portion of the signal. As a result, the signal strength in that region is high enough to override the natural noise level. (Noise is caused by a variety of sources including atmospheric conditions, local and space interference, sunspots, etc. As a result, for a signal to be

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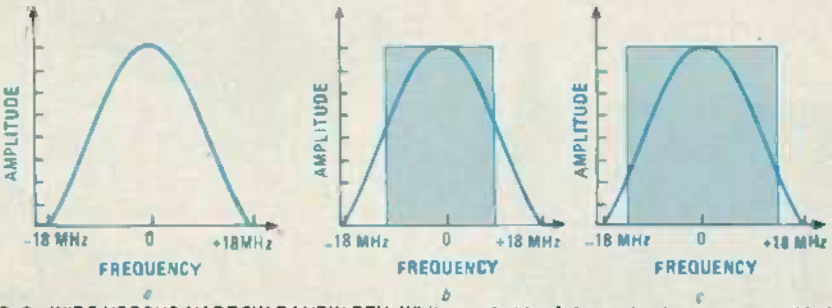


FIG. 2—WIDE VERSUS NARROW BANDWIDTH. While most video information is concentrated in the center portion of the signal (see *a*), luminance and color detail information is found at the signal edges, as is the majority of the noise. Using a narrow bandwidth IF (see *b*) allows most of that noise to be cut-off, but at the expense of the color detail and luminance. Using a wide bandwidth IF (see c) allows all of the picture information to be processed, but will also provide a noisier picture.

useable. It must override that noise "level.") But at the outer edges of the signal, the concentration of energy is much lower and the noise is no longer completely overridden. Because of that, about 90% of the noise in a signal is found at the edges of that signal.

It is of course possible to design a receiver with either a narrow or a wide IF bandwidth. With a narrow bandwidth, as shown in Fig. 2-*b*, the band edges are cut-off, allowing only the stronger central portion of the signal to pass. With a wide bandwidth, as shown in Fig. 2-*c*, all of the signal, as well as all of the noise is allowed to pass.

Now, with 90% of the picture information contained in the central portion of the signal, it would seem logical to go the narrow bandwidth route to obtain as noise-free a signal as possible. There is one major flaw to that, however.

That flaw is that two important parts of the picture information are contained in that ten percent of the signal that is thrown away. Those are the depth-of-field of the color and the high resolution detail in the black and white. To retain all of the color depth and all of the luminance (black and white) detail, you need a to go the wide bandwidth route.

If the satellite signal is good and strong, you can afford to select a wider bandwidth since the sheer strength of the signal will allow the receiver to display a high quality, noise-free picture even with that wider bandwidth. On the other hand, if the signal is weak (because of your having chosen a smaller-than-recommended dish, because of your location, or both), you may need to sacrifice color and detail to get a useable picture.

Receiver data sheets specify IF bandwidth. Some go for the narrow end, a few go for the wide end. Most hang out in the middle, with bandwidths between 24 and 26 MHz.

One last point before we move on. If your installation includes a projection TV, you may not have a real choice as far as bandwidth is concerned. That's because those sets "blow up" the image significantly. What was a small blemish on a 12-inch screen (and perhaps not visible to the naked eye) becomes a glitch or glob on a four- or six-foot screen. Worse than that, when you take a picture designed to be viewed on a 19-inch tube and blow it up to projection-TV size, the scanning lines themselves becomes visible. And when your satellite receiver has lost the depth-of-color and the luminance detail because of a narrow receiver bandwidth, the picture becomes fuzzy and indistinct; it simply loses its ability to be a pleasing, well defined video image.

So when the installation includes such a set, the best advice is to stick with a dish that's large enough to allow you to use a receiver with a wide bandwidth. That will help make sure that when the picture gets enlarged for display, you don't end up with a fuzzy image that always seems to be slightly out of focus.

Audio considerations

Satellite television "broadcasting", is not broadcasting at all. It was never intended to be a system to transmit individual programs to individual homes; it sort of wound up that way because people got together and starting building equipment that would receive the satellite signals.

Satellite television is simply a relay system, using a single repeater station in-the-sky to relay uplinked microwave signals to stations around the country. Consequently, unlike regular TV, AM, or FM broadcasting, no regulatory agency has ever prescribed technical standards to which every satellite program relayer must adhere (aside from rules governing interference to other users).

As you might expect in such an environment, there are a number of different audio formats currently in use (currently 16, though it is expected to grow to as many as 26 within a year). And the audio that is relayed is not limited to just the video signal's audio channel (or channels in the case of stereo). Each transponder has numerous audio subcarriers that carry a wealth of subsidiary services.

Which leads us to our next question: Are you interested in the program audio for television only, or do you also want the non-television audio services?

Program audio (the audio that accompanies the video signal) is normally transmitted on a specific subcarrier frequency between 5 and 8 MHz: for example, 6.8 MHz. A TVRO receiver has a tuning knob that allows continuous tuning of the subcarrier frequencies. As a point of information, around 80% of the program audio subcarriers are on 6.8 MHz, another 10% are on 6.2 MHz and the balance are scattered between 5 and 8 MHz.

You might expect that the program audio on the various satellites and transponders would follow a more-or-less uniform format. Unfortunately, that is not the case. For instance, consider audio bandwidth. Because there are no FCC or even industry standards to follow, the programmers have been free to choose almost any bandwidth that suits their needs.

That has put the satellite receiver designer in a bind. That's because while most program audio is transmitted with an FM (deviation) bandwidth of around 250 kHz, some are far greater. The Nashville Network and The Disney Channel, for example, have bandwidths that are closer to 500 kHz. To get around that, most receivers give you two selectable audio bandwidths, labeled narrow and wide.

If the receiver you use does not have an appropriate bandwidth for the audio signal you wish to receive, it is obvious that the reception will not be satisfactory. When you tune in an audio subcarrier that is wider than the receiver's bandwidth, the audio sounds muddy and indistinct. When you tune in subcarrier that is narrower, on the other hand, the audio sounds scratchy or noisy. Therefore, you want to select a receiver that has an appropriate range of bandwidths for the services that you are interested in receiving. We'll return to some tests you can conduct to determine that shortly.

So far we have been concerned with program audio. It is possible for a transponder to transmit not only its own program audio, but also a considerable number of non-TV-program related audio (see Fig. 3-*a*). The WGN transponder (F3R, TR3), for example, has more than a dozen subcarriers that carry material that has nothing to do with the television. Some of those are data signals, while others are music broadcast services intended for use by AM and FM radio stations. Satellite Music Network, as an example, uses several subcarriers on the WGN transponder to carry an adult contemporary music service, a country and western music service, and an MOR (*M*iddle *O*f the *R*oad) music service. Each of those services is transmitted in stereo (see Fig 3-*b*).

And stereo brings in a some further complications.

We've already mentioned that there are many different systems used to transmit monoaural audio. There are, as you might by now have guessed, also different tech-

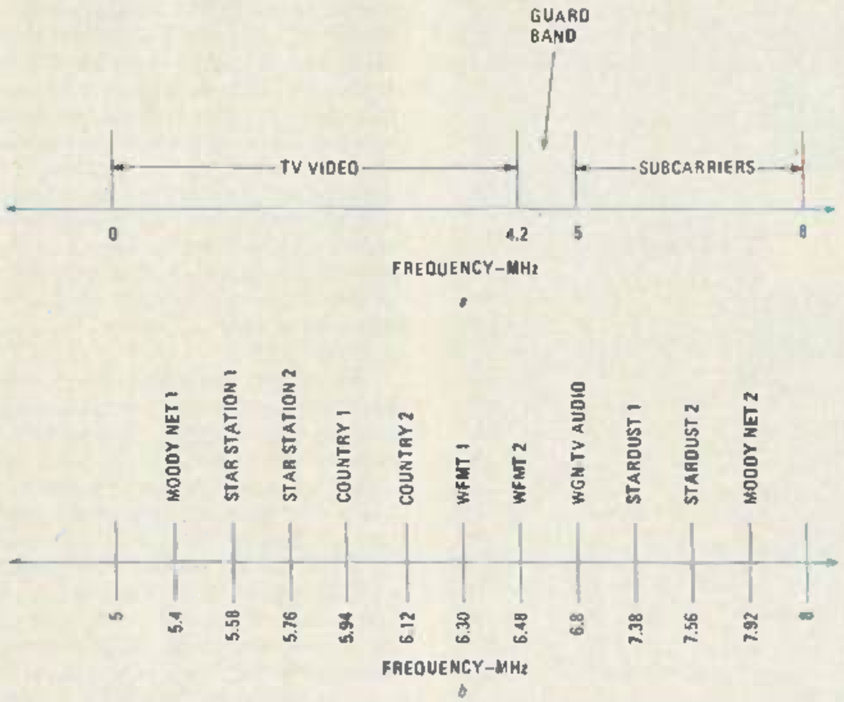


FIG. 3—A TYPICAL TRANSPONDER SIGNAL consists of the video signal, a guard band, and a number of audio subcarriers (see *a*). The audio subcarriers for F3R, transponder 3 (WGN) is shown in *b*.

niques used to transmit stereo sound.

When the left audio is transmitted on one channel and the right audio is transmitted on another channel, we have what we call discrete stereo. To receive discrete stereo, the receiver designer has to build into the TVRO system two separate audio subcarrier tuners: one of which the user tunes to a designated subcarrier frequency (such as 5.58 MHz) and the other of which is tuned to another separate subcarrier frequency (such as 5.76 MHz.). One audio channel is found on one of the subcarriers, the other channel is found on the second subcarrier. The system connects to the in-home stereo system simply by connecting the right output of the TVRO receiver audio to the right input on the stereo, and so on.

Not all stereo is transmitted in that format. Some are transmitted in a matrix format. There are still two separate signals, but each involves mixing the left and right channels in a L + R, L − R format. It still requires a pair of subcarriers. One might be on 5.80 MHz and the other on 6.80 MHz, for example. With that system, the user tunes one of his subcarrier tuners to 5.80 MHz, and the other to 6.80 MHz, and inside the TVRO receiver, matrix decoder circuits separate the right and left signals so they can once again be fed to a home stereo system.

Now some buying tips.

Your first concern is that the receiver that interests you will be compatible with the level of audio services you desire. Regardless of whether you want stereo or not, you do want clean program audio. It may be difficult to ascertain what is clean and crisp if you are trying to listen to a two-inch speaker crammed into the side of a TV set. So ask to have the audio fed through a good sound system.

Now, how good is the audio system? Here are some benchmarks.

- Tune in transponder 6 on F3R (SPN/Satellite Program Network). Place the receiver in the narrow position and look for the next-to-highest subcarrier (7.695 MHz); it will be a "comedy channel" (famous comedians doing comedy routines). See if the audio is noisy. That service uses a very narrow bandwidth, and if the narrow position provides clean, crisp sound here, then the receiver should do a good job with all narrow-bandwidth signals.
- Tune in transponder 4 or 24 on Galaxy I (The Disney Channel). If the receiver is stereo capable, set it for mono, and select a wide bandwidth. Now tune in the audio at 6.8 MHz. Check to see if the audio is "muddy" sounding. That audio channel uses a very wide bandwidth and if the audio is crisp and not muted, that receiver should have no problem with most wide bandwidth audio signals.

Perhaps more so than the video sections, the audio sections vary widely in performance between different receiver models and brands. There is a possible alternate solution if you fall in love with a receiver that has great video but not all of the audio features you would like (not all receiver designers have hopped on the "tune-every-audio service" bandwagon yet).

Stand-alone audio subcarrier tuners are available from a number of sources. Those allow you to treat the audio independent of the video. Again they, like the TVRO receivers with built-in audio tuning controls, should be compared as we previously suggested, since the mere fact that it is a stand-alone audio subcarrier tuner is no guarantee that the designer has allowed for the proper blend of audio bandwidths in use.

Avoiding hype

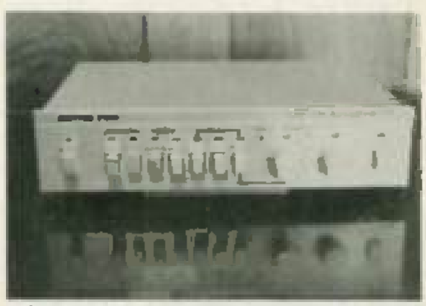
When home TVRO systems first came into the marketplace, all dishes were large, all dishes moved by hand (if at all), and everything cost a great deal of money. Today, fully 70% of the LNA's, 60% of the receiver's, 20% of the motor drives, and 10% of the dishes are created outside of North America. And the percentage of products being manufactured off shore has been getting larger by the month.

Panasonic and Uniden have been recent non-U.S. entrants into the marketplace. Numerous U.S. firms, although still branding their products as "U.S.-made, now are having assembly done in Korea, Taiwan, Hong Kong, or even Mexico. Even Europe is in the North American TVRO act (Luxor from Sweden). With nearly 500,000 home systems sold during 1984 and up to 750,000 home systems forecast for 1985, the market has become large enough to attract many of the better known volume producers.

It is, however, a marketplace that exists almost exclusively within North America and the surrounding areas (where US and Canadian satellites can be received). That is not likely to change in the foreseeable future since North America utilizes certain satellite frequencies and those satellites provide certain services that exist no place else in the world in the same format.

If you are reading this overseas, the first bit of hype to avoid is that you can buy a satellite dish and watch HBO in Ghana, Singapore, etc. The world of international satellite reception is an entirely different subject from that addressed here, and the $500 to $8000 systems we have discussed won't even dent the requirements you will face outside of North America or the Caribean.

The next bit of hype to avoid deals with signal scrambling. The present industry exists to some extent because with a home



STAND ALONE audio subcarrier tuners allow you to treat the audio separately from the video.

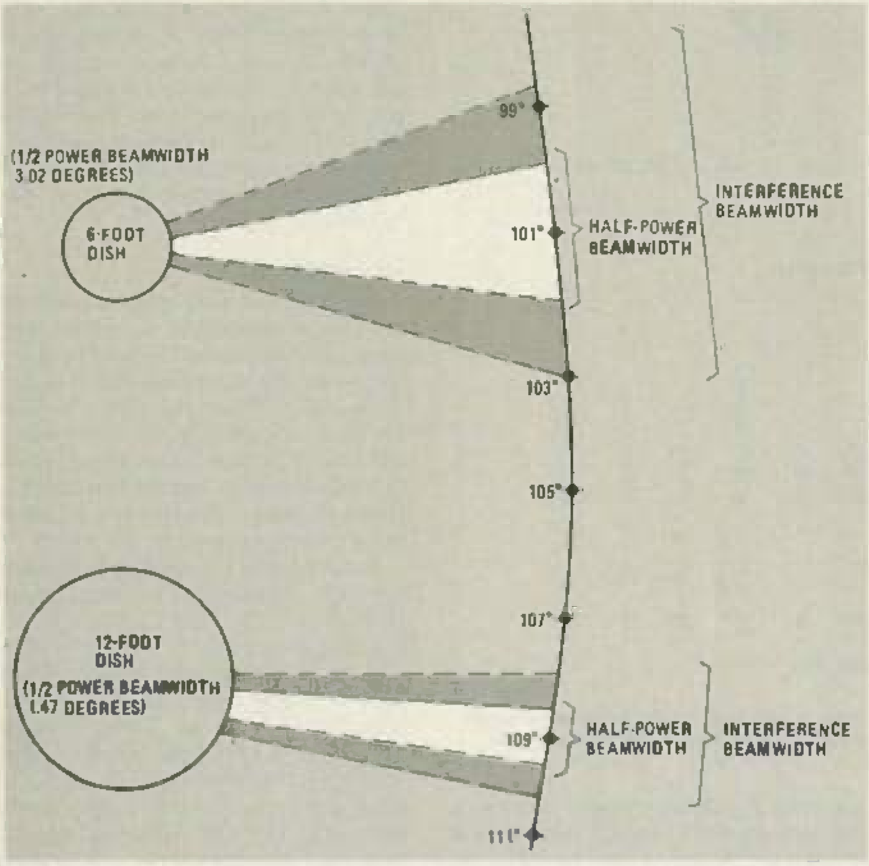


FIG. 4—THE DISH'S SIZE directly affects it beamwidth. As is shown here, the smaller diameter the dish, the larger the beamwidth. That can prove to be a problem for small diameter dishes if two-degree spacing is used. In that case, signals from adjacent satellites can be a source of interference.

TVRO you can tune in satellite program feeds from services such as HBO and Showtime. For many years those services have been open, or available to anyone with a TVRO. And for many years, there have been rumors and there has been speculation that some (or all) of those services will scramble.

Naturally if a substantial quantity of those 90 or so real TV channels did scramble, the desirability of owning a TVRO might change.

As you read this, at least HBO and Cinemax are virtually ready to turn on scrambling equipment. Showtime and The Movie Channel have announced they will also scramble. So, does that spell the end of TVRO?

Not at all. The programmers, if and when they scramble, are doing so because the home TVRO market is now reaching a point where the programmers can anticipate some new, additional revenues from TVRO's. They want to do business with TVRO system owners and after they scramble, there is every reason to expect that they will make their services available to you for a reasonable monthly fee; not unlike cable TV charges for the same services. So the hype that all signals will scramble (four out of 90 is hardly all) and TVRO's will be useless is just propaganda from ill-informed reporters.

The final bit of hype to avoid deals with super-small systems using dishes in the four foot to less-than-seven foot category. We already know that small dishes have less gain, and even in Kansas (where signals are generally strongest) people still prefer 10-foot dishes. They also will have problems dealing with two-degree spacing. Let's see more about that.

Satellites, as we have seen, stretch across the sky in a belt over the equator. Each satellite is assigned an orbital slot by some agency (such as the FCC in the U.S.). The satellite stays within 35 miles of that slot at all times; if it wanders, its orbit is corrected via telemetry. That is important because if a satellite were to wander considerably, it would be difficult to track with a satellite dish, and its signals could interfere with those from an adjacent satellite.

In fact, it is because they are sufficiently apart in the sky that the whole system works at all, since they do use the same channels and we depend upon the directivity of our dish to look only at a single satellite at a time. That directivity is called the dish's beamwidth, and that beamwidth depends greatly on the diameter of the dish—the larger the dish's physical size, the narrower or smaller that beamwidth (see Fig. 4). So, small dishes have broad beamwidths and big dishes have narrow beamwidths.

Now to our problem. The FCC wants to cram as many satellites into that portion of the sky set aside (by international agreement) for U.S. (and Canada/Mexico) use as possible. They want to move the satellites closer together, without causing interference between satellites to the users on the ground. At the present time, U.S. satellites are spaced 2.5 to 4 degrees apart in the Clark Orbit belt. The majority of the present satellites are at least 3 degrees from their neighbors, but the FCC warns us that within the next five years or so, they want to make all satellites uniformly 2 degrees apart.

The catch for small dish owners is that those dishes under 8 to 10 feet in diameter have no proven ability to still function properly when satellites get down to 2 degree spacing. And smaller dishes, 6 feet in size and down, will almost surely have very real problems. With those dishes, when you are pointed at the desired satellite, signals from other satellites on both sides, two degrees away, will certainly cause some amount of interference. Your satellite receiver, seeing both the desired signal and the non-desired signals will simply treat the non-desired signals as interference or noise. The bottom line will be less-than-perfect reception.

To be sure that your dish will still be useable when 2-degree spacing becomes the norm, our advice is to get a guarantee. Most responsible dish manufacturers will certify to you, in writing through the dealer, that their dish will function with two-degree satellite spacing.

Warranties and guarantees

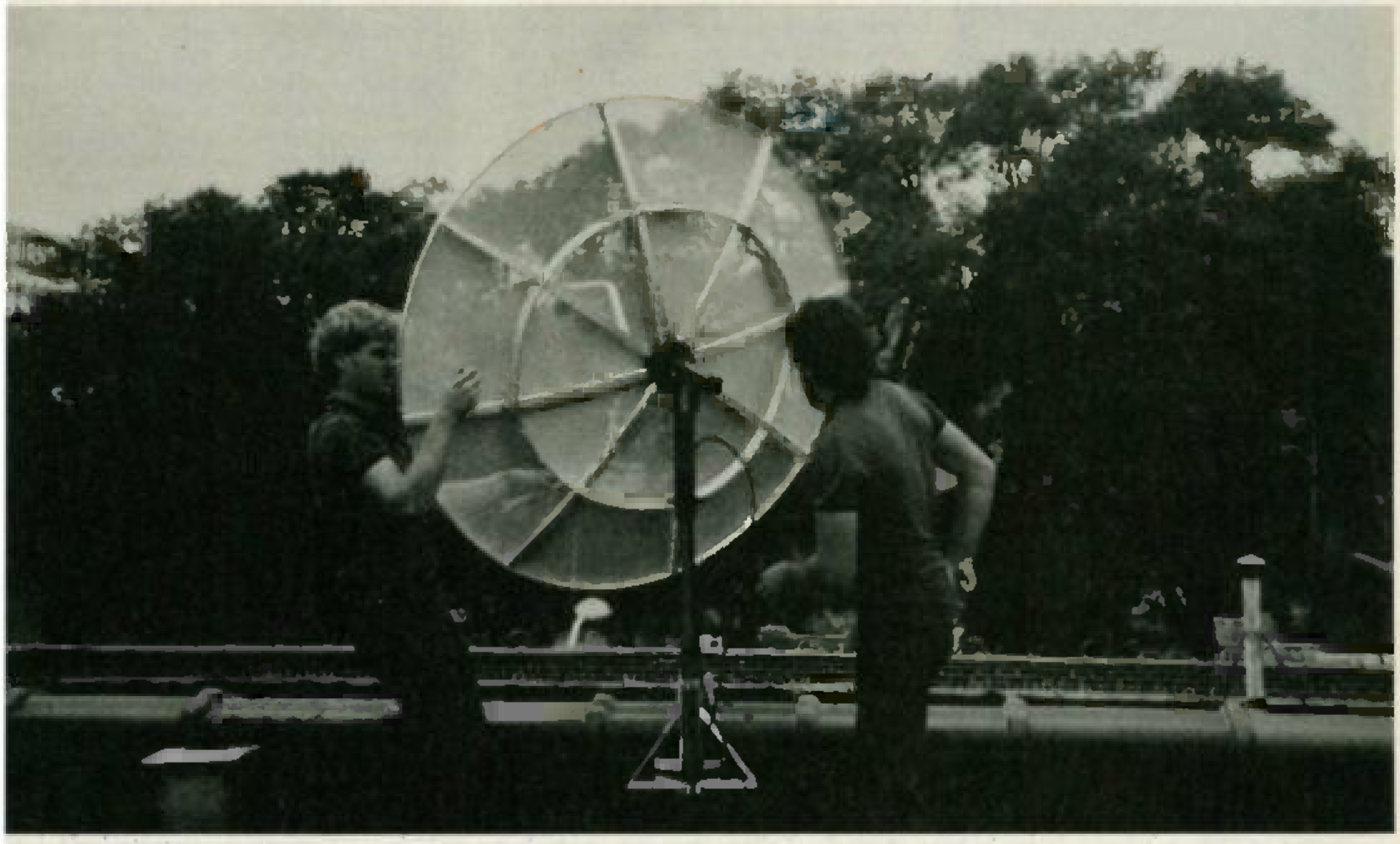
Finally, we leave you with this observation. Early TVRO products were only as good as the local dealer's ability to cope with failures and to respond to the customer/user's plea for assistance. But, times are changing.

Well over 50% of all electronic units and perhaps an even greater percentage of dishes now carry manufacturer warranties. A 12-month original equipment manufacturer promise of performance or replacement statement is pretty standard these days, and some extend to two years and more.

Your bill of sale should make direct reference to the warranty/guarantee coverage and if the original equipment manufacturer provides his own printed statement, that document should become a part of your records—just in case.

The TVRO product area has become far more sophisticated, in both technology and business experience at the dealer level, in just the last 12 months. The industry is a rising star that many expect to continue to grow rapidly for the next five years or more. These may no longer be the pioneering days of yesteryear, but there is still plenty of excitement and challenge in finding the right equipment package for your own home. R-E

Installing your TVRO



BOB COOPER, JR.* SATELLITE TV EDITOR

Take the guesswork out of TVRO installation with this step-by-step guide.

Part 2

LAST TIME, WE BEGAN to outline a model TVRO system. Let's continue by looking at one of the most obvious parts of a TVRO—the dish.

Assembly details vary from dish to dish. We are going to give you some guidelines; but out of necessity, they will be generic rather than specific. When assembling your own dish, follow the instructions supplied with the unit.

Most dishes assemble upside down, and work should be done on a flat surface. All pieces should fit and all bolts should slide through without your having to tug at parts, pry with heavy wedges, or (heaven forbid!) drill new holes for bolts. If you find something does not fit (i.e. holes do not line up), stop and stand back. Before you attack the stuck part with a pry bar or drill, see if perhaps you have misaligned some previously installed part that, in turn, results in the new part not aligning properly.

All name-brand dishes are now "gang drilled," which means that all of the holes are drilled at one time and in one operation. Workman error (misdrilling one hole) is virtually a thing of the past. Before you curse the manufacturer's quality control, check your own!

*PUBLISHER, CSD MAGAZINE

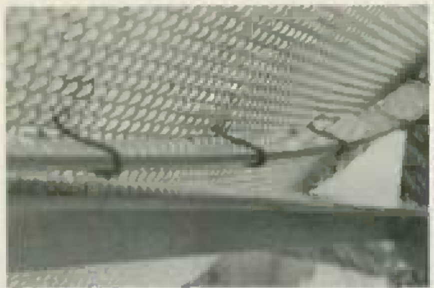
When assembling the dish superstructure, or in the case of fiberglass or solid metal surface dishes, don't wrench tighten any bolts until all pieces in the "pie" are in place. There is always a small amount of adjustment room in connecting segments together and if you start taking up that adjustment room by wrench tightening before you have all of the pieces in place, you may adjust yourself right out of the tolerances required to slide the last piece into place.

When you do tighten up the bolts with wrenches, follow a pattern. Do the inside (closest to the center or hub) bolts first, for example, and do the bolts opposite one another (across the hub or center) working around the dish (i.e. 12 o'clock and then 6 o'clock, 3 o'clock and then 9 o'clock, and so on). When all inner bolts are tight, then start over with the same pattern on the outer rings of bolts.

When the dish is completed, carefully turn it over so that it faces up. That lets you sight across the dish from the near side to the far side to see if the two align precisely. Now move 90 degrees around the dish and sight across it again. If any of the sides appears to be out of alignment, there is a potential warp in the framework holding the dish. Find out why and fix it, because a warped dish will not work properly.

If your dish is of the screen-mesh variety, don't hesitate to use lots and lots of clips (attaching the mesh to the under support pieces). The clips do more than assure that the screen mesh won't blow away: they force the mesh down to the undercarriage and therein ensure that the surface will follow as closely as possible the desired parabolic curve.

Clips are seldom "fun" to install, and the tendency is to shortcut the job and install just enough to get by. That is a bad mistake, as performance of a screen-mesh dish depends upon forcing the surface into a near-parabolic curve: and that only happens when the mesh actually adapts to the parabolic curved undercarriage-support



USE PLENTY of clips! In many designs, the mesh surface adheres to supportive under structure only when lashed down with clips. If you use too few clips, the system will not perform to specifications.

pieces. Take an extra hour to put in lots and lots of clips and you will be properly rewarded with first-class pictures.

Get plenty of help to lift the dish onto the mount. If the dish gets away from you and falls, it will hit on a edge and bend or warp; probably permanently. If that happens, you'll be best off starting all over again.

The dish mount should include instructions for setting something called declination offset for your locale. That is a special adjustment, usually built into the rear of the arm protruding back from or away from the rear of the dish. It is very important if you want your dish to track the Clarke Orbit belt properly. You will need an inclinometer to set that offset adjustment. Most dish manuals have a chart that lists the declination offset amount for various states or areas.

The feed is that device that mounts on a pole out in front of the antenna. Its job is to gather the reflected signal and pass it on to the rest of the TVRO system. It needs to be adjusted properly if your system is to work. Some feeds allow only one adjustment by the installer; others allow several.

FEED-SUPPORT ARM places the feed and LNA (or LNB/LNC) at the focal point of the dish. The feed arm adjusts in and out to ensure precise setting for maximum signal.

The most basic adjustment is setting the distance away from the dish. The dish manual will tell you the focal length, and that is the distance measured from the center plate of the dish, at the hub, to the edge of the feed that is nearest to the center of the dish. Use a rigid tape measure and slide the adjustable feed pole or pipe to reach that distance.

Another adjustment is the side-to-side centering. That, if available or required with your dish, ensures that the feed is looking squarely at the center of the dish, and therefore all around the dish surface equally.

If you want to make sure that the feed is properly centered (left and right, up and down), take a roll of string or long metal tape measure and measure the distance from the edge of the feed front to the rim of the dish at several points. The dish should be equal distance from the rim to the feed edge all the way around. Otherwise, the dish is warped and/or is somehow off center.

Tracking the dish

There are numerous techniques for locating your first satellite with your dish; once that's done, assuming everything is working properly, the dish should automatically track through the remaining satellites in the Clarke Orbit belt. The technique we would like to share with you is among the oldest, but it works very well.

Start by making sure your declination (offset) is properly adjusted. Now, using the chart you prepared that shows the elevation and azimuth headings for your location to the various satellites, select a satellite that is fairly low to your west, such as G1, F3R, or D4.

Take the elevation heading (15.1 degrees for F3R from Albany, New York for example) and hand-adjust the antenna's elevation (using the motor drive control if you have one) so that an inclinometer laid against the flat back on the dish reads 15 degrees. Now you have the dish set for one satellite's elevation.

Next, turn on the monitor or TV set (this assumes, of course, all of the electronics is now hooked up—we'll talk more about that later) and set the receiver to either scan (if a scanning feature is available) or a strong signal (such as transponder 7 on F3R, which is ESPN). Slowly rotate the dish on its pipe-stand mount toward the expected azimuth heading for F3R (246 degrees in Albany). With the dish already set at the proper elevation, you will "run across" F3R as you come up on the 246 degree heading. Stop there and temporarily lock down the bolts that tighten the dish-mount collar to the pipe-stand mount.

Now operate only the motor control or hand crank, and move the dish east. Place the receiver in scan so that the receiver is changing channels automatically as the dish moves. As the dish's azimuth heading changes, the polar-mount mechanism will also cause the dish elevation to change, raising the dish higher and higher as it tracks to the east. That allows it to track the arc of the Clarke Satellite belt. (We have been assuming all along that you are using a polar mount; other types are available, but they are very difficult to adjust when moving from satellite to satellite.) Along the way, you will note flashes of signal as the dish tracks first past one satellite, then another. Stop when the dish is aimed at F4; transponder 7 (National Christian Network) on that satellite is also strong in most areas.

Now, adjust only the dish's mechanical elevation setting for best picture; do not touch the azimuth adjustment (i.e. don't spin the dish on the pipe mount by loosening the collar to pipe bolts). When you have peaked for best signal, operate the motor drive or hand crank and return to F3R.

Once you are back to that satellite, if the picture is no longer as good as it was when you first found it, adjust only the azimuth by carefully loosening the collar to pipe set bolts and nudging the antenna first one way and then the other. When you have the picture peaked, re-tighten the bolts in the following manner.

- Make each bolt finger tight.
- While watching the receiver signal-level meter (or if none is available, the TV screen, although that's a poor second choice), take a wrench and make one quarter turn on each of the collar tightening bolts in succession. Do not tighten one all the way and then move on to the next, since by doing so, you will slip or slide the collar on the pipe.
- Repeat the sequence, a quarter turn at a time, until all bolts are tight. Do not over-tighten; those bolts typically will break off if you use more than moderate wrench pressure.

Return to F4R and double check that it is still peaked. If necessary, re-touch its signal level by carefully adjusting the elevation adjustment. (If adjustment is needed, it is usually caused by an ill-threaded rod or turnbuckle.)

The feed system

The information on centering the feed aside, there is one adjustment required on the feed proper. That is the skew adjustment. Modern satellites (all but Westar 3 are modern by today's standards) transmit 24 channels of possible service. Twelve of those channels are transmitted using vertical polarization, and 12 using horizontal potarization. Polarization, of course, is the technique that makes it possible to cram 24 channels of programming into the frequency space allocated to 12. But that's not our concern here. (For more

ELEVATION is set on this antenna with turnbuckles.

information on that topic see "All About Satellite TV," in the June 1984 issue of **Radio-Electronics**.) Instead, we'll concentrate simply on how you install and properly adjust the feed.

The feed installs on a plate of some sort at the end of the feed arm or bracket. As we mentioned earlier, the length of that feed arm can be adjusted so that the feed is properly located. In addition, however, the arm (or in some cases, only the plate that the feed is mounted on) rotates. Let's see how that rotation is used to make the skew adjustment.

First of all, install the feed on the plate using the hardware provided. Adjust its distance to the center of the dish as described earlier. Once the system is operating on at least one satellite, tune in a signal. Note, using one of the many satellite TV guides (sometimes, one of those is even included with your dish) whether the transponder you are viewing is horizontally or vertically polarized. Going back to our old friend, F3R, transponder 7, we find that it is vertically polarized (on that satellite, odd-numbered transponders are vertically polarized; even-numbered ones horizontally polarized). Set the polarization control in your system for vertical. Examine the signal displayed on the monitor. Then switch to transponder 8, and re-examine the signal. If automatic polarization switching is built into receiver, the act of changing transponders should also have changed the polarization of the feed and you should have a good picture. If your receiver does not have automatic switching, you will have to set the polarity, via the appropriate control, for horizontal.

Unless you are extremely lucky, there is bound to be some evidence of the transponder 7 signal present. That may include drifting vertical lines, or even two video signals (the one from transponder 8 and a weaker one from transponder 7). If present, we obviously need to remove any sign of the vertically polarized transponder 7 signal. (If you have a receiver with automatic polarity switching, the first step is to temporarily disconnect the polarity control lines between the receiver and the LNB—simply unplug them from the back of the receiver.) To do that, mechanically rotate the feed support arm a touch until any signs of the adjacent transponder disappear. Now, switch back to transponder 7, but *leave the polarity control set for horizontal*. Once again, rotate the feed, if necessary, to make all signs of the vertically polarized transponder 7 signal disappear. Once that's done, tighten the bolts that lock the feed-support arm in place.

The electronics

Everything we have discussed up to this point applies to any type of TVRO system you might install. The rules are the same for LNA/downconverter, LNB, or LNC systems. The type of system you select will, however, affect what follows.

As we feel that block downconversion (BDC) offers some significant advantages, such as the ability to have multiple receivers without restricting the choice of viewing to a single transponder, we will outline a system that uses that technology. A BDC system consists of the following:

- Some form of signal amplification at the feed (LNA, LNB).
- Some form of frequency downconversion. If you use an LNA, you will need a separate block downconverter. If you use an LNB, the downconverter and LNA are in a single package.
- Cabling from the LNA/downconverter or LNB to the receiver
- Signal splitters that will allow you to route the satellite signals to multiple receivers (if your system calls for that).

The job of the block downconverter is to convert the satellite's 3.7- to 4.2 GHz signals to some lower band of frequencies. Among other things, that allows the connection between the dish and the receiver to be made using common coax, rather than special high-frequency (and very high cost) cable. The output frequencies of a block downconverter varies by manufacturer, and range from 270-to-770-MHz to 1140-to-1640-MHz, but all have one thing in common: They all use a 500-MHz band of frequencies, such as 450 to 950 MHz. That is because, in the block downconversion systems, all signals in the 500-MHz input band (4.2 GHz − 3.7 GHz = .5 GHz = 500 MHz) are output to the receiver. Thus, the output band is a faithfull reproduction of the input band, only lower in frequency.

Even though the output of the downconverter is much lower in frequency than the input, it is still high enough for line loss to become a significant problem, especially at the high end of the range of output-frequency bands used. The trick, then, is to ensure that each receiver in the home system receives adequate signal strength from the block downconverter. That factor must be considered when planning out your system. Also, in a multiple-receiver setup, the individual receiver locations should be isolated from one another to ensure that there is no unwanted interaction between those units.

Neither problem is really anything unique to satellite TV. They've all been face and solved by CATV and MATV operators.

There is, however, an important difference. In setting up a home distribution system for satellite TV, we cannot simply march into our local parts supplier (such as Radio Shack) or a local CATV supply house, and purchase the components we need. That's because the frequencies used in satellite TV are generally higher than those used for cable or broadcast TV. Thus, since the signal splitters, taps, and so on, generally available from the above mentioned sources, are designed for use at lower frequencies, they will work poorly, or not at all, for our application. Fortunately, appropriate equipment, intended specifically for satellite-TV applications, is made by several manufacturers, and should be available from your installer or dealer.

Loss and gain

Receivers in a satellite system are categorized as masters and slaves. The difference is that the master receiver, which should be located where there is the most TV traffic, controls certain functions for the entire system, such as satellite selection and polarization selection.

Power for the LNB (or LNA and block downconverter) comes from the master receiver and is usually supplied via the same coaxial cable that carries the output from the downconverter indoors

In satellite TV "lingo" the downconverter is labeled the *headend*, or more simply, the point where the signals originate. The downconverter has some output level, specified in dBmV, where 0 dBmV is 1 millivolt (measured across a 75-ohm coaxial cable). A typical signal level from a block downconverter is +10 dBmV.

That +10dBmV signal has to be shared between each of the receiver locations. (The typical satellite receiver requires a minimum input signal level of 0 dBmV.) There are two approaches to that. For larger systems, a tapped trunk approach, similar to that used by cable companies is the best route to go. For a relatively small system (4 or fewer receiver locations), as shown in Fig. 4, the splitter approach is recommended, since it makes slightly better use of the available signal levels. In

Fig. 4, we show a system with two receiver locations on the ground floor, and two receiver locations on the second floor. The connection from the downconverter to the house is made using a single length of RG-6/U. At the entry to the house, we have a two-way splitter: between the downconverter and the splitter we also have a line amplifier, but let's ignore that for now. The splitter splits the signal into two "legs". One of those legs, as we said before, feeds the two downstairs receivers. To do that, the signal is fed to a second two-way splitter. One output from that splitter feeds the master receiver, while the other goes to the first-floor slave. (Note that the control signals and power are fed from the master receiver to the LNA/downconverter.) Meanwhile, the second leg is once again fed to a two-way splitter whose outputs are used to feed two upstairs slave receivers.

While we've just outlined what looks to be a very efficient small distribution system, can we be sure that it will work as intended? To answer that, we have to keep some points in mind.

- The downcoverter output is approximately +10dBmV (though that can vary, so check the manufacturer's specifications for your unit).
- The minimum acceptable input level at each receiver is 0dBmV.

From the above, it appears we can sustain about 10dB of loss before we run into problems. That loss will come from two sources: the splitters and the cable. Turning first to the splitters, there are two between each receiver and the downconverter. The typical two-way splitter has 4.0dB of "loss." (Actually, only about 1 dB is really lost, the balance of the 4 dB is simply the signal being split into two parts.) So before we even consider cable losses, we have 8dB of loss. Now, what about those cable losses?

The cable losses will be considerable. Just how much will depend upon what frequencies are output by the downconverter. Remember that various receiver manufacturers offer different output-frequency ranges. And the top end or highest frequency in the range will have the greatest loss. Table 3 shows the typical losses for RG-6/U and RG-59/U coax at various typical "high-end" frequencies.

Note that the values given in Table 3 are only typical, and will vary (sometimes greatly) with the grade and manufacturer. It is important to understand that neither RG-6/U nor RG-59/U are really intended for use much above 900 MHz (try to locate manufacturer specifications above 900 MHz and you will quickly agree!) so the cheaper grades of RG-59/U "TV-hook-up cable" sold prepackaged by many of the national chain stores are apt to suffer far greater losses (per 100 feet) than what is quoted here. Our best advice is to stick to quality cables from manufacturers who will supply you with guaranteed loss-per-100 foot characteristics.

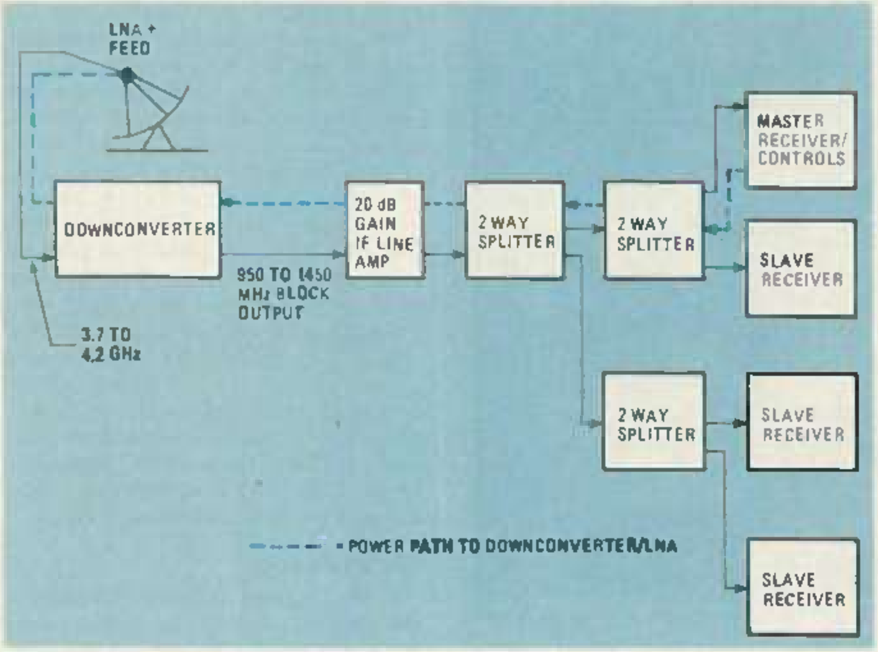


FIG. 4—A FOUR-RECEIVER SYSTEM. Use of the line amplifier ensures that signal levels will be sufficient to overcome any line loss or the loss caused by the splitters.

TABLE 3—CABLE LOSS

Top end frequency	Cable type	Loss per 100-feet
770 MHz	RG-6/U	6.0 dB
770 MHz	RG-59/U	7.5 dB
950 MHz	RG-6/U	7.0 dB
950 MHz	RG-59/U	8.8 dB
1450 MHz	RG-6/U	9.5 dB
1450 MHz	RG-59/U	11.0 dB
1640 MHz	RG-6/U	10.1 dB
1640 MHz	RG-59/U	12.0 dB

So, if we have lost 8dB of signal in our two splitters—and we can only lose 10 dB before we have a signal-level problem, it would appear we have 2dB left to lose in the cable. If our system uses a downconverter with an IF output of 950–1450, that means that we only can use about 21 feet of RG-6/U cable (total) for our hookup if we are to have satisfactory results at the high end of the band.

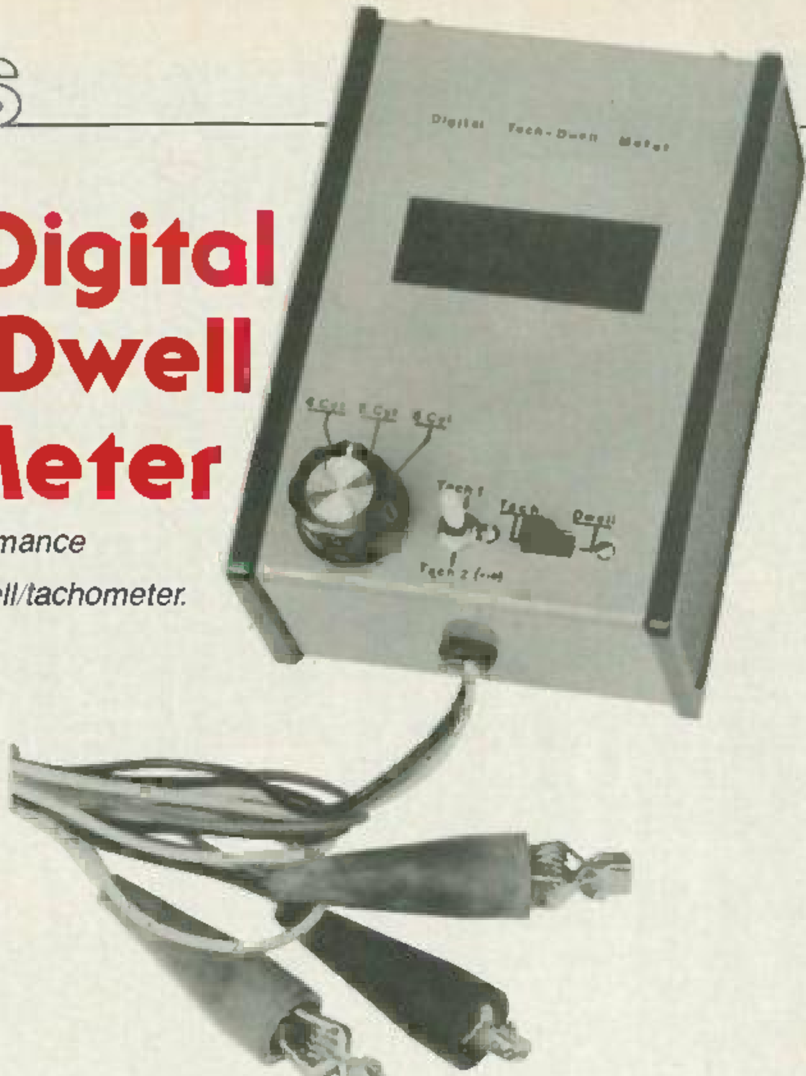
It is unlikely that we can reach all four sets in this system with no more than 21 feet of cable between the downconverter and the most distant TV receiver location. The solution is to use an amplifier.

As with the splitters we looked at earlier, line amplifiers intended for cable service often do not operate well at the frequencies output by satellite-TV downconverters, especially the higher frequencies. Fortunately there are a number of manufacturers that offer equipment specially intended for satellite-TV service.

Satellite-TV amplifiers typically have gains of 20dB, with a *slope* of 2 or 3 dB. For those unfamiliar with it, let's explain what is meant by slope. Remember that cable losses increase with frequency. A length of RG-6/U, for example, may have 9.5dB of loss at 1450 MHz, but it will have only 7.0dB of loss at 950 MHz. That's a 2.5dB differential, and the object of our system is to maintain not only a minimum of 0dBmV to each receiver, but to also attempt to keep the level "balanced" (i.e. the same) at the input to each receiver and on each channel. A "sloped amplifier" has 2 to 3 dB more gain at 1450 MHz than it does at 950 MHz. That sloped gain acts to compensate for the expected additional cable losses at the higher frequencies.

In summary, many of the original problems of TVRO reception have been eliminated by newer equipment designs. Everything about TVRO equipment has become more consumer/user "friendly" in the past 18 months, and the industry is rapidly approaching a "mature" design level from which innovation will switch to product efficiencies rather than product features. Most equipment now arrives on your doorstep with reasonably adequate installation instruction manuals, and most equipment now carries at least a one-year OEM warranty. R-E

Digital Tach/Dwell Meter



Tune up your car for peak performance with this easy-to-build digital dwell/tachometer.

DAVID DEMERS

HAVE YOU BEEN SHYING AWAY FROM TUNing up your car because of the difficulty of making such measurements as dwell angle and engine rpm? If so, your car may not be running at its best. And even though gasoline prices have come down in recent months, you can still waste a tremendous amount of money by driving a car that is improperly tuned up.

Tuning up your car does not have to be difficult. You can start by building this digital dwell/tachometer that will make measuring your engine's idle speed and dwell angle nothing short of simple.

Handheld dwell/tachometers have been available at a reasonable cost for some time now. But those devices use analog meter movements. The meter we'll build uses a digital readout. It's not only more accurate; it's easier to use because there's no meter scale to interpret and no parallax error to worry about. That's important when you're crouching under the hood.

The tach/dwell meter

Those of you who are not familiar with the operation of your car may be wondering what a dwell/tachometer is used for. Well, the combination tachometer and dwell meter is one of the most common and useful test instruments for engine maintenance. As its name suggests, it measures two important parameters: engine speed (in revolutions per minute or rpm's) and the dwell angle (in degrees) by monitoring the voltage across the breaker points.

For those of you unfamiliar with how a car's ignition system works, we'll give a simplified explanation of the dwell angle. In a standard ignition system, the spark plugs fire when the breaker points open and interrupt the current flowing in the ignition coil. That causes the coil's magnetic field to collapse, producing the high voltage necessary in the coil's secondary to fire the plugs. The breaker points are opened by a cam in the distributor. The angle through which the distributor rotates with the points closed is the dwell angle. An electronic ignition operates differently, but with the same results.

The waveform of the voltage across the breaker points is shown in Fig. 1. The ringing at the leading edge of the pulses is due to the collapsing magnetic field of the coil. The number of the pulses in a given unit of time is directly related to the rpm of the engine.

The meter we will build can measure engine speed in two ranges: TACH 2 or RPM ×10 has a range of 0–999 and TACH 1 or RPM ×100 has a range of 0–9999 rpm. The dwell meter has a range of 0–99.9 degrees to check the setting of the breaker points (or the corresponding circuits of an electronic ignition).

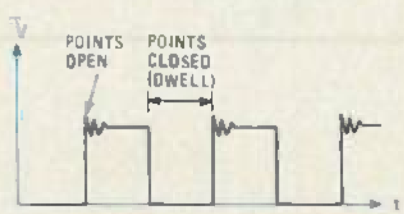


FIG. 1—TYPICAL VOLTAGE WAVEFORM of breaker points.

Measuring engine rpm

The schematic of the tach/dwell meter is shown in Fig. 2. The heart of the circuit is IC2, a 4046 micropower phase-locked loop or PLL. The incoming signals are fed to the PLL after being buffered by IC1-a and its associated components. The frequency of the incoming signal is multiplied by either 90, 60, or 45, depending on the setting of the CYLINDER SELECT switch, S2. That switch selects the proper output from counters IC3 and IC4, which are set to divide the output frequency of the PLL by those amounts, and then send the divided output back to the comparator to the PLL to keep it "locked on" to the input signal.

The PHASE PULSES output at pin 4 of IC2, the 4046 PLL, then go through an AND gate IC5-d (which only passes the signals if the PLL is locked on to an input signal, preventing stray readings), and then to the input of IC6.

When in the TACH mode, IC6—a 14553 3-decade, multiplexed-output counter—counts the number of pulses present at pin 12, during the timing interval generated by IC8 and the associated circuitry of IC1-b. Because of the varied multiplication rate for the different cylinder selections (90, 60, and 45 for 4, 6, and 8 cylinders,

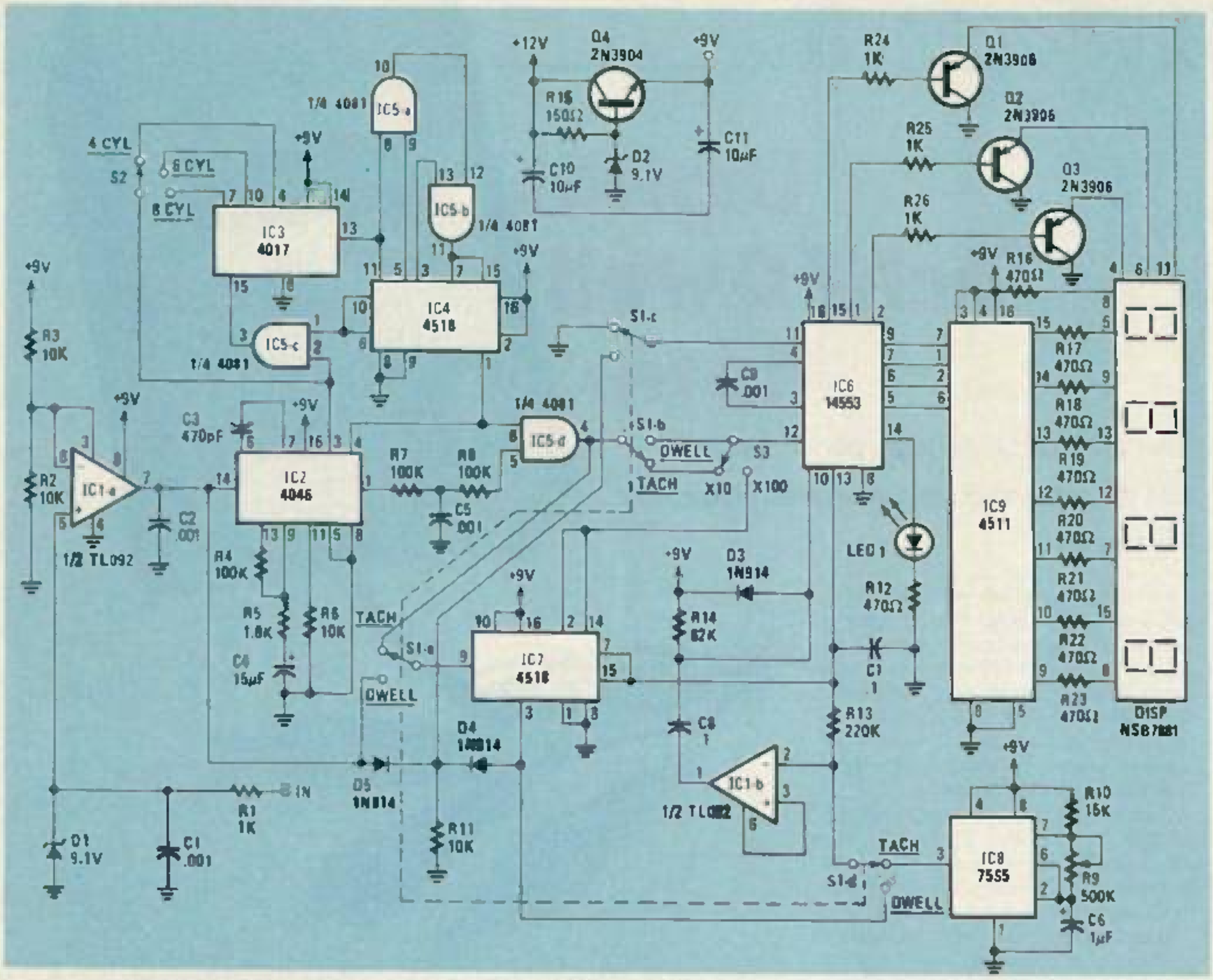


FIG. 2—DWELL/TACHOMETER SCHEMATIC. As shown, the meter is set for 4 cylinders, low tach range. Because the TL092 op-amp that the author used is very hard to find, you might want to substitute National Semiconductor's LM358 for IC1.

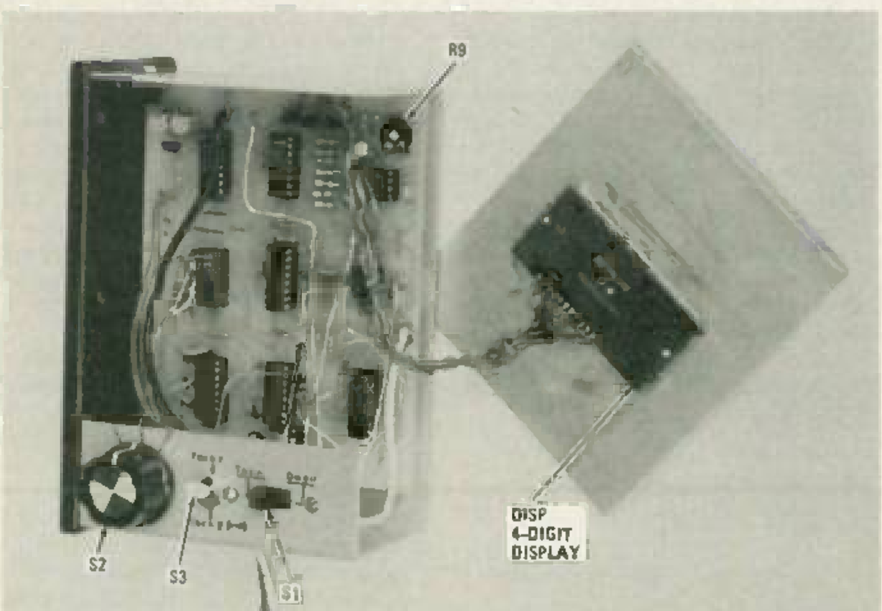


FIG. 3—THE AUTHOR'S PROTOTYPE shown with the cover removed. Note that the display is simply glued to the front panel.

respectively), the time interval is always constant at 1/3 of a second. That is adjusted with R9, a 500K potentiometer; it is the only adjustment in the circuit.

In the high-tach (TACH 1 or ×100) range of 0–9990 rpm, the output of IC2 (the 4046 PLL) is routed by switches S1-a and S3 through IC7, a divide-by-ten counter, which increases the count range tenfold. In the low tach (TACH 2 or ×10) range of 0–999 rpm, that counter is bypassed.

Measuring dwell angle

In the DWELL mode, the operation of the circuit is a little trickier. The maximum dwell (which is measured in degrees) is determined by the number of cylinders. For a four-cylinder engine, the maximum dwell is 90 degrees, for a six-cylinder, 60, and for an eight-cylinder, 45 degrees. You will recall that those maximums are also the amounts by which the frequency of the incoming signal is being multiplied. The multiplied signal is applied to pin 12 of IC6, the three-digit counter.

In order to measure the dwell, it is necessary to count only during the time that

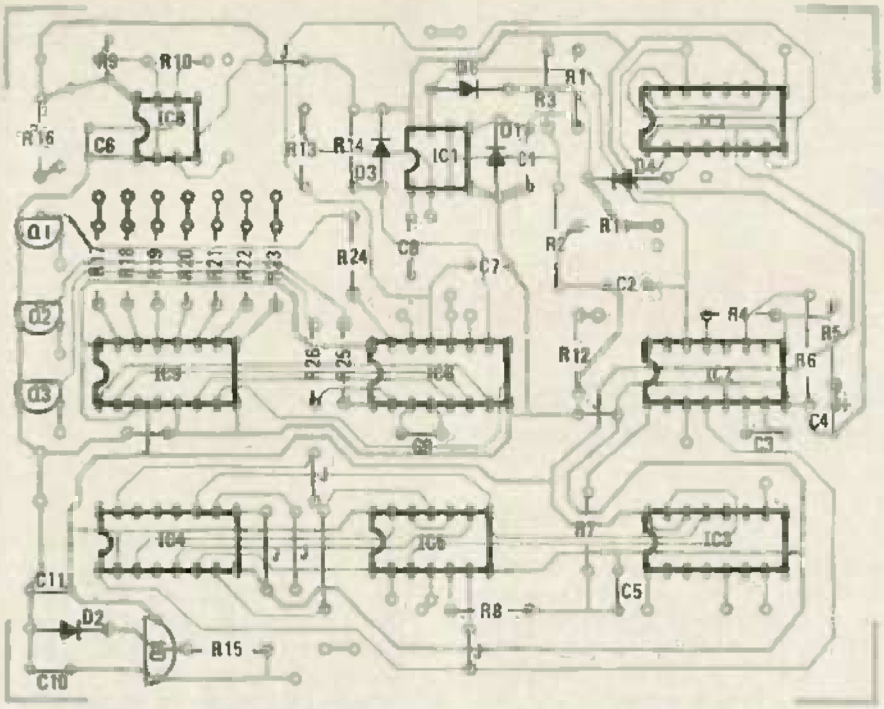


FIG. 4—PARTS PLACEMENT PATTERN for the dwell tachometer. The PC board pattern is shown in our new "PC Service" department.

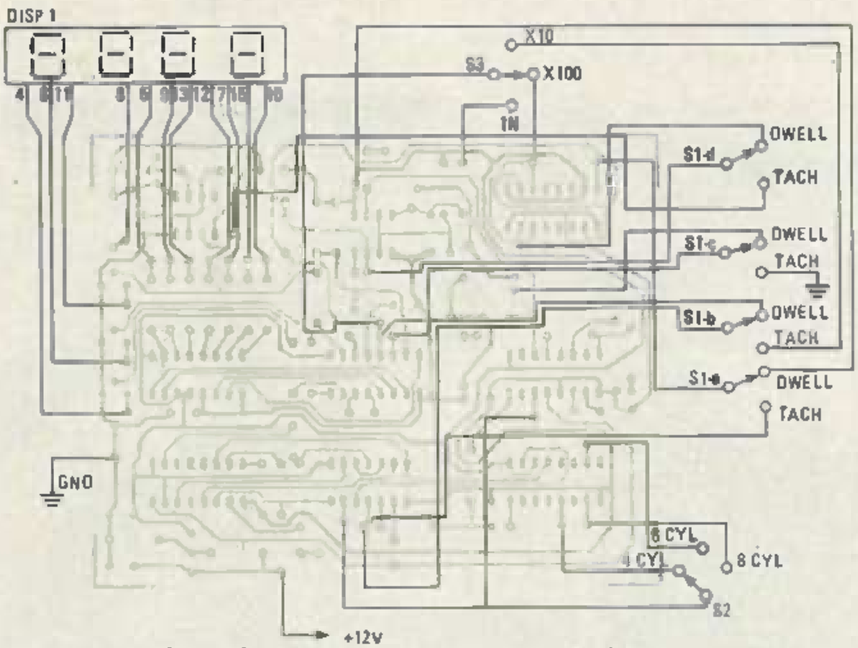


FIG. 5—THE OFF-BOARD CONNECTIONS are shown in this separate diagram.

PARTS LIST

All resistors are ¼ watt, 5% unless otherwise indicated

R1, R24, R25, R26—1000 ohms
R2, R3, R6, R11—10,000 ohms
R4, R7, R8—100,000 ohms
R5—1800 ohms
R9—500,000 ohms potentiometer
R10—15,000 ohms
R12, R16–R23—470 ohms
R13—220,000 ohms
R14—62,000 ohms
R15—150 ohms

Capacitors:

C1, C2, C9—.001 µF ceramic disc
C3—470 pF ceramic disc
C4—15 µF, 16 volts, tantalum
C5, C7, C8—.1 µF ceramic disc
C6—1 µF, 16 volts, electrolytic
C10, C11—10 µF, 16 volts electrolytic

Semiconductors

D1, D2—9.1 volt Zener
D3, D4, D5—1N914
LED1—standard red LED
Q1, Q2, Q3—2N3906
Q4—2N3904
IC1—TL092 op-amp
IC2—4046 micropower PLL
IC3—4017 decade counter
IC4—4518 dual BCD up counter
IC5—4081 quad AND gate
IC6—14553 three-digit BCD counter
IC7—4518 dual BCD up counter
IC8—7555 low power timer
IC9—4511 BCD-to-seven segment latch/decoder/driver

Other Components

DISP—NSB7881 4 digit, common-cathode, multiplexed display (National)
S1—four pole, 2-position
S2—one pole, 3-position
S3—SPDT toggle

Miscellaneous:

PC board, IC sockets, switch knobs, etc.

A printed-circuit board is available from E²VSI, PO Box 72100, Roselle, IL 60172, for $15.00 postpaid.

the points are closed. Thus, if the points were almost always closed, the reading would approach the value of the multiplication factor of the input signal, which is the maximum reading possible. A signal from IC1-a is applied to the DISABLE pin of IC6 (pin 11), which halts the count when the point voltage is high (when the points are open).

The reading's accuracy is increased by averaging the count over ten cycles. That is accomplished by using IC7 to divide the output of IC1-a by ten. The output of IC7 is fed to the DISABLE pin of IC6.

Building the dwell/tachometer

Construction of the unit, which is shown in Fig. 3, is relatively easy if you are familiar with printed circuit board techniques. A suitable pattern appears in our special "PC Service" section on page 67. Using that pattern, you can directly etch the board from the magazine page! An etched board is also available from the source mentioned in the Parts List.

A parts-placement diagram is shown in Fig. 4. The circuit is simple enough so that it can be built using breadboard or wire-wrap techniques, if you are careful.

If you do use a PC board, mount the IC sockets first, followed by the resistors, capacitors, and other components. Then the eight jumpers may be added. Next, you have to wire the off-board components such as the display and the switches. Because there are so many off-board connections, a separate off-board diagram is shown in Fig. 5. The display wiring should be relatively easy as long as you follow the schematic and parts-placement diagrams. Just make sure that you keep the wires to the proper length for your cabinet. In wiring the switches, everything is straightforward except that the pole of S2 has two points on the board to be connected to. One is at pin 2 of IC5, the other at pin 3 of IC2.

continued on page 82

Servicing Cordless Telephones

A cordless telephone, like any other piece of electronic equipment, is bound to break down sooner or later. This article will show you how to troubleshoot and repair the problem.

CHRISTOPHER KITE

Part 3 THIS MONTH, WE TURN our attention to troubleshooting the base unit. Figure 2, a block diagram of a cordless phone, has been repeated to aid in our discussions.

Usually the base-unit receiver consists of several stages: an RF amplifier, first IF (first mixer, local oscillator, and IF filter), and second IF stage (second mixer, local oscillator, IF filter, and detector). First, check the local oscillators for activity; if they fail to oscillate, they are defective and are probably the cause of the problem. After the local oscillators have been verified as operational, check the output of each stage. An RF probe connected to a multimeter is a convenient method of making those measurements.

The next step is to check that the pilot-signal detector is detecting the signal and causing the telephone to go off-hook. If the pilot signal (guardtone) is being detected, a signal should be sent to the relay driver to cause the telephone to go off-hook. If the pilot signal is not being detected, vary the frequency of the guardtone signal to make sure that the pilot-signal detector is not set up to receive a different frequency guardtone. If the pilot-signal detector detects a different frequency from the one that was originally selected, adjust the pilot-signal detector in the portable to detect the pilot signal being produced by the pilot-signal generator in the base unit (see Fig. 9). Though it is possible to do that the other way

around, the results are usually less satisfactory.

If the pilot-signal detector is operating, the problem is either in the relay driver or the relay. Check that the output of the relay driver is sending a signal to the relay to cause it to switch to an off-hook state. If it is, the relay is defective. If it isn't, the relay driver is defective.

Dialing problems

If a pulse-dial cordless telephone fails to produce any digits at the dialed number decoder, the dialing IC is probably defective. Most pulse-dial cordless telephones have a dialing IC that turns the pilot signal generator on and off. That causes the base unit to switch on and off-hook and pulses the telephone line. Because all the other circuits were operational in the previous test, the dialing IC is essentially the only component that could be defective. That can be verified by checking dial pulsing in the portable unit with an oscilloscope.

If incorrect digits appear at the decoder, the base-unit relay is probably defective. Even though the relay operated properly for the ring test and dial-tone test, it is possible that it is causing the cordless telephone to dial the wrong digits. If the relay spring loses some of its tension or the relay becomes "sticky," the duty cycle of the pulses is changed and telephone company equipment sees the wrong digits. Replacing the relay will solve that dialing problem.

As with pulse-dial cordless telephones, the components that could possibly cause tone-dialing failure are very limited. The first step is to check the output of the crystal used in generating the DTMF tones. Use an oscilloscope to insure that the crystal is oscillating. If the crystal is oscillating, you should check the output of dialing IC. If the crystal is not operating, it should be replaced.

The dialing IC should output the proper tone (frequency) pairs for each digit. If it doesn't, it should be replaced. If both the dialing IC and crystal are operating, then

TABLE 2—DTMF FREQUENCIES

Digit or Symbol	Frequencies (Hz)
1	697 & 1209
2	697 & 1336
3	697 & 1477
4	770 & 1209
5	770 & 1336
6	770 & 1477
7	852 & 1209
8	852 & 1336
9	852 & 1477
0	941 & 1336
*	941 & 1209
#	941 & 1477

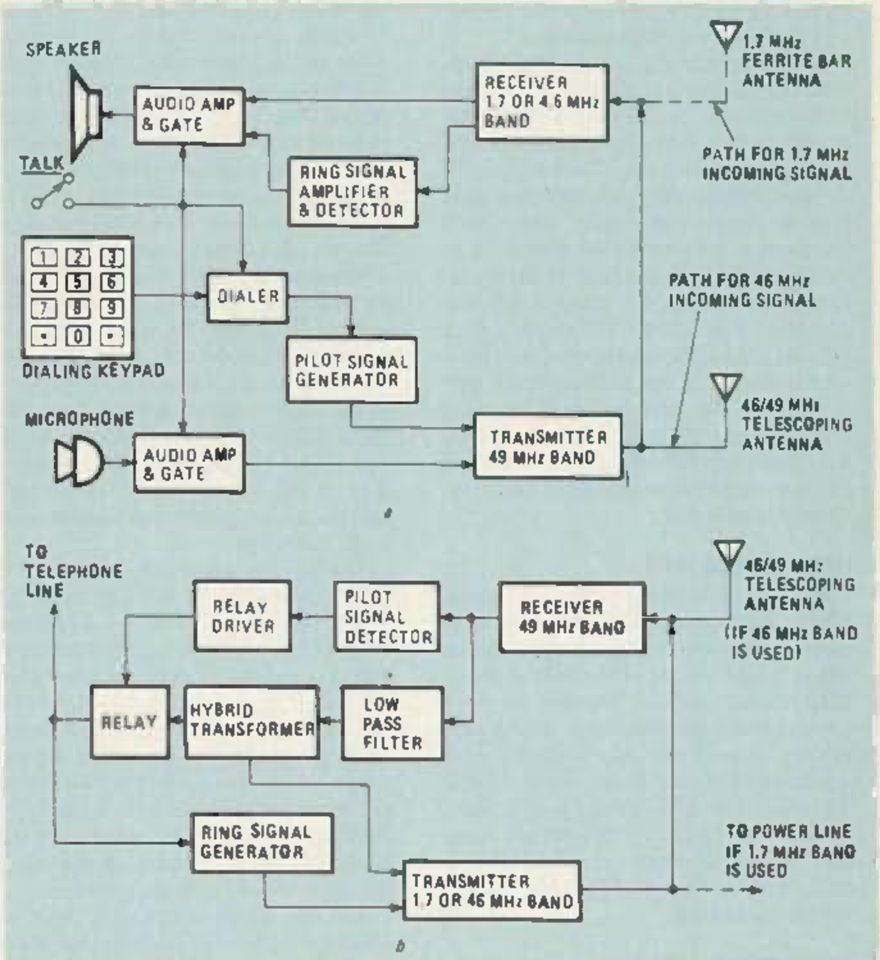


FIG. 2—HOW A CORDLESS TELEPHONE WORKS. A block diagram of a portable unit is shown in a, while the block diagram of the base unit is shown in b.

FIG. 9—IF THE PILOT SIGNAL generated by the portable can not be detected by the base, the detector circuits in the base are the ones that should be adjusted.

there must attenuation somewhere in the signal path that is causing the tone level to be so low that it cannot be recognized. Table 2 shows the proper frequencies for the tone pairs for each digit.

If the portable unit proves to be operating properly, the problem is in the base unit. The two most common problems are distortion caused by the detector circuit, or improper tone-level adjustment. Measure the level of the dialing tones with an AC voltmeter. If the tones do not produce an amplitude of at least 0.25 volt, the problem is probably caused by an improper level adjustment. Check the service manual for your cordless telephone and find the level-adjustment potentiometer. Adjust it for correct tone level. If the level is correct, the problem is most likely distortion caused by the detector circuit. Connect an oscilloscope to the output of a demodulator circuit and check the signal for distortion. If distortion is present, the detector circuits in the cordless telephone are defective.

Poor voice level

The first step in troubleshooting why the voice level is insufficient is to check the portable unit. Use an audio generator to inject an audio tone into the microphone circuit of the portable unit. Trace the signal through the circuitry with an AC voltmeter. Check that there is a signal being fed to the audio-amp-and-gate. The audio-amp-and-gate should feed the amplified voice signal to the transmitter were it is used to modulate the carrier signal. If the voice signal is being fed to the transmitter, but the demodulated RF signal has no audio present, there is probably a broken connection between the audio-amp-and-gate and the transmitter.

If the portable unit is operating properly, the next step is to check the base unit. At the base unit, the receiver demodulates the RF carrier and outputs the guardtone and voice-audio signals. The low-pass filter should output the voice audio and feed it to the hybrid transformer. The hybrid transformer should feed the signal out to the telephone line and back to the transmitter (the level of the signal fed to the telephone line should be much higher than the level of the signal fed to the transmitter) where it is sent to the portable unit as sidetone. Any problem must lie in the low-pass filter, the hybrid transformer, or the connection between the two because all other components involved have previously been tested.

Low sidetone level

Because the sidetone is fed to the portable unit from the base unit, the only likely cause of very low or nonexistent sidetone would be the failure of the hybrid transformer in the base unit. Because all other circuits involved have been tested previously, that is the only problem with sidetone that we are likely to see. Check the modulation level of the base transmitter with voice or audio tones applied. Less than 3-kHz deviation at normal voice peak-level indicates a problem in the hybrid transformer.

Poor voice quality

If the voice quality of the cordless telephone proves to be unacceptable, the problem could lie in either the portable or base unit. Connect an oscilloscope to the telephone line simulator. Inject a low-distortion sinewave at the portable-unit microphone. If distortion is evident on the scope, use the oscilloscope to examine the audio circuits of the portable-unit microphone circuit, and the base-unit receiver discriminator and audio circuit. If no distortion is present at the telephone line simulator, check the hybrid transformer in the base unit's transmitter, then the discriminator and speaker circuits of the portable unit's receiver.

Troubleshooting poor performance

When we talk about a cordless telephone performing poorly, we are usually referring to range problems. There are several things to consider when trying to diagnose range problems. Many of us think only of RF power when we try to correct a range problem, but there are, in fact, several reasons that the range of a cordless telephone might not be up to specifications. Just as low RF-power might affect range, receiver sensitivity could also be the cause. An additional cause might be an offset ring-signal frequency. Range is also affected by the amount of shielding in the building and the effectiveness of the AC wiring as a 1.7-MHz antenna. Also to be considered is the fact that poor range could be caused by the base-unit transmitter, portable-unit transmitter, base-unit receiver, or portable-unit receiver (or any combination).

The most common problems causing reduced range are low RF-power and low receiver-sensitivity. Fortunately, those are also the easiest parameters to check.

When we tested the cordless telephone for ringing and dial tone, we measured the relative RF-power. As stated then, level readings for transmitters should be around 4 volts for most cordless telephones (some of the short range telephones have much lower output voltages, check the service manual for the telephone you are servicing). If the output voltage is not up to specifications, adjust the output of the weak transmitter.

Testing the sensitivity of a cordless telephone receiver is like testing the sensitivity of any radio receiver. Experience with similar type cordless telephones will quickly establish normal reference levels for each type. If the receiver does not operate acceptably, we must go through the receiver section and check for transistors that are not amplifying sufficiently or unwanted attenuation. Usually the problem will caused by a defective transistor. If that is the case, replacing the transistor should cure the problem.

The ring signal can become offset and affect the range of the cordless telephone. It is important that the ring-signal frequency match the frequency of the ring-signal detector. Use a frequency counter connected to a demodulator circuit to measure the ring-signal frequency error of the base unit's transmitter. If the frequency is off just a slight amount, it could cause the range of the cordless telephone to become dramatically shorter. Ring-signal frequency error can also cause other operational difficulties and the ring-signal generator should be adjusted whenever an error is noticed.

Testing digitally-coded phones

When testing digitally-coded telephones, it is important that you consult the service manual for the telephone under test. Digital-coding techniques vary greatly from one manufacturer to another and even from one model to another.

Some digitally-coded telephones establish a "handshake" before voice communication is possible. With one popular scheme, the 1's and 0's of the digital code are created by shifting the RF carrier between two frequencies. The digital code is decoded by the base unit's receiver, which turns on the base unit's transmitter and encoder, and sends a code back to the portable unit. Lastly, the portable unit's receiver decodes the returned digital message and completes the handshake by shutting off the encoder and enabling the voice circuits. The problem with troubleshooting that closed-loop system is that almost any problem, either RF or digital, will prevent the handshake from being completed. When the handshake is not completed after a few tries, the system shuts down, preventing RF testing.

With such phones, it is best to bypass the digital code (using jumper connections that are listed in the cordless telephone service manual) and test the base unit without the use of the coding. That permits testing of the RF and audio functions. Generally, if the unit works when the code is bypassed, the coding or decoding circuitry is faulty. Several things must be kept in mind when testing with that method, however. Some digitally-coded phones use no guardtone or ring signal; they send a digital code for ringing and a digital code to signal the base unit to go off-hook. That means that causing the portable unit to ring without using the base unit is very difficult. The rest of the circuitry can be tested however; if all is OK, the problem lies in the ringer circuits.

Fortunately, most portable-unit transmitters can be activated and checked just by setting the portable unit to TALK. Usually it will be possible to view the digital code on an oscilloscope connected to a demodulator circuit. Most manufacturers seem to use a scheme that involves generating the digital code at the beginning of transmission. When using an oscilloscope, you probably won't be able to decipher the code. However, you can verify that the digital code is actually modulating the carrier. Chances are, if a code is being transmitted, the encoding circuits are OK. That means that the fault is probably in the decoding portion.

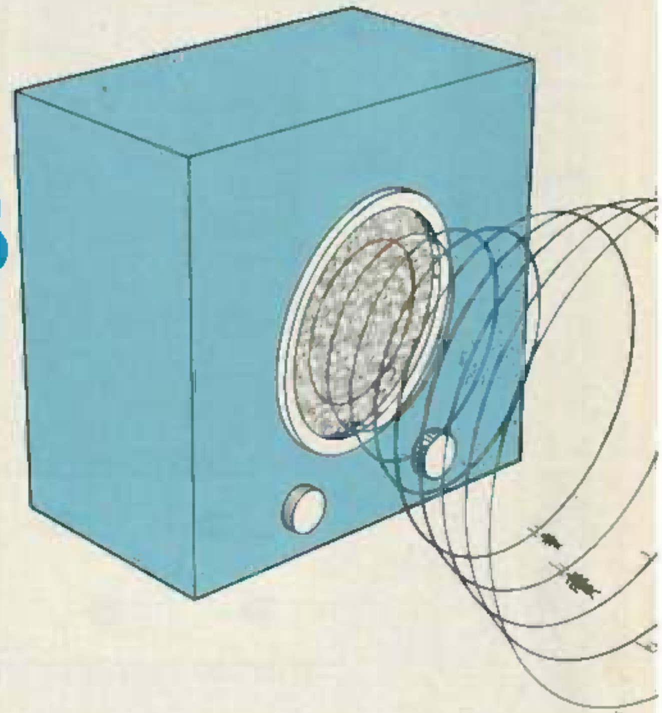
It is also possible with some units to use the portable unit to capture the base unit then turn off the power on the portable unit and maintain the link to the base unit with an RF generator. Use the power switch, rather than returning on-hook, so that the disconnect code is not sent.

Some cordless telephones have built-in systems for testing the phone. One such method involves setting all the digital-code selection switches to the ON position. That disables certain signals or tones that are generated for calling the user's attention to a problem.

Another method of testing the base-unit transmitter (if jumper connections are not listed in the service manual) is to activate the base unit's transmitter by applying a ring voltage to the telephone line. If the base unit's transmitter is operating and generating a ring code, the portable unit's receiver can be checked by monitoring the discriminator output or the CODE IN input to the digital encoder/decoder IC. R-E

ALL ABOUT

ULTRASONIC PEST-REPELLERS



ROBERT F. SCOTT

The claims made for those ultrasonic pest repellers seem fantastic at first glance—but they really work. In this article, we'll find out what makes those devices "tick".

OVER THE YEARS, THERE HAVE BEEN many articles published that proclaimed that ultrasonics, either in the form of pulses or a sweep signal, can be used as an effective insect and rodent repellent. I've always been skeptical of such claims and placed them in the same category with those electronic devices claimed to prevent swallows from nesting on the courthouse roof and prevent pigeons from defiling the Stonewall Jackson statue on the town square. Nevertheless, I filed those articles away for investigation sometime in the future.

Last summer, my hunting and fishing club took possession of a farmhouse that had been abruptly abandoned about a year ago. The house was absolutely overrun with mice and roaches that were bold enough to scamper about in full daylight. We were at a loss as to how to get rid of them.

Ultrasonic pest repellents had begun to appear in mail-order advertising and our club president suggested that we try one. Those devices, according to the literature, generate a signal that sweeps over a frequency range of approximately 22 kHz to 65 kHz, develop sound pressures ranging from 115 to 152 dB, and repel pests in areas of 2500 to 3500 square feet. Power consumption is typically 2 to 4 watts. Prices range from $30.00 to $70.00, plus shipping.

At first, I scoffed at the suggestion that we purchase an ultransonic pest repeller, but agreed to try one since they were available for a 30-day trial and full refund. The $30.00 model was available from several sources under names that include Pest Control, Pest-Elim 1500, and Westronix. We ordered one and it came within a few days. It was shipped in a plain unmarked carton and we were surprised to find that it did not carry a trade name or model number. We installed it in the clubhouse. Within two weeks, mice and roaches were nowhere to be seen—even when lights were suddenly turned on in a dark room. Now, we consider the clubhouse completely free of pests. Not a sign of them; even in the darkest corners and crannies.

Now that the pest repeller had done its work, I began to speculate on its circuit. An early article on the use of ultrasonics in insect and rodent control ("Electronic Pest Control", by Lyman Greenlee, *Popular Electronics*, July 1972) indicated that the repeller needed a power amplifier delivering 16–20 watts in the ultrasonic region and special high-power tweeters. Certainly that little plastic box didn't contain a 20-watt power amplifier or high-power tweeters. Also, a 16–20-watt power amplifier drawing only 4 watts from a supply would be about as close to "per-

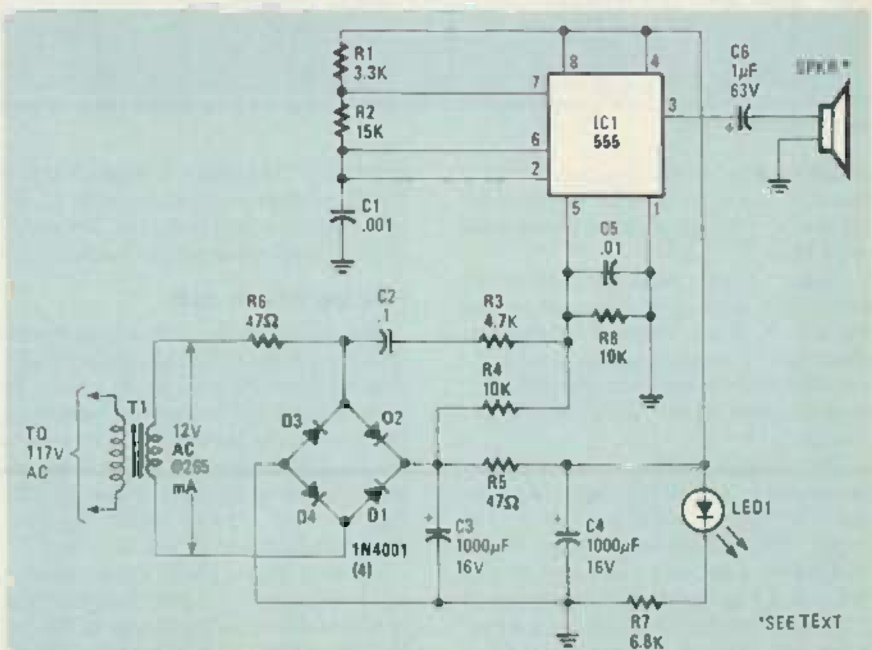


FIG. 1—SCHEMATIC DIAGRAM of a popular ultrasonic pest repeller. Despite its simplicity, the device was remarkable effective.

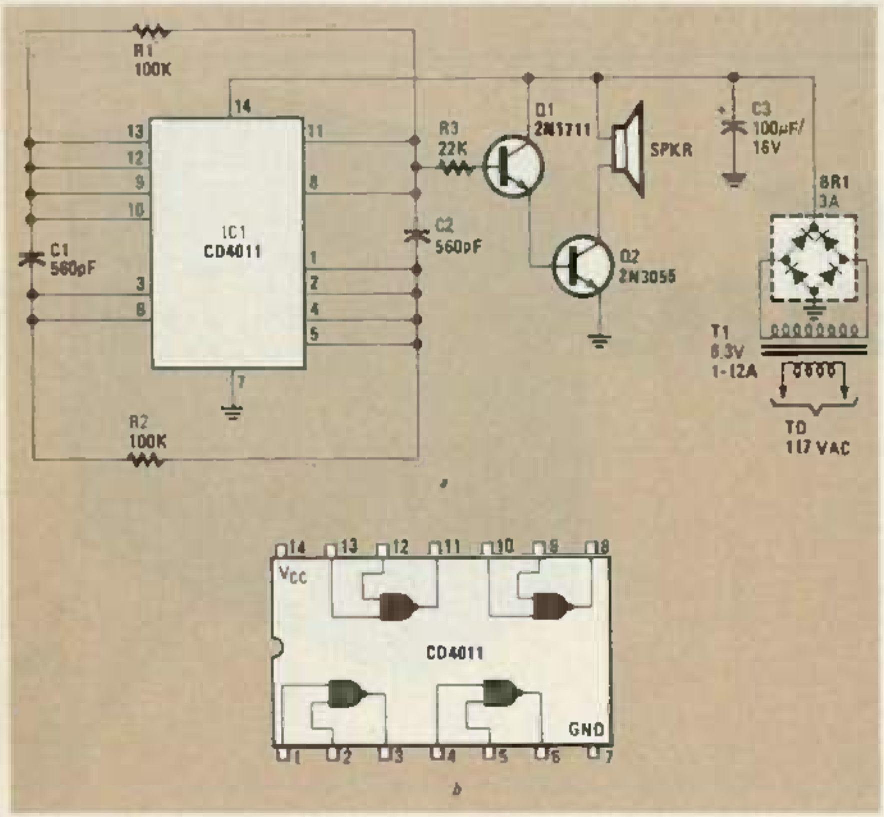


FIG. 2—THIS PEST REPELLER, of French design, is built around a CD4011 quad NAND gate. The schematic diagram is shown in *a*; a block diagram of the IC is shown in *b*.

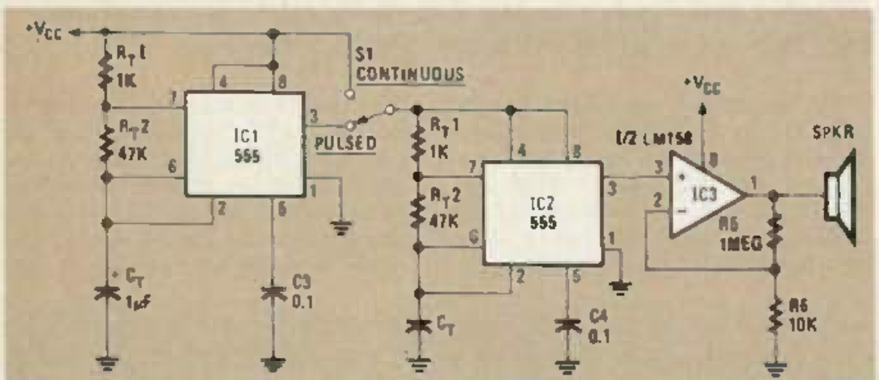


FIG. 3—THIS CIRCUIT IS ideal for experimenting with ultrasonic signals. It can supply either a pulsed or continuous output.

petual motion" as one can come. Thus, I couldn't wait to pry open the repeller's 6¼ × 4¼ × 1¼-inch plastic case and see what made it "tick".

Figure 1 is the circuit of the device we tested. We were quite surprised to find that the circuit was simply a 555 timer IC connected as a squarewave generator. Its base frequency is approximately 45 kHz, as determined by the values of R1, R2, and C1.

The 45-kHz "carrier" is frequency modulated by a modified trapizoidal voltage waveform applied to pin 5 of the 555 timer. That modulating voltage is developed by a network consisting of C2, R3, and R4 connected across one leg of the bridge rectifier. A check with an oscilloscope showed a sweep of approximately 20 kHz on each side of the base frequency. That sweep of from 25 kHz to 65 kHz is surprisingly close to the 22–65-kHz range specified in the ads. The speaker is a 2 inch piezoelectric tweeter.

How the French do it

The circuit in Fig. 2 is a pest repeller described in the French electronics magazine, *Le Haut Parleur*. In the article, the author claims that frequencies in the range of 20 to 40 kHz cause highly uncomfortable cavities to form in brain fluids and blood vessels of mice and insects, causing them to beat a hasty retreat. Radiated power levels can be as low as ⅓ watt.

Looking more closely at the circuit, a quad two-input NAND gate is connected as multivibrator operating at around 40 kHz. With the minimum of filtering used in the power supply, a residual 120-Hz sawtooth on the line from the power supply modulates the ultrasonic frequency. Two Darlington-connected NPN transistors provide some power amplification and drive for the speaker.

Circuit for experimenters

If you want to experiment with the effects of continuous or pulsed high-frequency signals, the circuit in Fig. 3 is ideal; it can provide either a continuous or pulsed output. It was developed by Signetics and described in *Electronic Products Magazine*.

Looking at the circuit, one 555 timer, IC2, generates the ultrasonic squarewave at a recommended 20 kHz. That signal can be supplied continuously or pulsed on and off by a second 555, IC1.

Experimenting with frequency and duty cycle is easy. Duty cycle is the "on" time compared to the total period, and can be set from slightly above 50% to almost 100%. In the astable multivibrator circuit, the duty cycle is set by the timing resistors, R_T1 and R_T2, and is equal to $R_T1 + (R_T2/R_T1) + 2R_T2$.

The on time is close to 100% when R_T1 is chosen to be as small as practical while limiting the current through the discharge transistor to the maximum specified in the data sheet. (The discharge transistor, which is on-board the 555, is an open-collector NPN device with the collector going to pin 7 and the emitter to ground at pin 1. The maximum current through it varies with different manufacturers so you should check the maker's data sheet to be sure.)

If you want a duty cycle of less than 50%, connect a general-purpose silicon diode such as the 1N914 across R_T2 with its anode at pin 7 and cathode at pin 6. That effectively shorts R_T2 while timing capacitor C_T is charging, and the duty cycle is now $(R_T2/R_T1) + R_T2$ and it can be varied from around 0 to nearly 100%. The frequency of the squarewave generator can be found from $1.44 C_T(R_T1 + 2R_T2)$, where resistance is in megohms and capacitance in microfarads.

If you want to vary the duty cycle of the oscillator while keeping the frequency constant, use the basic circuit shown in Fig. 4.

In that circuit, a single potentiometer is used for the two timing resistors. In that scheme, it is possible to set the value of one of the two "timing resistors" to zero. As that is undesirable, two resistors, R1 and R2, have been added to set minimum values for those timing resistors.

Use the basic circuit shown in Fig. 5 when you want to vary frequency while keeping the duty cycle constant at approximately 50%. The variable element used in that circuit, R_T-a and R_T-b, is a two-gang linear potentiometer. Note that the value of the two variable elements are

continued on page 82

CIRCUITS

DESIGNING WITH DIGITAL IC'S

This month, we'll see how to interface TTL and CMOS devices to each other, and to other circuitry.

JOSEPH J. CARR

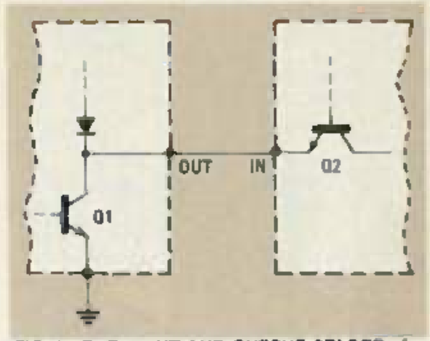


FIG. 1—THE INPUT AND OUTPUT STAGES of a TTL IC are shown here. As is indicated, no special interfacing circuitry is needed when going from the output of one TTL device to the input of another.

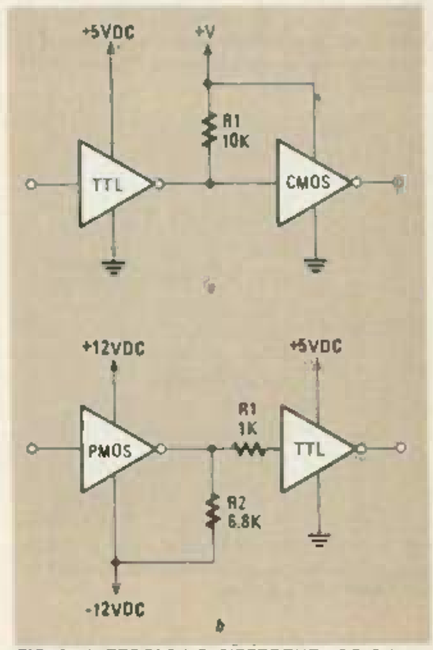


FIG. 2—INTERFACING DIFFERENT LOGIC families. Here, the methods used to interface a TTL output to a CMOS input (a) and a PMOS output to a TTL input (b) are shown.

Part 4 BY DEFINITION, THE inputs and outputs of a "family" of logic IC's can be interconnected without the need for additional interfacing circuitry. For instance, Fig. 1 shows the output stage of one TTL IC and the input stage of another. A TTL input is a current source consisting of the emitter of an input transistor. One standard TTL input ("fan-in" of 1) sources 1.8 milliamperes of current at +2.4 to +5.0 volts. A TTL output sinks current. Normally, a TTL output will sink ten TTL inputs (i.e. 18 mA), although some TTL-compatible microprocessor output lines have a fan-out of only 1 or 2 rather than 10.

Few problems are encountered when interfacing IC's of the same family, but certain rules must be followed and/or techniques used when either interfacing IC's of different families (or sub-families!), or interfacing devices such as lamps, relays, solenoids, or motors. In this article, we will deal with some of those rules and techniques.

Interfacing logic IC's

There are times when we will want to interface logic devices with ones from other families. Figures 2 and 3 show several ways that that could be done.

In Fig. 2-*a* we see how any TTL output can be interfaced to any CMOS input. Recall that a TTL output is a current sink, while a CMOS input offers a very high impedance. Therefore, we must provide a current source from the +V supply to satisfy the TTL output. Resistor R1 serves as the current source in Fig. 2-*a*; its value is scaled to limit the current to approximately one TTL load when the TTL output is low. For CMOS devices operated from a +12-volt-DC power supply, a 10K resistor (R1) is used.

Figure 2-*b* shows a PMOS device used to drive a TTL input. In that case, we have a 6800-ohm pull-up resistor between the PMOS output and the −12-volt DC power supply, and a 1000-ohm resistor in series with the TTL input. The latter resistor is used to protect the TTL input stage when the output from the PMOS device goes negative.

The circuit of Fig. 3-*a* is similar to the one shown in Fig. 2-*a*, with the exception that the CMOS device is operated from the same +5-volt DC power supply that serves the TTL devices. Note that a 2000–to 3000–ohm pull-up resistor is sufficient here.

Figures 3-*b*, 3-*c*, and 3-*d* show methods of interfacing CMOS outputs to TTL inputs. The 74Lxx and 74LSxx TTL devices have substantially lower drive requirements than regular TTL. We can therefore, drive one 74Lxx or 74LSxx TTL input from a standard CMOS output (Fig. 3-*b*). Only the 4001 and 4002 CMOS IC's (see Fig. 3-*c*) are capable of driving a standard 54xx/74xx TTL input.

There are two CMOS 4000-series devices (Fig. 3-*d*) that are designed to drive TTL devices under the right circumstances; those are the 4049 and 4050. If those devices are operating from a standard TTL DC power supply (i.e. +V = 5-volts DC, −V = 0-volt DC), then they can be directly interfaced with up to two 74xx, 74Lxx and/or 74LSxx devices. In some cases, you will find them capable of driving three or four 74Lxx or 74LSxx devices, but that falls into the category of "getting away with something."

Figure 4 shows a method for interfacing CMOS devices to LED's. The CMOS output functions as a switch in both cases. Also in both cases, there are current-limiting resistors in series with the LED, so that both the LED and the CMOS device are protected when the LED is turned on. Both NAND gates are wired as inverters, so

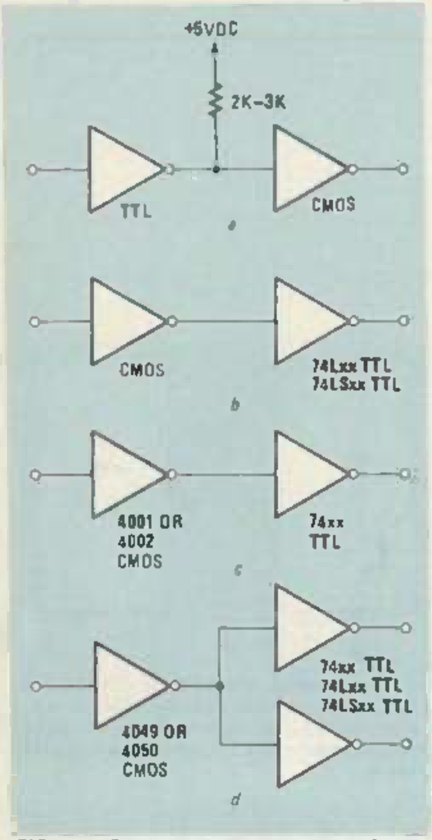


FIG. 3—MORE INTERFACING TECHNIQUES. Here, various ways of interfacing TTL and CMOS circuitry is shown.

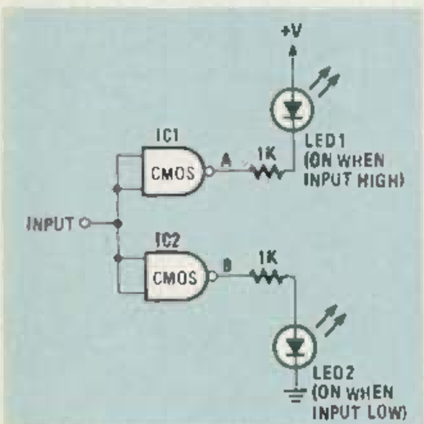


FIG. 4—THIS CIRCUIT SHOWS HOW a CMOS gate, configured as an inverter, can be used to control an LED indicator.

they will produce a low output when the input is high, and a high output when the input is low.

In the circuit, LED1 is wired to be on (i.e. lighted) when the input to gate IC1 is high. The output of IC1 will be low in that case, so that point A is essentially grounded. Current then flows through the LED and it is turned on. Alternately, when the input is low, point A is high, so both sides of the LED see approximately the same voltage. Under that condition, no current will flow in the LED, so it is off.

One problem with that type of circuit is that if the difference between the supply voltage and the voltage at point A is great enough, then LED1 may turn on dimly when it is supposed to be off. A higher-value series resistor may solve the problem.

Looking at the other part of the circuit, LED2 is designed to turn on when the input to the circuit is low. There, the LED and its current-limiting resistor are connected between the output of IC2 and ground. When the input is high, the output of IC2 is low, so both sides of the LED are at ground and the LED is off. When the input is low, on the other hand, the IC2 output is high, and current flows through the LED to ground, lighting it.

Interfacing LED's with TTL devices requires use of an open-collector device. Perhaps the most common of those are the hex inverters (the 7406, 7407, 7416, and 7417). Those IC's each contain six independent inverters with open-collector outputs. Figure 5 shows an LED indicator connected to the output of an open-collector TTL inverter. Figure 6 shows the same circuit, this time also showing the output transistor of the inverter.

Since the IC we are dealing with in Figs. 5 and 6 is an inverter, its output will be low when the input is high, and high when the input is low. Thus point A in Fig 6 will be grounded (i.e. low) when the input is high, and close to +V if the input is low. When point A is low, current flows through the LED and it is turned on. If the voltage at A is close to +V, then no current will flow and the LED is off.

If the above-mentioned inverters are used, then an LED may be operated from voltages greater than +5-volts DC. Scale the value of R1 according to Ohm's law to limit current in the LED to a safe value. For example, if a 20 mA (0.020-amp) LED is operated from a +12-volt power supply, the resistor should equal R = V/I = 12/0.020 = 600 ohms. Thus, for that application, a 600-ohm or larger resistor is used. Note that 680 ohms is the closest standard value, and will suffice. As to the power rating of the resistor, it should be greater than V × I, or 0.24 watts in this case, with a margin for tolerance. Here, a 0.5-watt unit should be used (a 0.25-watt unit does not give enough margin).

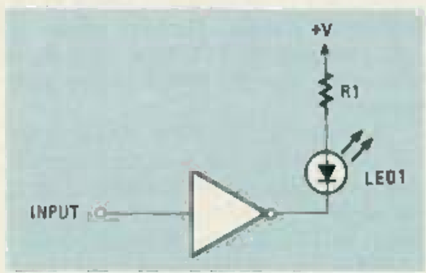


FIG. 5—THIS CIRCUIT SHOWS HOW a TTL inverter can be interfaced to an LED.

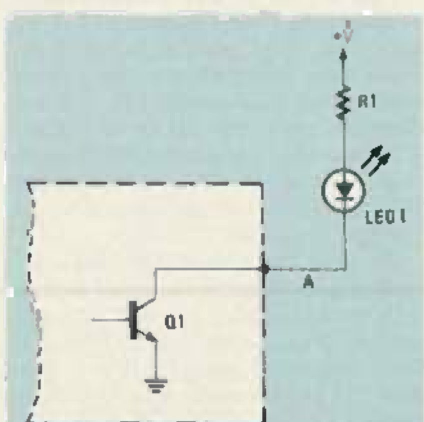


FIG. 6—WHEN THE INPUT TO THE INVERTER is high, the voltage at point A will be close to ground, causing current to flow through the LED, lighting it.

Two methods that can be used to interface an incandescent lamp are shown in Figs. 7 and 8. Even the smallest grain-of-wheat bulb draws more current than a TTL open-collector output can handle, so an external transistor (Q1) is used to handle the load. The TTL inverter controls the base of the transistor, thus also controlling the lamp. The transistor selected must have sufficient collector current, collector voltage, and collector power-dissipation ratings for the lamp being controlled. In addition, the beta must be high enough to saturate the transistor given the collector current and the drive capability of the inverter.

In Fig. 7, we see a regular TTL inverter driving an NPN transistor "lamp switch." An NPN transistor will conduct when the base is more positive than the emitter. In this circuit, therefore, the transistor conducts and turns on the lamp when the TTL output is high. Keep in mind that TTL outputs are not designed to supply current, so the base current for Q1

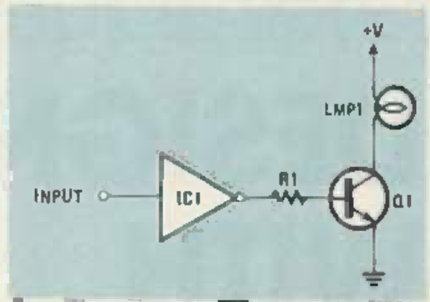


FIG. 7—WHEN THE INVERTER'S OUTPUT is high, the transistor conducts, causing current to flow through the lamp, lighting it.

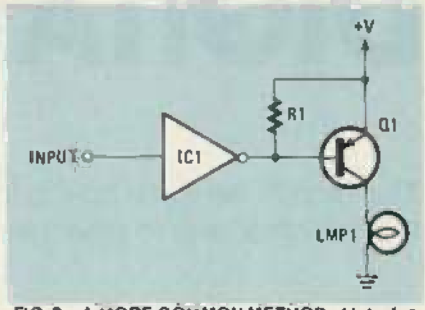


FIG 8—A MORE COMMON METHOD of interfacing a TTL inverter with a lamp is shown here.

that's available in this mode is limited.

A more common circuit is shown in Fig. 8. Here we use a PNP transistor as the lamp switch. Such a transistor will conduct when the base is more negative than the emitter. The inverter is an open-collector type, so it will ground the base of Q1 when the output is low. Under that condition, the emitter is at +V and the base is close to ground, so the the transistor conducts. When the output is high, however, the transistor is open-circuited, so resistor R1 keeps the base at essentially the same voltage as the emitter. Under that condition, the transistor does not conduct and the lamp is off.

Interfacing relays

Relays and solenoids can present special interfacing problems for digital electronics. Relays are electromechanical switches that are used to control high voltages and/or high currents. A relay consists of a coil electromagnet that activates a set of switch contacts. A solenoid is a device used to move or actuate mechanical objects. It consists of a hollow coil in which a movable core is placed. When current flows in the coil, a magnetic field is created that suddenly draws the core into the coil.

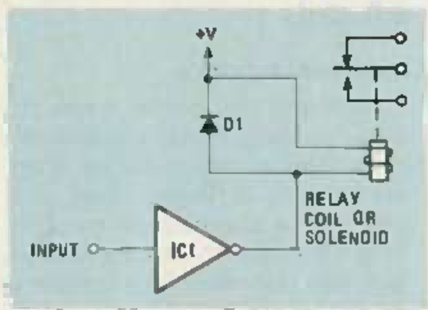


FIG. 9—AN OPEN-COLLECTOR TTL INVERTER can be used to directly control a relay or a solenoid if the device's current requirements are low enough.

Figure 9 shows a method for interfacing relays and solenoids to digital circuits. The relay/solenoid coil is connected as the load between +V and the output of an open-collector TTL device. When the TTL output is low, current flows through the coil and it is energized. Since the relay/solenoid is actuated when the TTL output is low, a high input to the inverter is required to actuate the relay/solenoid.

A diode, D1, is placed in parallel with relay coil in Fig. 9 to solve a special interfacing problem: "inductive kick." When an inductor is energized (current passes through the coil), a magnetic field builds up around the coil. If the flow of current is suddenly interrupted, the collapsing field creates a high-voltage spike that can damage electronic components. In digital circuits, the pulse from that inductive kick can upset circuit operation even when it does not destroy the components. Placing

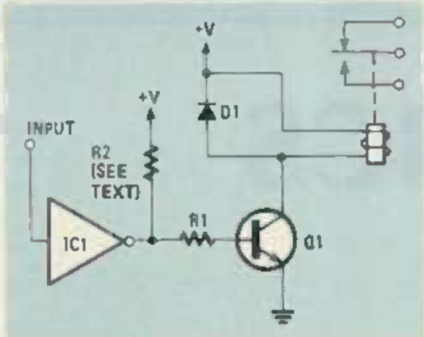


FIG. 10—FOR RELAYS WITH CURRENT requirements that exceed 30–40 mA, this interfacing circuit can be used. Diode D1 is used to keep the level of any inductive spikes to less than 0.7-volt.

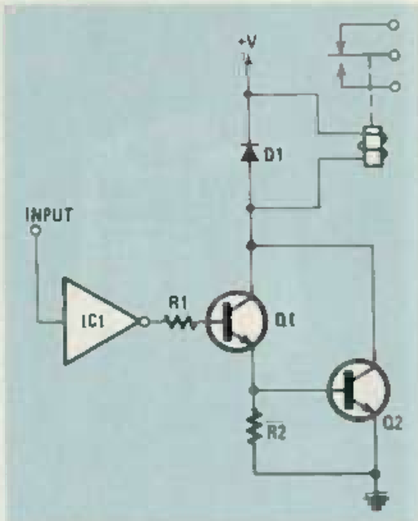


FIG. 11—THE USE OF A DARLINGTON PAIR allows a TTL inverter to control a relay or solenoid with very high current requirements.

the diode in the circuit as shown will clip any spikes to 0.7-volt.

The above method is only appropriate for use with relays that have current requirements of 30–40 mA, or less, and as such compatible with the capability of open-collector TTL devices. Two alternate methods of interfacing a relay or solenoid with higher current requirements are shown in Figs. 10 and 11.

Figure 10 uses a single transistor (Q1) to act as an electronic switch to control the relay or solenoid. The collector-emitter path of Q1 is in series with the coil, so the relay/solenoid will become energized when Q1 is turned on. That situation occurs when the base of Q1 (an NPN transistor) is more positive than the emitter. Since the base of Q1 is connected to a TTL output, the relay or solenoid is energized when the output is high. In some cases, a pull-up resistor is used between the TTL output and +V.

As in the previous case, a diode "spike suppressor" shunts the coil. A 1000-volt (PIV), 1-amp, 1N4007 diode is suitable for that application.

The value of resistor R1 depends upon the gain of Q1 (beta) and the required collector current. In most +5-volt DC circuits, 2700 ohms is used for all but the lowest-gain transistors.

The circuit of Fig. 11 is used for solenoids and high-current relays. Transistors Q1 and Q2 form a Darlington pair. That circuit provides very high beta gain, as the overall beta is the product of the beta's of the two transistors.

Interfacing the 555

The 555 is an IC timer that has achieved widespread popularity. It can be used to output either a single pulse or a string of pulses. Its output (pin 3 when the device is housed in its usual 8-pin DIP) is capable of sinking or sourcing up to 200 mA of current.

Figure 12 shows a simple method for interfacing LED's, lamps, or relays, providing that they have current requirements of less than 200 mA. This circuit is "left-handed" in that the relay, LED, or lamp is energized when the 555's pin 3 output is low.

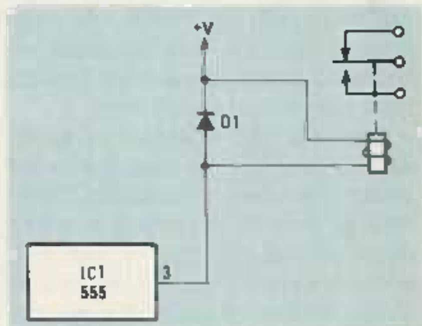


FIG. 12—AN LED, LAMP, OR RELAY (as shown), with a current requirement of less than 200 mA, can be interfaced directly with a 555 timer.

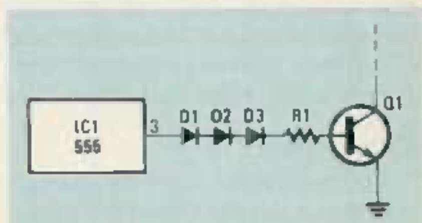


FIG. 13—A 555 TIMER CAN BE ACCIDENTALLY retriggered if noise is applied to its output terminal. To prevent that from happening, up to three diodes can be connected in series with the output, as shown.

Sometimes, a 555 is accidentally retriggered by circuit noise applied to the output terminal. Such noise is especially likely when inductive loads such as relay coils are driven. If that is a problem, then up to three 1N4000-series silicon diodes can be connected in series as shown in Fig. 13 to isolate the output of the 555.

In the next installment in this series, we will turn our attention to one of the building blocks of digital circuits, the basic flip-flop. At that time, we will discuss basic flip-flops, including the reset-set (RS) flip-flop, clocked RS flip-flop, and the master-slave flip-flop. R-E

ROBOTICS

MARK J. ROBILLARD
ROBOTICS EDITOR

Getting started in robotics

THE WORD "ROBOT" CONJURES UP many different images in people's minds; everything from Hollywood's lovable creations to the monstrous machines that many once believed would someday take over the Earth. Regardless of what you the think of them, they are everywhere today. For instance, your car was probably assembled and inspected for defects on a robotic assembly line.

Even so, the number of problems found in new cars tells a lot about the state of robotics technology. Robots are prone to make many mistakes; after all, look at who created them! However, those system miscalculations are not the same misjudgments of which man is so often guilty. They are, instead, problems that arise due to the limitations of the technologies involved. Today, the field of robotics is where personal computers were in the mid-1970's.

Our purpose

In this column, we'll try to keep you up to date on the latest happenings in robotics field. We'll also cover several technical topics and look at numerous robotic devices that you can build. You'll receive instructions on building a robotics laboratory, an intelligent platform, and an ultrasonic vision system.

We'll include indepth product reviews of the various robots. And you'll have the opportunity to read about those products before you see them anywhere else. And since the field is still in its infancy, believe it or not, you can make a significant contribution through personal research. As a reader of **Radio-Electronics**, you are used to participating in new technologies. For example, the first construction details for a personal computer appeared in these pages.

FIG. 1

Personal robots

About two and a half years ago, personal robots came to the attention of consumers through the introduction of RB Robot Corp.'s (14618 W. 6th Ave., Golden, Colorado) small cylindrical rover, the *RB-5X*. That microprocessor-based unit could directly execute BASIC programs entered by the user from a remote terminal. Several design changes have occurred since its introduction, including the addition of an ultrasonic range finder and a somewhat articulated arm.

Shortly thereafter, U.S. Heath Co. (Benton Harbor, MI 49022) introduced its *HERO-1* (see Fig. 1). Both the Heath and RB products showed that there was considerable interest in building and experimenting with intelligent vehicles.

Some time after *HERO* and *RB-5X* made their debut, a new company headed up by Atari's founder, Nolan Bushnell, introduced the *TOPO* robot. That unit was much taller, with a more human-like appearance; but its limited capabilities and non-existent third-party support kept it from reaching its full potential. Today, Heath's *HERO* is said to be leading in sales, with a rumored 8000 machines in existence. However, the field is constantly widening.

Industrial robotics

Although the public views the robotic production line as merely a collection of mechanized arms, the industry is having a love affair with those mechanical marvels. Assembly-line robots are usually supplied materials via a system of intelligent, roving, driverless vehicles. Those vehicles are built using a combination of technologies, including mechanical engineering, electronics engineering, and computer science.

From those fields come the design of the various robot parts. For example, mechanical engineering provides the body structure, the wheeled mechanics, and the arm linkages. Electronics engineering contributes the control circuitry and various sensory devices needed to help make the robot system interact with its environment.

The sensors include sonic distance-measuring systems, tactile sensors for finger tips, wheel-position feedback sensors based on optoelectronic or Hall-effect technologies, etc. Computer sci-

continued on page 70

PC SERVICE

As anyone who has ever tried knows, one of the most difficult tasks in building one of the many construction projects featured in **Radio-Electronics** is making the PC board using just the foil pattern provided in the article. True, all sorts of kits and things are sold to let you lift a foil pattern from a magazine page. But, while some of them do work, most of them don't. What usually happens is that you wind up copying the artwork by hand.

Well, we're doing something about it.

We've moved all the foil patterns to a new section of the magazine. They'll be printed by themselves, full sized, with nothing on the back side of the page. What that means for you, is that the printed page can be used directly to produce PC boards!

Actually the method you'll need to use to etch directly from printed artwork is a little bit different from the one you're probably used to using to produce PC boards, but we've done some testing and it works!

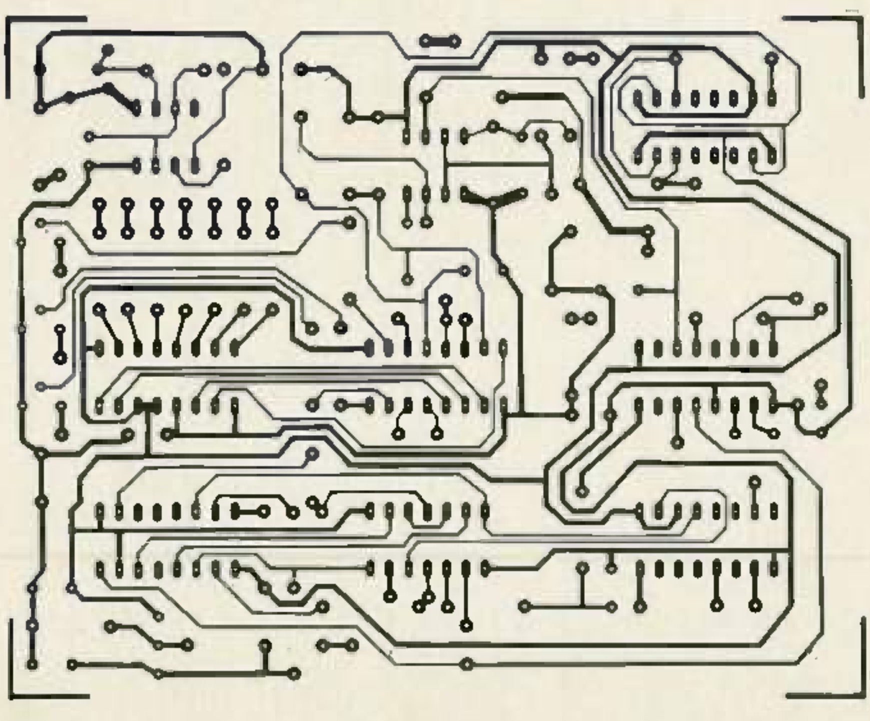
In order to produce a board directly from the magazine page, you first need to do a little bit of work on the foil pattern. The first thing to do is remove the page from the magazine and carefully inspect it either under a good light or on a light table. As a matter of fact you should really do both of those since each one will show up different kinds of imperfections in the artwork. What you're looking for are breaks in the traces, bridges between traces, and in general, all the kinds of things you look for in the final etched board. You can clean up the published artwork the same way you clean up you own artwork. Drafting tape and graphic aids can fix incomplete traces and doughnuts, and you can use a hobby knife to get rid of bridges and dirt.

Once you're satisfied that the artwork is clean, take a little bit of mineral oil and carefully wipe it across the back of the artwork. Don't get any on the front side of the paper (the side with the pattern) because you'll contaminate the sensitized surface of the copper blank. (If you *do* contiminate it, you won't notice anything when you make the exposure, but when you develop the board, the oil can act just like resist and keep the developer from dissolving the unwanted resist on the board.

After the oil has "dried" a bit—patting with a paper towell will help speed the process—place the pattern front side down on the sensitized copper blank, and make the exposure.

The mineral oil is optional, but it does do two things for you. It makes the paper much more transluscent and it makes the foil pattern appear darker. A successful exposure depends on having as much contrast as possible in the exposure mask and that's exactly what the mineral oil does.

Even though the mineral-oil treated paper is transluscent, it's still not anywhere as clear as lithographic film (which is what's normally used in producing PC



4-3/8 INCHES

PC SERVICE

boards). That means that you're going to have use a longer exposure time than you are probably used to.

We can't tell you exactly how long to make the exposure time, because we don't have any idea what kind of light source you use. A simple rule of thumb is to figure that there's a 50 percent increase in exposure time over lithographic film. But that doesn't necessarily mean you'll need a 50 percent increase. If you're used to taping up a pattern on mylar sheets, you'll find that rubbing the paper with mineral oil makes it just about as transluscent as mylar.

Note that sensitizers vary as well. Mineral oil isn't as transparent to ultraviolet light as it is to other parts of the spectrum. If your sensitizer wants to see ultraviolet, you may find using mineral oil to be more trouble than it's worth.

You'll have to experiment to find the best method to use with the chemicals you're familiar with. And once you find it, stick with it. Don't forget the "three C's" of making PC boards—care, cleanliness, and consistency.

Finally, we would like to here how you make out using our method. Write and tell us of your success, and failures, and what techniques work best for you. Address your letters to:

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Department PCB
200 Park Avenue South
New York, NY 10003

DESIGNER'S NOTEBOOK

ROBERT GROSSBLATT

Do-it-yourself test instruments

THE MORE EXPERIENCED YOU BECOME in electronics design, the more you depend on test equipment. While there are commercially available devices designed to test just about any kind of parameter you can think of, many designers wind up building their own test instruments to do quick-and-dirty tests on the breadboard. And the simpler the parameter, the more likely the test instrument used will be something home-grown.

If you're dealing with digital design, things like logic probes and pulse stretchers are more likely to be products of your own imagination. Logic probes are easily built. At the most basic level, all that's needed is an LED and a resistor. You can, of course, add "bells and whistles" like high and low tone generators, but the simplest circuit will do the job just as well.

Pulse stretchers are more complex to design, although a perfectly workable one can be built from a handful of parts. Which parts you use is up to you. Once you understand the theory, translating it into practice is simple. Pulse stretchers are really two-part circuits.

Pulse stretcher circuits

Figure 1 shows a basic pulse stretcher circuit. The first half is an input section that detects the pulse and triggers the second half of the circuit, a pulse generator. The factors to keep in mind when designing such circuits are the same ones you should consider in the design of any other circuit: The circuit should not affect the unit under test; its input impedance should be at least 1 megohm; it should operate over a wide voltage range, and it should be able to draw power from the unit under test.

The circuit in Fig. 1 is a good example of a simple pulse stretcher that meets all the criteria we've listed. It can be assembled from leftover parts in your circuit.

The input section is a single inverter, IC1-a. When a positive pulse appears at its input, an equivalent negative pulse is generated at its output. That discharges the capacitor through the diode, D1, and causes the output of the second inverter to go high. The inverter at the input reverts to its original state as soon as the input pulse ends, but D1 prevents the capacitor from charging up again through the input. The capacitor has to charge through the resistor in a time equal to the familiar formula T = RC.

You should recognize the second half of the circuit as a one-shot. If you so desired, you could even eliminate the second inverter and drive the LED directly from the input section. However, the output section of the pulse stretcher follows the same calculations: T = RC.

You can also use a 555 as a pulse stretcher...just set it up as a one-shot and you're in business. But you may find the inverter version shown here a bit handier, since there's always a spare logic gate or two left on the breadboard. In any event, once you understand the theory, it's easy to put together a pulse stretcher.

You've probably noticed that the circuit is set to detect *only* positive pulses applied to its input. Detecting negative pulses is just as easy. Two ways of accomplishing that are by adding another inverter to the input section, or by reversing the resistor and capacitor connections. If you go the latter route, remember to flip the diode around and tie the LED anode to +V instead of ground.

A full-blown pulse detector would be able to detect pulses of either polarity, and the output pulse should give some indication of the width of the input pulse you're detecting. Designing a circuit that does all that isn't really difficult; you can easily do it yourself. And if there's enough interest, I'll do it here. R-E

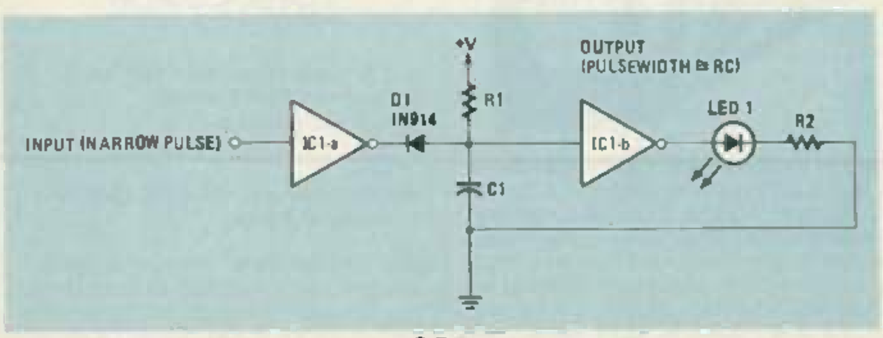

FIG. 1

ROBOTICS

continued from page 66

ence provides the software to control and use all the sensors to effectively control the wheels and appendages.

Almost any intelligent system can qualify for the term robot. What's meant by "intelligent system" is a fully integrated mechanical/electronic machine that has the ability to perform a seemingly intelligent task. An example of that is the increased use of automatic machine-vision systems that manufactures are using to detect subtle flaws in the workmanship of the mechanical arms.

Such vision systems use lots of electronics and some pretty sophisticated software routines to imitate the eye of a trained inspector. Those systems are slower than their typical human counterparts, but the precision achieved far surpasses that of the human inspector. And their overall output is constant.

The industrial future

Industrial robots have been around for several years, although the technology is considered to be in its infancy. While some manufacturing processes are automated, several thousand other tasks remain mostly manual operations. And although many universities and several corporations are involved in the study of robotic systems, there's still plenty of research not being done.

The price range for a typical arm system can be in tens of thousands of dollars. One factor that keeps costs high has to do with the power that's required to do the work. It's not easy to design powerful mechanized muscles.

Recent advances in what is called "light industrial" robots (those with limited capability) have driven the cost down. But, those robots were never intended for home use.

But what should a home robot do? That's a question that has been around even before the personal-robotics field emerged. And it's just one of the questions that we'll answer in the coming months. R-E

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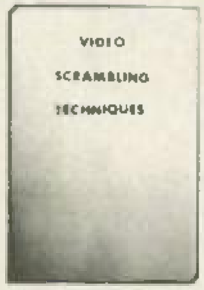

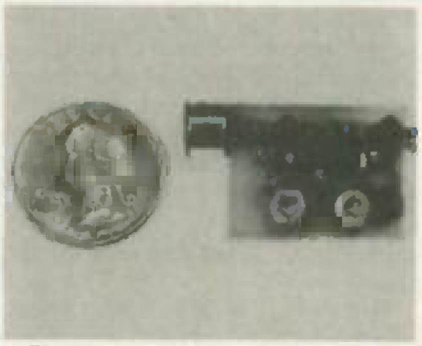

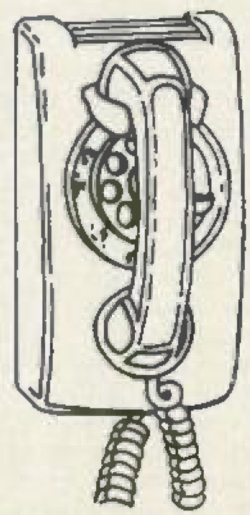

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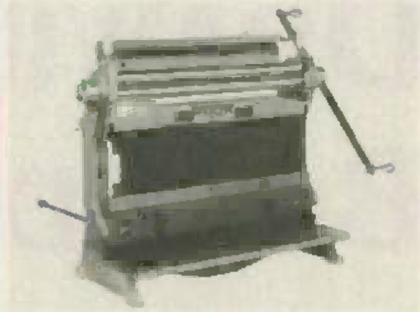

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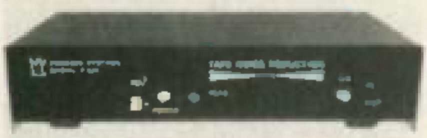

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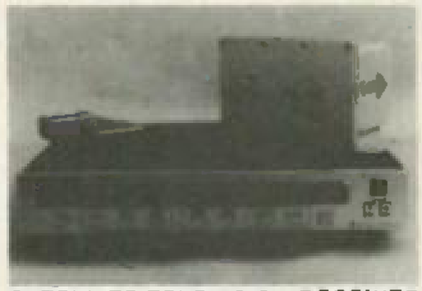

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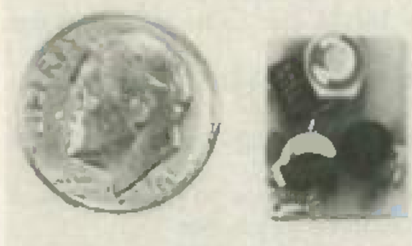

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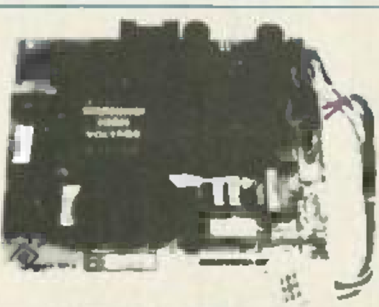

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DRAWING BOARD

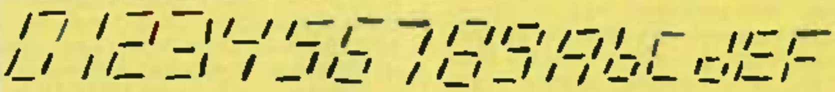
ROBERT GROSSBLATT

Putting the 5101 to work

THERE'S A KIND OF NATURAL LAW GOVerning the development of new electronic equipment. As the revision numbers on the boards go up, the amount of power drawn by the unit goes down. Something that starts life needing 86% of the output of the TVA usually winds up, a couple of revisions later, one tenth the size and running on barometric pressure!

Much of that progress is due to more efficient design, custom IC's, and microprocessors. But the major factor is the continuing evolution of CMOS technology.

The 5101 was an early entry into the low-power CMOS market. When it first appeared, most designers were knocked out of their socks by its low-power characteristics, and its guarantee to retain data at a low-power figure. Although technology has gone beyond the 5101, knowing how to use its low-power feature is still important.



0 = 0000	4 = 0100	8 = 1000	C = 1100
1 = 0001	5 = 0101	9 = 1001	D = 1101
2 = 0010	6 = 0110	A = 1010	E = 1110
3 = 0011	7 = 0111	B = 1011	F = 1111

FIG. 3

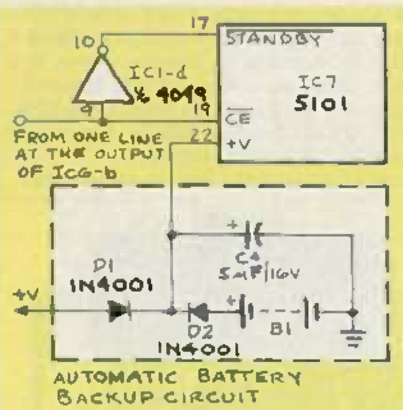


FIG. 1

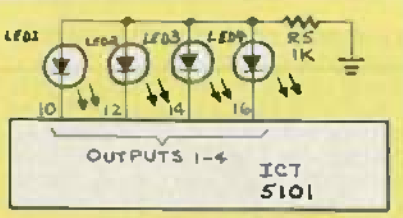


FIG. 2

Memory control

Although the data sheet for the 5101 gives the impression that using its standby feature is as easy as putting the right voltage on pin 17, there's a bit more to it than that. To be sure that your data doesn't disappear in the standby mode, there are four hard-and-fast rules that must be followed closely and in a certain order:

- The IC has to be locked in the read mode.
- The address lines have to be stabilized.
- All inputs and outputs must be turned off.
- The transition to standby power has to be glitch-free.

Locking the IC in the read mode is important, but often overlooked. Remember that you can write to the 5101 when R/W is brought low. That line is also brought low when system power is disconnected. But if another line stays active for any time after that, a phony-baloney write is generated. That means that the next time the circuit is powered up, you'll find some of the data overwritten.

There are two ways we can guard against that. One way is to lock the operation of pin 19, CHIP ENABLE, to the power-down procedure. The other way is to directly control the R/W pin, and synchronize it to the transition to standby.

Control synchronization

If you lock the device in read by directly controlling the R/W pin, the address lines must remain unchanged. However, the more traditional way is to completely disable the IC. Then, what's going on with the address bus is irrelevant.

The same thing applies to the I/O. Disabling the entire IC, naturally, disconnects the IC from the I/O bus. However, if things are done differently, you'll have to design a circuit that first disconnects the memory from system I/O. The outputs are no problem since the 5101 has a separate control (pin 18) to three-state the output. But a buffer arrangement of some type is needed for the inputs.

The last rule, and the last opera-

VOL. 2 NO. 7 July 1985

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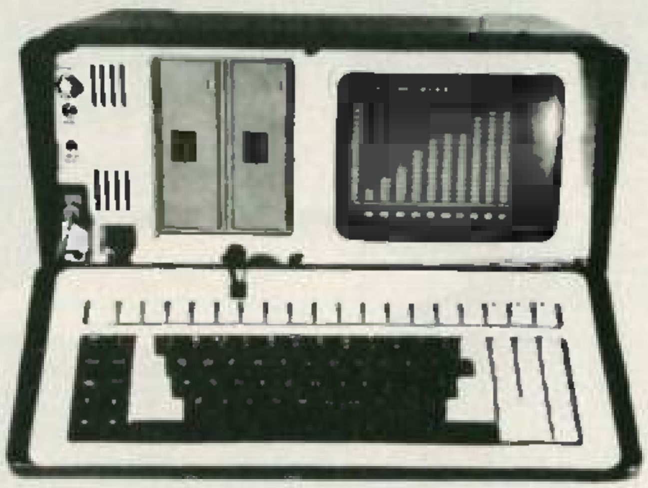

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The ZORBA users manual covers operation of the unit, all supplied software and all interface and internal information. A system diskette is supplied with all system files and utilities. A second diskette contains the sources for all ZORBA software including BIOS, SETUP, FORMAT, and PATCH.

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CIRCLE 264 ON FREE INFORMATION CARD

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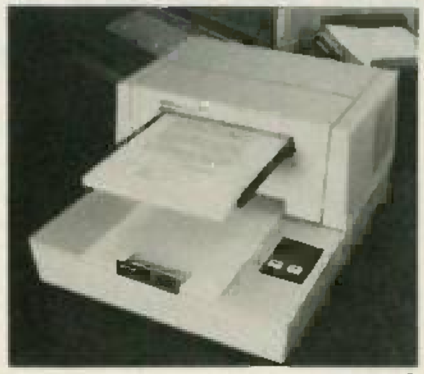
Vol. 2 No. 7 July 1985



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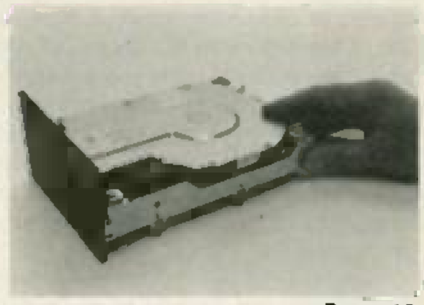

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ON THE COVER

Optical Character Recognition (*OCR*) has come a long way since its inception. We now see a form of it in daily use at grocery checkouts with Uniform Price Codes. Our cover shows the Desk-Top unit from DEST, Inc. See page 8.

NEXT MONTH

DIGITIZING TABLETS
Inputting without a keyboard isn't new but technological changes have been making it better.

CASSETTE-TO-CASSETTE INTERFACE
This simple construction project will take the drudgery out of tape copying for you.

DELUXING THE RADIO SHACK COLOR COMPUTER
Making your low-cost unit perform like a top-dollar investment.

EDITORIAL

Language: A tool for communication.

■There's an old saying among writers, "Write to *express* not to *impress*." One of the first things that technical writers learn, is that the first time you use a new technical term, you explain it. If you aren't communicating, no matter how well-written the piece may be, it's worthless.

We who are involved with computers are often guilty of the same kind of sin. We know what we mean, we know what we want to say, but we sometimes forget who it is that we're talking to. And if we use words, terms or expressions that our listeners do not understand, we are not communicating.

These "special words" that are indigenous to a specific field, are called "jargon." And they exist in every trade there is. Among the practicioners of that trade, the words are well understood, but to an outsider, they might as well be a complex foreign language.

While they form a sort of "spoken shorthand" to people within a given field, they only serve to confuse those who are neophytes. If you're out to impress people with your knowledge, you can sprinkle jargon into everything you say and when you see the utter confusion on their faces, you can mentally pat yourself on the back and remind yourself about how positively *brilliant* you are!

But rest assured that there are others—many others—who know a good deal more about computers than you do, and are capable of leaving you confused as well.

How much better to make certain that what you say is understood by everybody present. For one thing, it's only polite. For another, you'll be communicating. And if you really have something to say, it will be understood and appreciated by all. Those who are truly secure in their own knowledge don't feel that they have to impress anybody.

So of course, they make a much better impression!

Byron G. Wels

Byron G. Wels
Editor

COMPUTER DIGEST

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LETTERS

Out Of Warranty

After I hit the necessary break-in mileage on my car, I finally got to floor the accelerator and see what it could do. Now, finally, my computer has passed the warranty date. Does this mean that at last I can open 'er up and start modifying some of the innards without having to worry?—Tony Richards, Corpus Christi, TX.

It's not the same thing at all, Tony. Up until that warranty point, should anything have gone wrong, you could have brought your computer back for factory service—provided you had not opened it up. Now that the date has passed, anything that goes wrong, either with or without your help, is on your own shoulders and pocketbook. Good luck.

Glitch!

In the April, 1985 Issue of **ComputerDigest** there appear to be some mistakes in the program for "Resonant Circuit Design." One error was corrected by changing line 420 as follows:

```
420
T=SQR((Z*((9*D)+(10*G)))/D)
```

was published.

```
420
T=SQR((Z*((9*D)+(10*G)))/D/D)
```

is correct.

Also, line 100 should end with a quotation mark (") like line 90, and in line 140 the semicolon after CLS should be a colon. There should be a space between GOTO and 90. In line 220, delete the comma. And while line 450 is not *wrong*, I would recommend a space between the first quote-mark and the word IS.

After making these changes, the program ran quite well.—Jack Ivers, Westwood, MA.

Thank you Jack. We've received a few calls and letters on that one, and your information certainly helped. We really appreciate it.

Dear Abie?

My girl friend left me for another guy who is loaded with money, and I can't get her out of my mind. What can I do?—Ken Harwood, Hilo, HI.

Ken, I think you must have written TWO letters and put them in the wrong envelopes. I'm really curious to see how "Dear Abie" answers the one intended for us!

Computer Operator?

What exactly constitutes a "computer operator?" Granted, the guy who can write his own software and run it is a computer operator. But if this is true, how about the man who *buys* ready-to-use software and just *runs* it on his home computer? Isn't he an "operator?" What started all this was a friend who just bought a new car with a computer control in it, and now he's telling everybody he's a computer operator.—Frank Spevins, New York, NY.

It seems to be a matter of degree Frank. But be tolerant. If this makes him happy, go along with it. It doesn't hurt anything, does it?

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

SCHEMATIC DESIGNER SYSTEM, the *DASH-2,* is designed for engineers using the IBM PC/XT or AT, adding a new coordinated set of enhanced, mouse-driven editing features.

DASH-2 capabilities include:

Tag and drag, which enables the user to pick a symbol, a drawing area, or alphanumeric field and drag the targeted selection across the screen while maintaining connections.

Snap, which allows the user, when drawing a circuit connection, to position the cursor in the vicinity of a pin, "snapping" the connection in place. In the snap mode, when the cursor is inside a symbol cell, a pin cursor appears on the closest pin. The pin cursor jumps from pin to pin as the cursor is moved to locate the desired contact pin.

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Area definition, using mouse, whereby the mouse is used to locate any two opposite corners of the desired area. The area boundary is displayed in "real time."

The *DASH-2* add-on package (model *D2-MAP-PC)* for the IBM PC is priced at $5,980, with the complete *DASH-2* system (model *D2-545-PC),* including the IBM PC and printer, selling for $9,980. *DASH-2* for the IBM XT (model *D2-MAP-XT)* is priced at $6280, add-on-package, and $12,980 for the complete system (model *D2-SYS-XT).*—*FutureNet Corporation,* 6709 Independence Ave., Canoga Park, CA 91303-2997.

VIDEO DISPLAY TERMINAL, the model *ADM 12plus,* is a smart editing terminal useful for word-processing, financial spreadsheets, and other specialized applications. The block mode terminal is compatible with the Televideo 925, 950, 912, and 920 terminals, and the Lear Siegler ADM 2, ADM 12, and the ADM 31.


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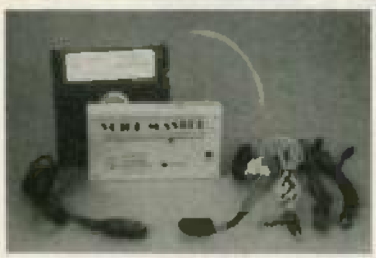
The terminal features programmable cursor keys for word-processing programs such as WordStar, a variable-format display memory, variable-speed vertical and horizontal scrolling. The model *ADM 12plus* provides two pages of 80/132-column by 24-line display memory (plus 25th status line), or a choice of wide and long page-memory configurations. A four-page memory option is also available to double the standard memory formats and add a 158-column by 48-line "Super Page" display-memory format.

The model *ADM 12plus* is priced at $745.00.—*Lear Siegler, Inc./Data Products Division*, 901 East Ball Road, Anaheim, CA 91805.

SPEECH SYNTHESIZER, the *Voice Master* for the Commodore 64, the Apple II, II+, and IIe (shown), is three products in one: a speech synthesizer, voice-recognition system, and music machine.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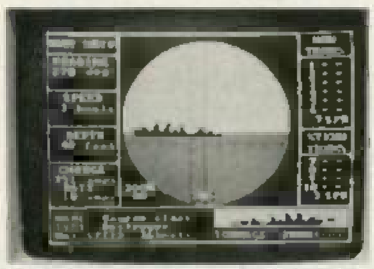
The *Voice Master* speaks clearly in your own voice, in any language, and with any accent. It is basically a digital tape recorder. To record speech, the user uses the command LEARN and speaks into the microphone what he or she wants the computer to say. To play back, the SPEAK command is used. Up to 64 different words, phrases, or other sounds can be in memory at one time, and entire vocabularies can be stored and loaded from disk.

To use the speech-recognition feature, the user stores the words or phrases to be recognized, using the RECOGNIZE command. Voice commands can be used to change letter keys to cursor keys and control cursor speed with voice pitch – faster and easier than using a mouse or joystick. Other applications include voice-activated padlocks, telephone dialers, and aids for the physically handicapped.

To use the voice harp, the user can compose and perform music in real time by humming or whistling. The user's voice or whistle pitch will write the notes—including duration and rests.

The *Voice Master* for the Commodore 64 (specify disk or tape) is priced at $89.95; for the Apple II, II+, or IIe, the price is $119.95. The *Sound Master* only, with demo disk and 32-page manual, is available for $39.95.—*Covox, Inc.*, 675-D Conger Street, Eugene, OR 97402.

EDUCATIONAL GAME, *Torpedo Run*, is a simulation which presents eight historical World War II submarine missions in which the player sub confronts enemy surface vessels in the same sequence as actually occurred.

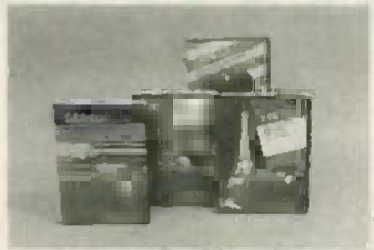

CIRCLE 24 ON FREE INFORMATION CARD

Players can compare their performances against that of the U.S. sub in those historic naval engagements.

Torpedo Run puts the player in the role of captain of a diesel electric submarine operating in the South Pacific. The player is challenged to develop good judgment, strategy decisions, and battle tactics. Constant on-screen display monitors such variables as speed, heading, depth, and remaining power and torpedo supply, and provide immediate data on enemy vessels. Enemy surface patrols drop depth charges. Increasing speed for underwater maneuvering risks depletion of electrical power. Surfacing to recharge batteries opens sub to attack.

It is interesting to speculate on how the actual submarine commanders might do with this game could they reenact the original missions.

Torpedo Run has a suggested retail price of $39.95.—*Brainpower, Inc.*, 24009 Ventura Blvd., Calabasas, CA 91302.

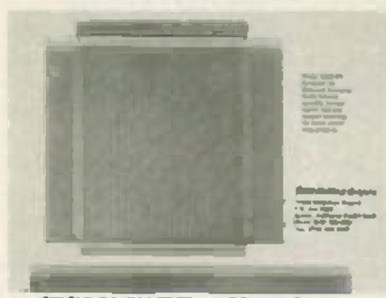

CIRCLE 25 ON FREE INFORMATION CARD

LANGUAGE SERIES, *LINKWORD*, is available for all models of the Atari computer, as well as for the Commodore 64. The four programs in the series consist of Spanish, French, German, and Italian. *LINKWORD* uses a system based on imagery, linking foreign words to acoustically similar English words to provide an easy-to-remember visual association. Using both the computer program and the audio cassette, the student can expect to learn a basic 400-word vocabulary, plus grammar and pronunciation in about 10 hours. The suggested retail price of *LINKWORD* is $24.95 for each language.—*Artworx Software Company, Inc.*, 150 Main Street, Fairport, NY 14450.

EXTENDER BOARD, the model *3690-20*, has test points for all 86 bus lines adjacent to the card connector for fast troubleshooting. Each line is marked for convenient identification.

The 9.00-inch long by 9.75-inch wide board is fabricated of 0.0625-inch thick FR4 expoxy-glass laminate, clad with two-ounce copper-plated bus lines. Bus lines are protected by a thick solder-mask coating to prevent short circuits during testing.

Card-edge-connector contacts have a 10-micro-inch gold flashing over nickel plating, while receptacle con-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tacts incorporate 30-micro-inch gold inlays. The model *3690-20* is priced at $50.70.—*Vector Electronic Company*, 12460 Gladstone Avenue, Sylmar, CA 91342.

SOFTWARE REVIEW

Dysan's "Interrogator."

A floppy disk drive is a precision device. Everything, from the rotational speed of the floppy disk—called the "Spindle Speed"—to the tolerances of the mechanism that positions the read/write head is measured in minute increments, and everything must come together with the same relationships each time the drive is used. Whether it's the first access, the tenth or the ten-thousandth, the read/write head must take exactly the same position(s) every time.

Insignificant variations in the speed of the disk or positioning of the read/write head can prevent a drive from reading disk files written earlier in the year, or files written by the computer at the next desk: It's the reason why disk files written by your office PC won't read on your home PCjr, and vice versa.

To insure that any drive can read the disks written by any other drive, floppy disk drives must be maintained within a narrow range of tolerance limits. Variations from these tolerances are termed *misalignment*.

Unfortunately, ordinary misalignment read/write problems which can be rectified by a moderately-priced alignment usually appear to the non-technical user as a computer malfunction or as a glitched disk, and many a dollar has been wasted on phantom computer repairs, just as many a perfectly good disk has been glitched attempting to "repair" or "recover" from a non-existent glitch. Yet all these problems and hassles can be easily eliminated in less than a minute by using a software package called *Interrogator* to evaluate a PC's disk drives.

Interrogator, which is produced by Dysan, the same company that manufactures high quality disks and the special test disks used by disk drive manufacturers and service technicians, consists of two 5¼ inch disks and an instruction manual. One disk contains a self-booting, menu-driven control program, the other disk is Dysan's Digital Diagnostic Disk (called a DDD), the same test disk used by disk manufacturers and service technicians. Together, they can evaluate the floppy drives of an IBM PC, XT or PC Portable, and can uncover potential disk drive problems before they begin to seriously affect writing and reading of the disk files.

To use *Interrogator* you simply load the self-booting control program and then replace the control program disk with the DDD disk. The DDD, which runs under control of the menu driven software, contains several test functions for such things as the spindle speed, alignment and positioning of the read/write head, and actual reading of test writes. Since most of the checks and tests are intended for the service technician they are run as individual tests and the results are displayed graphically in a form understood by technicians, or by someone with an idea of how a disk drive works. For the layman there is a menu selection called *Auto Sequence Tests* that automatically steps the drive through the tests, displaying the test results in layman's rather than technical terms, also indicating by a single phrase whether the drive has passed or failed the tests (whether the drive is within predetermined tolerance limits). Any test result that does not fall within the range of the preset tolerance limits is highlighted so the user knows what test has failed.

The screen displays of the *Auto Sequence Tests* for each drive can be printed for side-by-side comparisons or for future reference. *Interrogator* even permits the user to type a short comment at the bottom of each display prior to printing.

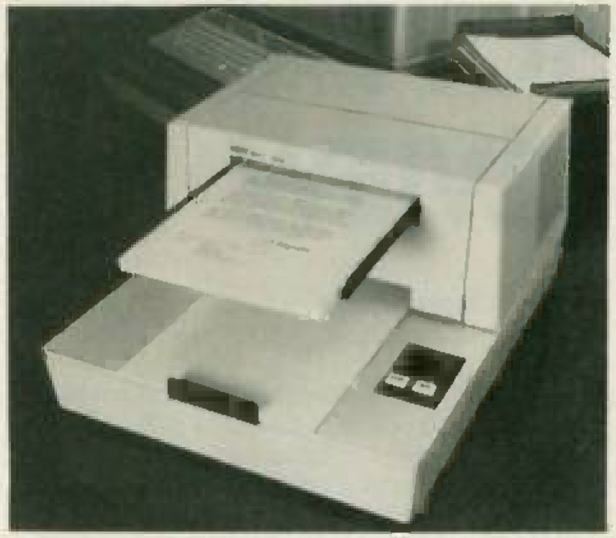
At each step of the test selection and printing the user responds directly to on-screen prompts using only the function keys. It takes no technical skill, knowledge or even experience with a computer to use *Interrogator*.

The documentation works on two levels. It covers the layman's tests and what they represent, then progresses through an easily-understood discussion of a disk drive's parameters, and finally covers the use and interpretation of the technician-oriented checks.

A menu driven PROGRAM SETUP allows the user to change the default conditions of the disk drive's track-seek time, head-settle time, read/write retries, and the total sides tested: the *Auto* sequence tolerance limits: the program parameters (monochrome or color and sound on or off): and to create backup disks with user-determined setup values and parameters. As initially supplied, *Interrogator* is configured for a monochrome monitor, and while the color display is most decorative, it serves no functional purpose. Similarly, while it might appear there is some need to change the tolerance limits, the average user would have no reason to do so. While it's possible a disk-service technician might have some reason to change the tolerance limits, they are best left as they are. Although the use of *Interrogator* almost insures the compatibility of disk files between several IBM personal computers, it is also surprisingly effective at detecting the cause of intermittent read and write failures. For example, the computer on which this review was written has had a recent problem with intermittent reads and writes from the B: drive. *Interrogator* disclosed that the drive was sluggish and out of tolerance when the computer was first turned on, but after several disk operations—what is called "exercising the drive"—the drive "pulled in." Knowing what was wrong, by exercising the B: drive until *Interrogator* showed all parameters to be within the accepted tolerance range, it was possible to avoid defective reads and writes until the computer could be freed for overhaul of the disk drives. Considering that the *Auto* mode runs a complete check in nominally 20 seconds, one could not ask for a more convenient way to check the system. —Dysan Corp., 5201 Patrick Henry Drive, Santa Clara, CA 95050.

OPTICAL CHARACTER RECOGNITION

There are other ways to input than the keyboard—easier ways.



MARC STERN

■If there's one thing you learn when you buy a microcomputer, it's this: the keyboard is a great input device, but sometimes you'll wish it were better. You usually realize this when you find a fantastic program which must be laboriously entered line-by-line from the keyboard.

Relief at hand

The need for alternative input methods is strong and the market points this out. At the moment, you can find digital pen tablets and bar code readers, as well as keyboards available for data input. Each offers its own advantages and, its drawbacks.

The bar code reader can accept input from Universal Product Code strips, but can't recognize handprinted or written data. Which brings us to an input alternative that can save you hours at the keyboard, the optical character recognition device.

The OCR

These can range from simple wand-like instruments that you draw across a typed or printed line, to sophisticated standalone devices which will read many typestyles and increase the versatility of any small-computer system. In fact, the key difference between the wand and the larger device is that the wand can recognize far fewer typestyles.

One of the most sophisticated units on the market—perhaps the most sophisticated—is manufactured by DEST Corp. of Milpitas, CA. DEST is one of the leaders in optical character recognition technology (OCR) and it offers this functionality in its WorkLess Station.

Looking like a standard office copying machine, the compact DEST device works automatically; recognizes over 100 characters from at least 10 typestyles, and inserts formatting codes for word processing programs. (See Fig. 1)

Shrinking technology

If you've been involved with computers for more than a couple of years, you've probably run across OCR readers. Typically, they were big units, standing as much as three or more feet tall. That has changed.

For example, there's an OCR device made by Oberon which looks like a secretary's copying stand. It holds a piece of paper and you move the OCR head across the line of type. Then, there's the WorkLess Station, which occupies the desk space of a microcomputer system. That the manufacturers have

STANDARD SPECIAL CHARACTERS

! @ # $ % ¢ & * ( ) + " ' : ; - = , . ? /

ADDITIONAL CHARACTERS RECOGNIZED BY WORKLESS STATION

§ ¶ ° [ ] £ ± ®© ™ † > < | ¼ ½

FIG. 1—THE DEST WORKLESS STATION is an example of today's advanced OCR technology. It is capable of recognizing about 10 typefaces, which cover the majority of typestyles used commercially. Because of this, it can accept a wide variety of printed input.

been able to achieve these size reductions is due to very large-scale integration technology which has taken the functions once handled by many computer boards and has put those functions on integrated circuit chips.

Further, these devices are smarter. In today's desktop, microprocessor-driven OCR device a 2,048-element, linear photodiode array can recognize almost any typeface used commercially. This contrasts with older OCR devices which were limited to specially designed "computer" typefaces—Courier 10 and 12.

(In a recent test, in fact, a DEST unit recognized a typeface which it wasn't supposed to be able to recognize. The specifications on this unit, in fact, seem conservative. Although the company claims it will recognize 10 or so typefaces, chances are it will recognize many more.)

Intelligent character recognition

Now that we've established that OCR is a vital input technology, it's interesting to see how a typical system works.

For starters, this system is driven by an eight-bit microprocessor (MPU) unit —DEST uses an 8085. The MPU controls the entire device.

Take a look at Fig. 2 and you'll see—in block form—how the system works. The photodiode array sends its information to a video unit, which digitizes the input and which, in turn, sends it to a control unit and on to the isolation unit where the MPU is housed. The isolation unit is connected to an optional format unit, which takes the raw, digitized output and formats it into word-processor-compatible text output. It also sends the formatted data to the host computer system. If a character isn't recognized immediately, recognition, correlator and typestyle extender modules are brought into play.

In essence, that's the entire system, but, it's a good idea to explore its operation in detail so you'll have a better idea of how OCR technology works.

When the system operator first inserts a sheet of printed material into the OCR unit, it is scanned by a lamp which illuminates a mirror and lens and focuses the line on the photodiode array. The array receives a focused, one-pixel high reflection and each diode detects the amount of light corresponding to one pixel. The diodes turn this information into a series of voltages representing the data and these analog signals

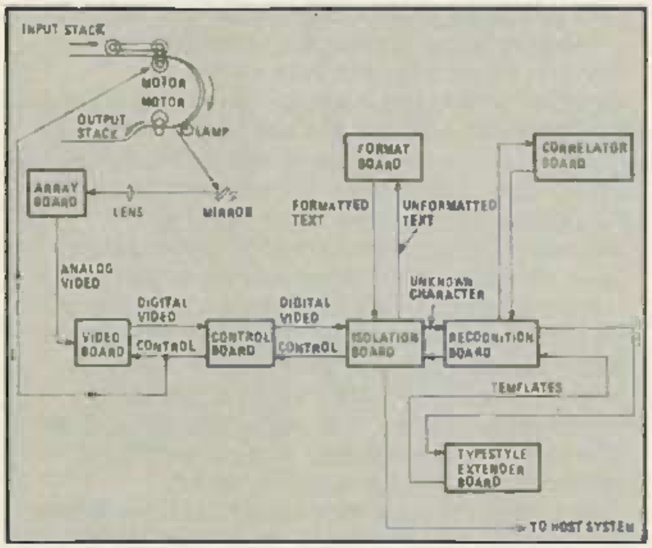


FIG. 2—PRINTED INPUT IS DIRECTED from a mirror to an array module which turns the pixel-high scan lines into their analog equivalents. From there, it is processed by a video board and sent through a controller module to the isolation module. The isolation module filters input and directs the digitized character flow to the recognition module and correlator board. These are the essential pieces of the OCR picture, although some units add optional format and extended typestyle modules.

are sent to the video module, where each pixel is digitized. (See Fig. 3)

That digitization determines whether the pixel is black or white and the information—similar to the image digitization in a facsimile machine—is sent through the control module to the isolation module where the image is stored in the unit's random access memory.

The isolation module is the heart of the unit. It usually contains the MPU, as well as a DMA controller. The rest of the circuitry contains serial to parallel conversion logic; 32K of read-only memory-based (ROM) character isolation routines; 32K of RAM, and a universal synchronous-asynchronous receiver/transmitter (USART) to communicate with the host computer system.

(The last feature makes this device system independent. It can be used with any small-computer system on the market that employs and RS-232C serial communications interface. Further, it can be immediately interfaced with that system, rather than requiring special interface cards or configuration routines. You can see the value of a universal type of input device.)

In operation, the isolation module of a typical OCR device isolates each character on a background frame. Some systems use a 24 by 32 pixel frame, which gives the system enough character definition to work with.

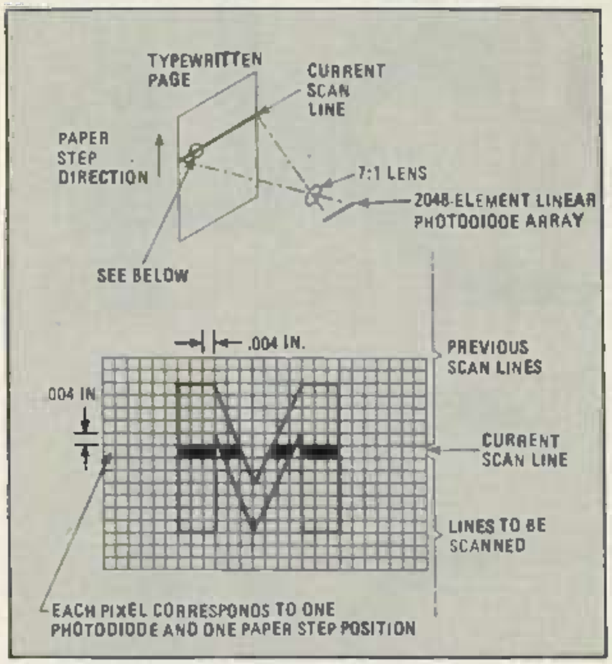


FIG. 3—USING A 2,048-ELEMENT linear photodiode array, an advanced OCR unit creates a series of one-pixel scan lines. The diode array detects the light. Each character occupies a 24 × 32 pixel matrix.

This type of definition is also great enough to compensate for skewed or bowed lines, close or touching characters or underlines.

When the system is finished isolating the particular character, it is sent to the recognition module, which, in conjunction with the correlator module, compares the characters to those stored in ROM. The recognition module contains RAM to store the still-unknown character and it contains a ROM-based recognition routine for the character identification. When the text is identified, it is sent to the computer in page form, using the RS-232C port. A format module can set this information up for a specific word-processing program if it is commanded to.

Character recognition

The heart of today's OCR device is the typestyle recognition routine stored in ROM. This can be permanent ROM or erasable programmable read-only memory (EPROM).

In general, these routines are generic and are capable of recognizing a wide variety of typefaces from many manufacturers. (See Fig. 4.) There are some limited OCR systems which require typeface-specific ROM for the device to work correctly, but today's sophisticated devices are capable of recognizing a great range. For example, the DEST system can recognize about 10 generic typestyles, which cover about 95 percent of the typefaces used today.

The typical advanced OCR system today uses a character-recognition system that is as much a filter as it is a character-identifier. The algorithm used for character recognition also accommodates such things as ink splatter, copier specks and stroke-width variations. In this mode, it acts as a filter to take extraneous "noise" out of the picture. For example, let's say you are attempting to read a document loaded with copier specks. The device's programming makes allowance by filtering out any speck that is smaller than the dot on an i. The filtering action also normalizes any letter stroke abnormalities.

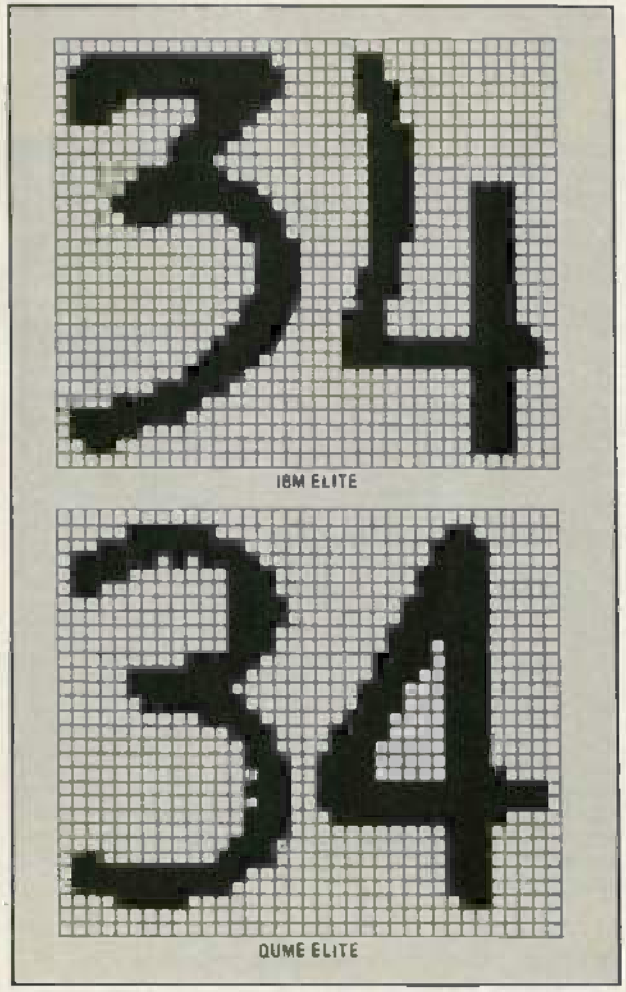


FIG. 4—THE CHARACTER-RECOGNITION ALGORITHMS in an advanced OCR device, such as that made by DEST, is generic. This means it is capable of recognizing a wide variety of typestyles from various manufacturers.

The character-recognition routine is actually a matrix-type matching algorithm, a system such as that employed by DEST matches unknown characters with those stored in ROM templates. And, if the system fails to achieve a good match, the character is rejected until the best known-to-unknown character match is achieved. Interestingly, the program algorithm also has the capability of dealing with a duplicate match situation. If an unknown letter falls best not only under one A template in the program's memory, but that it also fits under another A category. In this situation, the algorithm determines which is the better fit and recognizes that letter.

But if the system still can't determine what letter a character is supposed to represent, the algorithm has a fail-safe built in, a context resolution system which it uses to distinguish among characters of similar shape.

For example, with some typefaces the digit 1 and the letter "l" and the digit 0 and letter "O" are almost indistinguishable.

In this situation, the program takes advantage of artificial intelligence techniques and resorts to deduction. Look at the price $35.10 and the word still. In each case, there are characters that just can't be identified on the basis of their shape -- 0, "O", 1, "l."

Like someone using deduction in the numeric example, the program sees there is a 5 in the immediate vicinity and makes the determination that it is working with a number. It doesn't look at the decimal, but relies on positional information, instead. Since it does, it determines that a one and zero follow the decimal point. Likewise, using positional information, the algorithm sees an "i" before the two "ls" in still and therefore determines it is a word.

If the algorithm still can't determine a letter after all the filtering, the microprocessor in the system issues a reject-character code and sends it to the computer where it appears in the text. Since the algorithm recognizes most letters, it is easy for the computer user to search through and replace those characters with a word-processor's global search command.

Fortunately the occurrence of rejected letters is fairly rare. Statistics show they occur about once in 2000 characters. Further, those characters which might slip through the cracks in the recognition algorithm and which might turn up as incorrect letters are even more rare, on the order of once in 20,000 to 30,000 characters.

Special cases

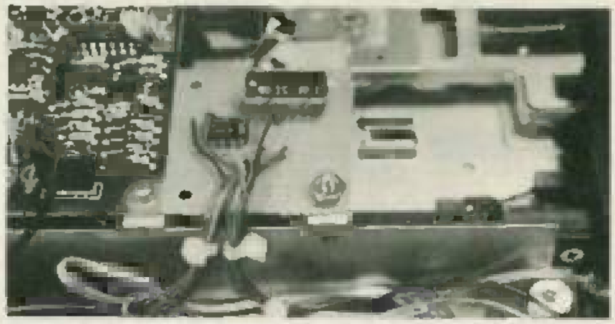
Today's advanced OCR has a feature that earlier systems lacked, the ability to recognize an extended character set. For example, earlier and more limited systems usually can recognize 80 to 90 characters at a maximum. However, today's advanced system can recognize 100 or more.

Today's OCR device can now be used by the microcomputer user and it will be a welcomed addition, indeed.

WRITE-PROTECT NOTCH BY-PASS

You paid for both sides of your disks. Here's how to use both sides.

NOEL NYMAN



SMALL CIRCUIT BOARD with IC, switch and resistor all in place illustrates the simplicity of this circuit. It allows you to write to both sides of the disk with no need for punching holes.

If you own a single-sided floppy disk drive, you may have read that the opposite side of your diskettes can also be used to store data and programs. During manufacturing, all disks are tested for data recording integrity on both sides. Those not meeting manufacturer's standards on one side are packaged as single-sided disks.

Using the uncertified "backside" of disks isn't recommended for valuable data or for disks that will be read frequently. When you flip a disk over, the cleaning material inside the jacket may release particles of dust and oxide to the disk surface and corrupt your read/write head. Dual-sided drive owners don't have this problem: their disks turn in one direction only. However, many computer owners use this technique for archival or back-up disks which are read infrequently.

To write on a disk, the write-protect notch must be uncovered. On a single-sided disk, there is no write-protect notch for the back. Special punches are available that will cut a neat, square notch. Most users prefer to use a conductor's punch or a scissors. Using any of those methods may damage the disk jacket or warp the disk itself.

How it works

Here's how to modify your drive to electronically bypass the write-protect circuitry. We'll use the Commodore 1541 disk drive in our example, but the same idea should be adaptable to Atari drives or any other disk drive that doesn't use the small timing hole near the disk's center.

In most disk drives, the write-protect notch is sensed optically. An LED is mounted opposite a phototransistor with the write-protect notch lined up between them when the disk is inserted. If the notch is uncovered, the light from the LED causes the phototransistor to conduct.

On the Commodore 1541, this brings the write-protect line low (ground potential or near zero volts) and signals the drive circuitry that the disk can be written to.

If a write-protect tab is in place, or there is no notch on the jacket, the light path is blocked and the transistor does not conduct. This leaves the write-protect line high on the 1541 and the drive will not write to the disk.

To bypass the circuit, hold the write-protect line low by shunting the phototransistor with a resistor. This is easy in most drives since the phototransistor is mounted on the drive mechanism and the leads from it plug into the circuit board. No changes are required on the circuit board itself.

Be careful!

You may want to wait until the warranty expires before attempting any modification. If possible, obtain a schematic of your drive from a dealer or repair service. The drive circuits use CMOS chips which can be damaged by improper handling. Use normal CMOS precautions when working around the circuit board.

First unplug all cables, then remove the top cover from the Commodore 1541 by loosening the four mounting screws accessed through holes in the bottom cover. Remove the metal shield that covers the circuit board. Two screws on the left side secure the shield.

Look for the largest plug, labelled "P6" on most boards. It is a 15-pin plug but only a few wires are connected. Counting from the back of the drive, locate pins 12 and 13. These are the wires coming from the phototransistor.

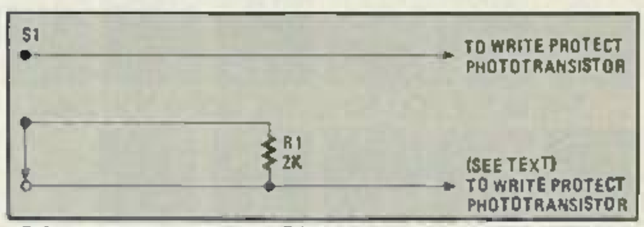


FIG. 1—IN ITS SIMPLEST FORM, the schematic above uses only a switch and resistor.

To make sure you have the right wires, carefully bare the insulation near the plug and connect a voltmeter or logic probe to them. Pin 13 is the negative or ground side. Plug in the power cord and turn on the drive. Be careful not to touch the circuit board while the power cord is connected. The voltmeter should read near zero volts.

Put a disk part-way into the drive so the write-protect area is blocked. The voltage should increase to almost three volts, a TTL logic one or high. If you get these readings, you have the proper wires.

Figure 1 is a diagram for installing a switch and resistor to bypass the phototransistor. A 2K resistor (R1) worked on the drives we tested, but you may have to try values between 1K and 2K to get reliable operation. Do not simply short the two wires together, as this might damage the phototransistor or other circuit components. If you mount the resistor directly to the switch, no separate circuit board or stand-offs will be required to hold it.

Additional circuitry

Although this simple modification will allow you to write to the uncertified side of the disk without punching notches in it, we recommend the circuit shown in Figure 2. This will flash the green "Power On" LED whenever the write-protect bypass switch is turned on.

We used the LM3909 (IC1) because it provides a bright LED flash at low voltage. This lets us use the 2 volts available at the green LED's plug directly with no

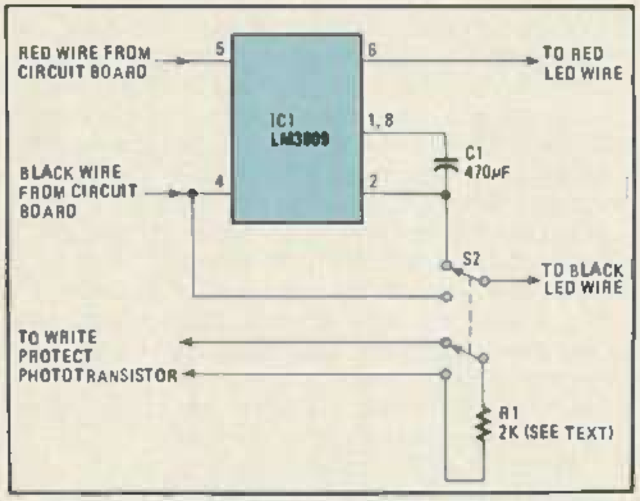


FIG. 2—MORE ELABORATE CIRCUIT is still not complicated, but accomplishes a great deal more. Resistor R1 might have to be changed. See text.

changes on the drive circuit board. Cut the red and black wires going to the green LED and connect them as shown in the schematic. You may want to use plugs and sockets to connect the circuit to the drive so you can remove it if you need to have your drive serviced.

Any double-pole, double-throw switch will work, but select one that will fit into the case past the drive chassis before you start punching holes. The switch we used is a miniature toggle that can be located almost anyplace. A slide switch might have been more compact, but would have required additional holes. The circuit board we used fits nicely in front of the "short" circuit board used in the newer 1541 drives and can be bolted to the unused circuit board mounting tab.

Once the switch and LED flasher are in place, test by trying to SAVE a program to a disk with a covered write-protect notch. With the switch in the on position, the green LED should flash and the program will SAVE to the disk.

Avoid confusion

You should turn the switch on only when you SAVE to or format a disk with no notch. If the switch is left on, your drive can get very confused and give you strange errors. To illustrate this, turn the write-protect switch off, put a disk with an uncovered notch in the drive, and type the following in direct mode (Commodore only):

OPEN2,8,2,"X,S,W"

This tells the drive that we're about to write information to a sequential file we've called "X." The red LED should come on and stay on, indicating that a data channel is open to the drive. Now remove the disk from the drive. The red LED will go out. The drive "knows" that you've removed the disk and that the data

PARTS LIST

IC1—LM3909 LED Flasher
R1—2000 ohm, ¼ watt resistor
C1—470uF Electrolytic Capacitor
S1—SPDT Toggle Switch
S2—DPDT Toggle Switch
Circuit board, plugs and mounting hardware

channel shouldn't be held open.

Type: CLOSE2

To get rid of the open file in the computer, then try the same experiment with the write-protect switch on. This time, the red LED does *not* go out! The disk drive uses the high-to-low transition of the write-protect line as the back of the disk crosses the light path to tell that you've removed a disk. With the write-protect switch on, this line is held low and the drive doesn't see any change. If you change disks in this way, you will have difficulty LOADing files on the first try. More important, if you SAVE to the second disk, you may overwrite important data or programs because the drive will use the Block Availibility Map of the previous disk.

Properly used, the write-protect switch will give you access to the back of your disks without the need for expensive punches or danger of damage. It also gives you a measure of security since there's no telltale notch to indicate that anything has been recorded on the back.

Using the electronic circuits shown here, you can write to the back of the disk at your own volition; you'll find this a great convenience if you haven't had this facility before. It effectively doubles the capacity of your disks.

However, it's always a good idea to mark or number your disks so you'll know which disks are written on both sides, and what information is contained on the backs. A separate sheet or ledger can be maintained as a menu so you can quickly and easily locate the information you require at any given time. You might also want to carefully clip one corner of the disk envelope so you can easily tap out any collection of oxides and/or debris that might accumulate in the envelope and possibly foul your heads.

ADDING A HARD DISK DRIVE

Here's how to add that hard disk drive you've always wanted.

HERB FRIEDMAN

■As software for personal computers gets more complex, programs require greater storage capacity for the program and related data. Even the two-sided disk is hard-pressed to hold a complete program; the PC-DOS version of *WordStar* and its spelling checker, *CorrectStar* can't fit on one disk: They require two disks, and become a pain to run from conventional floppy disk drives.

The easiest, most cost-effective way to increase storage capacity for an IBM and some IBM-compatible personal computers is to retrofit the PC with a hard disk drive having at least 10 megabyte capacity. Although the hardware for 10MB of storage can cost you anywhere from a shade under $800 to the price of a used car, higher cost equipment doesn't always make the system better: It often just makes it more expensive. (While hard disk systems of 15, 20 and even 30MB are available, their cost and capacity are often beyond what's needed by the average technician, so we'll restrict our comments to the 10MB equipment.)

Three kinds of installation

There are three ways to add a hard disk drive to a PC: 1) *Internally*—the hard disk drive replaces the computer's floppy B: drive; 2) *Externally*—the hard drive is in an external cabinet with its own power supply and the PC retains both of its floppy disk drives; 3) *Expansion-External*—the external hard disk unit also has expansion slots for accessory adapters such as Asynchronous Communications and Parallel Printer Adapters.

As you might surmise, the least expensive hard disk retrofit is a straight internal replacement, while the most expensive is the expansion-external because it's going to have much of the same hardware as the original computer.

At the minimum you will need the hard disk drive and a hard disk controller, which is an adapter card that plugs into the computer, or the expansion unit. Although the hard disk drive and controller is the rock-bottom minimum configuration, the controller requires its own "long" expansion slot, which means the minimum PC configuration requires a floppy disk controller, a hard disk controller, and at least a monochrome or color monitor card: That's three slots out of a maximum of five before you add any other adapters. A multi-function card and an internal modem will fill the computer.

The internal hard disk drive

An internal hard disk drive replaces the computer's floppy B: drive. The capacity of a PC's 63 watt power supply is no longer a primary consideration when substituting a hard disk for a floppy because the new half-height hard disk drives, such as the "Qubie" (See Fig. 1) uses about the same power as the full-size flopy disk drive for which the PC was originally designed. A straight swap of a hard for a floppy drive does not require a heavier power supply even if the computer's expansion slots are fully loaded. But, a hard disk runs continuously—it does not cycle on and off like a floppy drive—so there is always a minimum power drain. If the computer is also equipped with a memory expansion adapter, extra serial ports, and an internal modem—another user of moderate continuous power—the 63 watts from a PC's power supply might be barely adequate for reliable operation.

The power supply let's you know if there's an overload condition by turning itself off. If your PC's power supply can't accommodate the extra continuous load of a hard disk, the least-expensive way to provide extra power capacity is through an auxiliary power

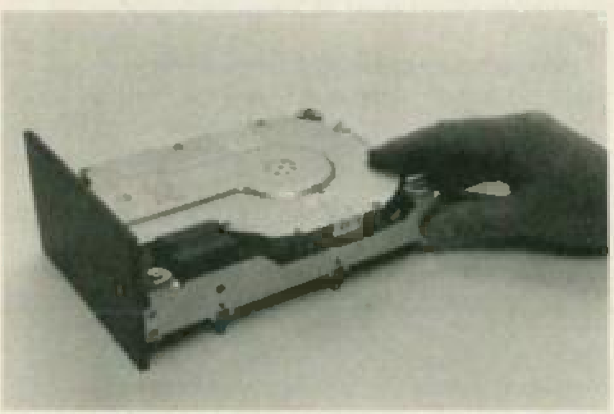


FIG. 1—MOST RETROFIT HALF-HEIGHT hard disk drives come with a full size front panel so the drive can directly replace a full size floppy disk drive.

FIG. 2—TO INSTALL THE HARD DISK simply unplug the cables from the floppy B: drive, remove the two screws that secure the drive and slide the floppy drive out of the cabinet, replacing it with the half-height hard disk.

supply for the hard disk drive that piggybacks on the rear apron. Qubie', and several other suppliers of hard disk units, sell "piggyback" power supplies specifically designed for retrofit hard disk drives. While you could just as easily replace the PC's power supply with a 130 watt unit, the piggyback supply is all you need, and it's about half the cost of a 130 watt retrofit or replacement power supply (See Fig. 2.)

The external hard disk drive.

Although internal hard disks are relatively inexpensive and convenient to install—the hardware simply plugs together—they are often more trouble than they're worth because you lose the floppy B: drive (unless you also replace the A: drive with two half-height floppy drives, in which case the overall cost is going to get out of hand). The problems caused by loss of the B: drive can often prove insurmountable because much software is specifically intended for a data disk on drive B:, or works between drives A: and B: and won't run from a hard disk. Also, if you leave your computer connected to a telephone line for remote access via a modem, you leave the files on your hard disk exposed to unauthorized use: Someone can easily issue a FORMAT command and erase the hard disk's files.

All such problems are avoided by using an external hard disk unit, which can be nothing more than the

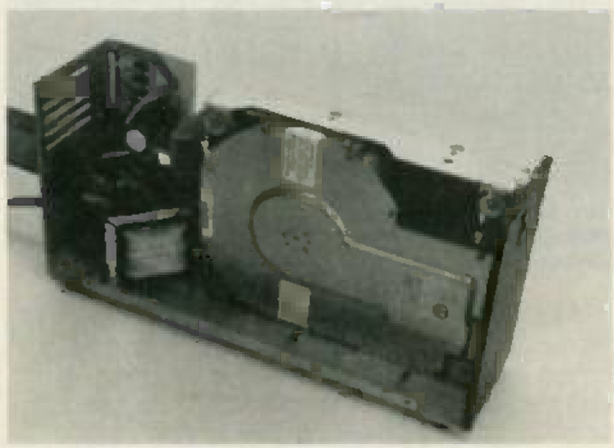


FIG. 3—IF YOU WANT AN EXTERNAL hard disk the drive can be installed in a conventional enclosure power supply such as used for floppy drives.

same drive used for the internal installation, but in a separate cabinet with its own power supply (See Fig. 3). The connections are generally the same ribbon cables used for internal hard disks, only now they are passed from the hard disk controller, out the back of the computer, into the external hard disk cabinet. Normally, the cabinet and power supply for an external drive adds anywhere from $200 to $300 to the cost of the hard disk unit. You could do the same thing by using a conventional $45 floppy disk cabinet/power supply from Software Support, Inc. (One Edgell Road, Framingham, MA 01701).

Although an external hard disk still requires a hard disk controller in the PC, you don't have to remove the B: drive, and more important, you can turn off the hard disk by turning off its external power supply. (On boot-up the PC's POST (Power On Self Test) automatically determines if the hard disk is available.) If you now leave the PC connected on-line to the telephone only the A: and B: drives can be accessed; it's as if the hard disk doesn't exist at all. If you need to allow on-line access to some hard disk files, copy them to a floppy disk before putting the computer on-line.

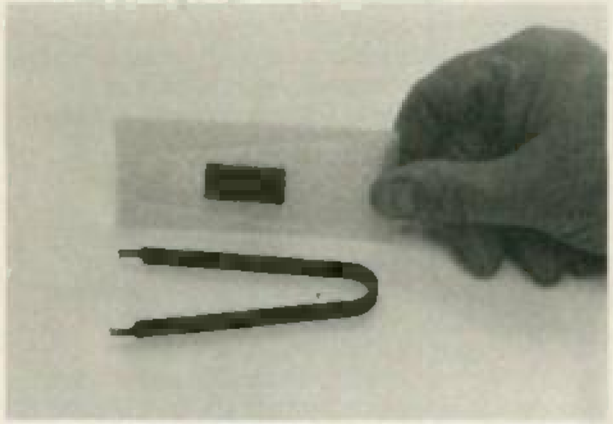


FIG. 4—IBM's EXPANSION UNIT comes with a new BIOS ROM (on the conductive foam) and a removal tool which is used to extract the existing pre-March 1983 ROM.

External-expansion.

Unless your budget can afford replacing your present floppy disk controller with one of the combination floppy/hard disk controller adapters, you must give up one more expansion slot, leaving a maximum of three for everything else including the monitor. If you require greater expansion capacity the best option is a device called an *Expansion Unit*, which contains a power supply, one or two hard disk drives, the hard disk's controller, a *Receiver Card*, and up to five open expansion slots. Let's explain the *Receiver Card*. Some sort of "communications system" system is required to exchange signals between the computer and the expansion unit. This is accomplished through an *Extender Card*—a "transmitter"—in one of the PC's expansion slots, and a *Receiver Card* in the expansion unit: A multi-conductor cable interconnects the two.

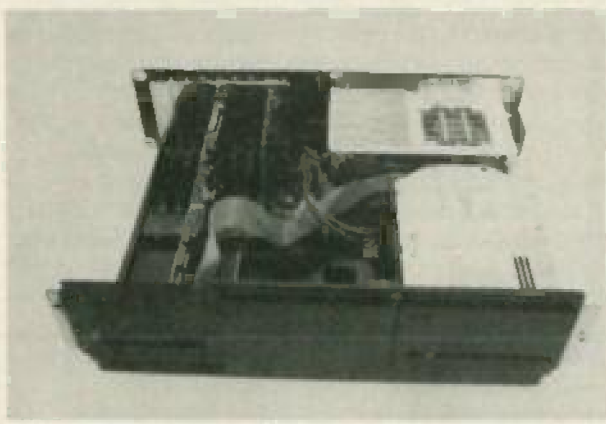


FIG. 5—The expansion unit contains its own power supply, the controller, a Receiver Card, and one hard disk. An empty compartment (on the left) is provided for a second hard disk drive.

The "communications circuit" permits some of the PC's adapters, such as Asynchronous Communication Adapters, Parallel Printer Adapters, a Prototype Card, a Game Control Adapter, and the Hard Disk Controller to be moved to the expansion unit. The Monchrome Display/Printer Adapter, memory expansion adapters and the floppy disk controller can not be moved to an expansion unit (unless the expansion unit provides DMA—Direct Memory Addressing) See Fig. 4.

Although there are several hard disk expansion units in the marketplace, the best value will prove to be the IBM Expansion unit shown in Figure 5, because it comes in a complete kit that even includes a ROM module and a special IC tool.

Auto boot.

In order to access memory options of more than 544K and an Expansion Unit—to boot directly to a hard disk rather than Drive A:—an IBM PC requires a "late" BIOS ROM: the ROM installed in all PCs manufactured after March 1983. (The date of manufacture is attached to a cloth tag usually placed over the internal speaker wires.) If you purchase the IBM Expansion Unit the ROM is supplied in the kit along with a special tool used to remove the original ROM. (If you don't need the ROM you don't use it.) If you purchase a non-IBM Expansion Unit you don't get the ROM; instead, you usually get a software package containing a utility that allows the early model computer—usually called the PC-1—to recognize the hard disk after it boots from a floppy. Alternately, you could purchase an IBM ROM upgrade kit (under $30) so the PC-1 boots directly from the hard disk.

Unfortunately, as many users have learned the hard way, IBM has undocumented and proprietary features in their BIOS: If you want a guarantee that most future software will work both the new ROM and a fully PC-DOS 2.x IB—compatible hard disk expansion unit is suggested. For maximum convenience, a hard disk unit should permit the computer to boot directly from the hard disk without need for utility software.

Programming the hard disk

If you use an IBM hard disk, or a fully IBM-compatible hard disk such as the Qubie', it will be automatically programmed as the next higher drive as determined by the computer's internal floppy drive selector switches: DIP switch sections SW1-7 and SW-8. If the DIP sections are programmed for two floppy drives—drives A: and B: —an IBM-compatible hard disk is automatically programmed as Drive C:; a second hard disk is automatically programmed as drive D:. If you want to use two RAMdisks (disk emulators) they will be drives C: and D:, and most RAMdisk software requires that DIP sections SW-7 and SW-B be configured for four disk drives: two floppy and two RAMdisk; hence, the hard disk(s) will be automatically programmed as drive E: (and drive F:). While it really doesn't make any difference whether the hard disk is recognized as C: or E: (or anything else), some applications software which is intended for use on either a floppy or a hard disk specifically looks for the hard disk as drive C:. If your computer's DIP sections program the hard disk as drive E: the software will never locate the disk files.

IBM has built some very cute "tricks" into the POST which tells you a lot about the condition of the hard disk. If the hard disk in internal—if it's part of the PC—the POST automatically recognizes it as device 1801. If there are any problems with the installation the numerals 1801 will appear in the upper left corner of the screen at power up. If no numerals show the drive is most likely functioning correctly. External hard disks are automatically recognized as device 1701. The nice part about auto-recognition is that if you forget to turn on the external hard disk's power supply POST indicates a 1701 error on the screen, reminding you to turn on the hard disk and reboot. (you must reboot for the computer to recognize a change in device configuration.) On the other hand, if you want your hard disk turned off the 1701 display let's you know for certain that it's off. (See Fig. 6.)

FIG. 6—THE COMPUTER CONNECTS to the Expansion Unit through a somewhat bulky connecting cable. The Expansion Unit can be disconnected by simply "pulling the plug."

If you install an internal hard disk retrofit and have any thoughts of eventually making it external make certain you have a BACKUP of everything on the hard disk because moving a hard disk into a new magnetic field—such as the power transformer of an external power supply—can glitch one or more tracks, sectors, or files. After you complete the external installation check both the DOS and your files for proper operation. If anything appears to have been glitched don't waste time trying to get it to work. Simply reformat the disk (which erases all data) and RESTORE the files from your BACKUPs; then avoid moving the hard disk unit because they are not as shock-resistant as the hard disk drives used for portable computers; shock and vibration can cause the head(s) to slam into the disk, damaging the magnetic surface and the recorded data. If you must move a hard disk unit, avoid the possibility of damage to the magnetic surface(s) by first *parking* the heads by running the *RELOCATION* program which is on the IBM DIAGNOSTICS that was supplied with your computer. The relocation program can be accessed as item No. 3 from the menu, or run the SHIPDISK.COM program on the diagnostics disk directly from PC-DOS.

tion to be done, is to make sure that the switch-over to standby is completely glitch-free. No matter how well you design the rest of the procedure, if there's much bouncing at the +v pin at shutdown, you're sure to foul up the data stored in the memory.

Now that we have an idea of what must be done to use the standby feature of the IC, let's put it to practical use in the circuit we've been designing. The best way to set things up is to lock the operation of the STANDBY control, pin 17, to the CHIP ENABLE, pin 19. If we do that and sync them properly, as shown in Fig. 1, we'll be sure that the IC is put to sleep properly, and that the timing is correct. You'll note that an automatic back-up battery supply is shown separated from the rest of the circuit by dashed lines. It simply kicks in automatically when there is a power failure.

Note also that pin 17 and pin 19 are controlled by the same line on the data bus and are separated from each other by a spare inverter. (The inverter is one leftover from previous columns in this series.) If you look over the truth table of the 5101 (which appeared in the April "Drawing Board"), you'll see exactly what's going on.

As long as the line feeding the memory is kept low, the entire IC is enabled. That low also causes the inverter to output a high to pin 17, taking the IC out of the standby mode. A low sensed at pin 17 puts the IC to sleep. But that inverter does more than let us lock the operation of both control pins together.

Remember that we're concerned with both the state of those pins, and the order in which things happen. If we don't sync things properly, the IC will go to sleep, but the data will probably glitch. The propagation delay of the inverter makes sure that that part of the power down operation happens in the right order.

When a high is applied to pin 19, the entire IC is disabled. And later, after a propagation delay, the standby mode is chosen. That means we have to modify the schematic of the circuit we've been building over the last few months. By tying the operation of pins 17 and 19 together, we need only three of the lines coming out of IC6-b.

The last thing to consider in our demonstration circuit is what to do about the display. Unfortunately, standard display drivers are going to be somewhat inadequate. Unless you use oddball IC's, display drivers do really weird things when presented with straight binary data. Everything is fine as long you stick to BCD. But if the most-significant bit is high, the display will usually be useless.

For our purposes, the easiest thing to do (as Fig. 2 shows) is to just hang LED's off the outputs. You can do the same thing on the outputs of the latches. That gives you a way to see what's happening on the address and data bus while keeping an eye on the state of the memory's control pins. (I'm the first to admit that that's a less-than-ideal solution.)

Getting standard display drivers like the 4511 or 7448 to deliver meaningful information when presented with straight binary is a tricky business.

Therefore, it's time to start another contest. The rules are really simple; I'm looking for the simplest, most elegant way to design a display driver circuit to produce displays like those shown in Fig. 3. It goes without saying that the winner will have the circuit published in Radio-Electronics. R-E

NEW IDEAS

Telephone off-hook alarm

IMAGINE SITTING AROUND WAITING for an important telephone call that never comes—and later finding out that the reason that you never received the call was because you (or someone in your household) had left the phone off the hook. Or, how about waiting for a call when, unknown to you, your line has gone dead. Either situation can be frustrating—to say the least.

Well, there's an easy way to solve both of those problems—the *telephone off-hook alarm*. A schematic of the off-hook alarm is shown in Fig. 1. That circuit has two indicators to tell you when your telephone receiver—or any extension receiver—is not in its cradle: a lamp, LMP1 and a piezoelectric buzzer, PB1. The lamp lights whenever a receiver is removed from its cradle or the line goes dead.

The buzzer sounds after the phone has been off the hook for a preset period (about 35 minutes), unless the circuit is reset or the receiver is returned to its cradle. The reset switch also allows you to stay on the phone for periods beyond the preset time limit.

Circuit operation

The telephone off-hook alarm is made from several common IC's and a handful of external components. Figure 1 shows a voltage divider/lowpass filter at the input to the circuit (made of resistors R1 and R2, and C1). That combination passes a fraction of the telephone line's DC voltage, which is fed to pin 6 of IC1 (an LM339 comparator).

When the phone is on the hook, the telephone line has about 50 volts across it, but once the receiver is lifted from its cradle, that value drops to around 10 volts. Potentiometer R3 is adjusted so that 2 volts is applied to the noninverting input (pin 7) of IC1. Because of the

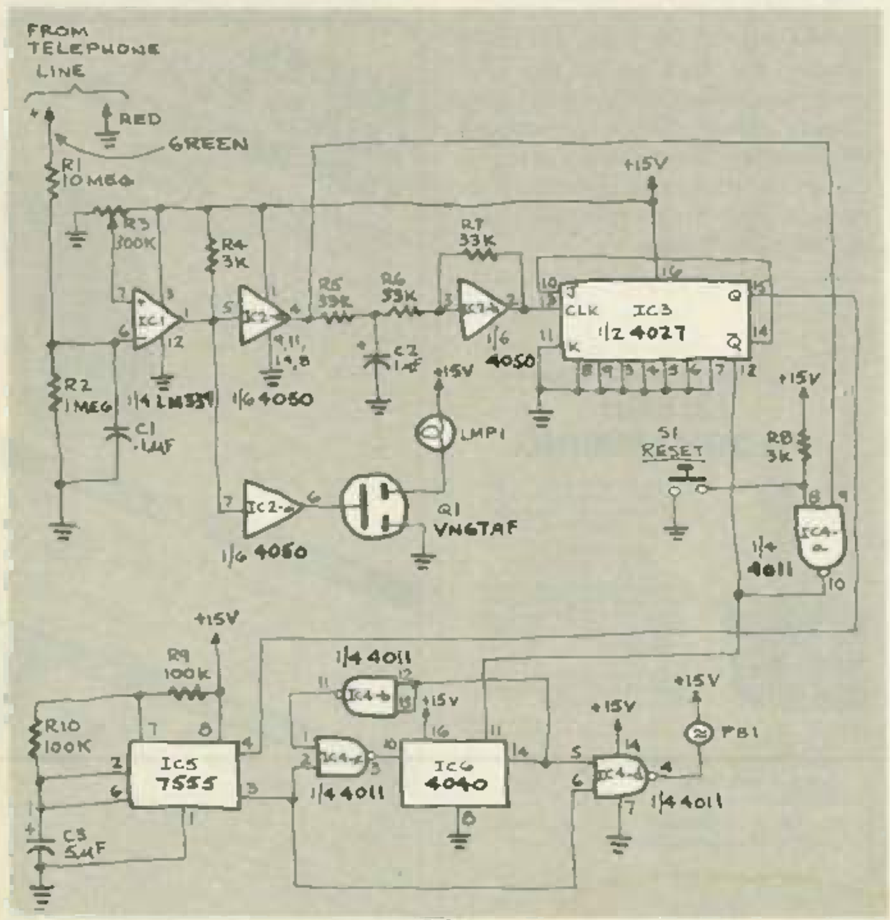


FIG. 1

NEW IDEAS

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

All published entries, upon publication, will earn $25. In addition, for U.S. residents only, Panavise will donate their *model 333*—The Rapid Assembly Circuit Board Holder, having a retail price of $39.95. It features an eight-position rotating adjustment, indexing at 45-degree increments, and six positive lock positions in the vertical plane, giving you a full ten-inch height adjustment for comfortable working.

I agree to the above terms, and grant Radio-Electronics Magazine the right to publish my idea and to subsequently re-publish my idea in collections or compilations of reprints of similar articles. I declare that the attached idea is my own original material and that its publication does not violate any other copyright. I also declare that this material has not been previously published.

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Mail your idea along with this coupon to: New Ideas Radio-Electronics, 200 Park Ave. South, New York, NY 10003

10-to-1 ratio of R1 and R2, most of the line voltage is dropped across R1.

With the phone on the hook, the voltage appearing at pin 6 is about 4.5 volts, but when the phone is lifted from its cradle that value drops to about 1 volt. When that happens, IC1 outputs a high that follows two paths.

In the first of those paths, that high is fed to IC2-c (⅙ of a 4050 buffer) to provide sufficient drive to turn on (VMOS) transistor Q1. With that transistor turned on, LMP1 lights showing that a receiver is off the hook.

In the other path, the signal is fed to IC2-a, which outputs a high that causes capacitor C2 to charge. When C2 is charged, it triggers IC4-a (¼ of a quad NAND Schmitt trigger) into conduction. The low output of IC4-a toggles JK flip-flop IC3, which then triggers the 7555 (CMOS) timer, IC5. The output of IC4-a is also fed to pin 11, RESET, of IC6 enabling it.

The timer produces a 1-Hz squarewave output that is fed to IC4-d (pin 6), and to IC6 through IC4-c. Now IC6 begins to count, and after about 2048 seconds (or 34 minutes), pin 14 of IC6 goes high. That high is fed to IC4-d, causing its output to go low, which in turn causes the piezoelectric buzzer, PB1, to sound. The circuit is designed so that the buzzer continues sounding until either the phone is hung up, or the circuit is reset by pressing switch S1.

The circuit is powered by a 15-volt, 300-mA supply; and, since the circuit is made of mostly CMOS IC's, power consumption in the standby mode is low. In operation, the lamp draws most of the power. If you want to reduce power consumption even more, the lamp may be replaced with an LED, allowing a power supply with a lower output to be used.

A word of caution: *Do not* earth-ground the circuit. Also, be sure that the power supply is isolated from the AC line.—*William Stamile*

STATE OF SOLID STATE

A new series of CMOS counters

ROBERT F. SCOTT,
SEMICONDUCTOR EDITOR

COUNTERS ARE AMONG THE MOST useful digital-logic circuits. They can receive uniform pulses (representing units to be counted) and develop a voltage that is proportional to the number of pulses input. That makes them useful for such applications as measuring time, period, or frequency.

LSI Computer Systems has introduced a new series of complementary CMOS divider IC's (a divider, of course, is a counter that produces an output for every n^{th} input pulse, instead of for every input pulse). The five new devices, which have been dubbed the RED series, and their functions are: RED 5/6, divide by 5 or 6; RED 50/60, divide by 50 or 60; RED 100/120, divide by 100 or 120; RED 300/360, divide by 300 or 360, and RED 3000/3600, divide by 3000 or 3600.

The counters are used as time-base generators operating from either 50- or 60-Hz line frequencies. They produce outputs ranging from 10 pulses per second (RED 5/6) to 1 pulse per minute (RED 3000/3600), depending on the particular IC.

The devices feature low power dissipation and high noise immunity and can operate from supplies of from +5 to +15 volts. The output is low-power TTL compatible when the IC is operated from a +5-volt supply. The clock input can accept a 50 or 60 Hz sinewave directly thanks to the inclusion of an onboard pulse shaper. The output is in squarewave form, except for the RED 5/6 when used in the divide by 5 mode. Inputs, in addition to the clock input, include 50-/60-Hz division select, input enable, and reset. All of the inputs are protected.

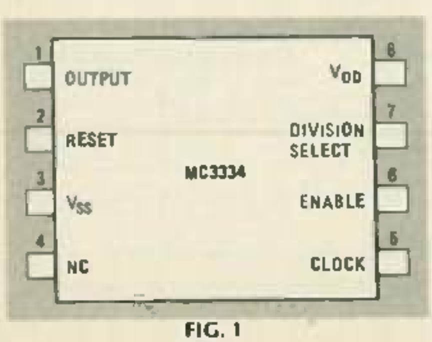

FIG. 1

Figure 1 is a pinout of the RED series counters. The devices are identical in all but one respect—the number of Johnson-type decade counters used in the output. For instance the RED 5/6 uses a single counter, while the RED 50/60 uses two counters. Figure 2 shows the counter-timing diagram. Note that the counting will always be proper if, as at points A through E, the reset and enable signals are allowed to switch only when the input clock is low.

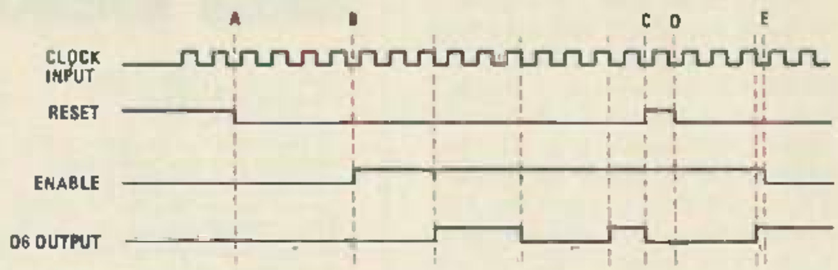

FIG. 2

The counter advances by one count on each negative transition of the input clock, as long as the ENABLE is high and RESET is low. When ENABLE is low, the input clock pulses are inhibited and the counter is held in the state it was in prior to switching. A high reset signal clears the counter to zero. A low on the DIVISION SELECT pin causes a divide by 6, 60, 120, 360, or 3600, depending on the counter being used. A high on the DIVISION SELECT pin causes a divide by 5, 50, 100, 300, or 3000.

The units are priced as follows: RED 5/6 and RED 50/60 devices, \$1.65; RED 100/120, RED 300/360, and RED 3000/3600 are \$1.95, each in lots of 1 to 24. For orders of less than \$25.00, add \$5.00 for shipping and handling. For the RED series data sheet, contact—LSI Computer Systems, Inc., 1235 Walt Whitman Rd., Melville, NY 11747

New low-dropout regulator

A positive voltage regulator that can source output-current up to 1.5 amperes with an input/output differential of typically 0.65 volt is now available from National Semiconductor. The latest addition their line of regulators, the LM2940CT-5.0, features an output current in excess of 1 amp that, along with the low dropout voltage, makes it useful in applications where the input voltage is kept at a level within a volt or two of the output.

The device is a plug-in replacement for similar NPN-type regulators and is pin-for-pin compatible with the LM340. Its guaranteed accuracy is ±3% at 25°C. The LM2940CT-5.0 is ideal for use in battery-powered applications and in automotive applications where large transient voltages, such as ±45 volts, can be expected.

Its features include internal short-circuit current limiting, thermal-overload protection, low quiescent current, reverse-battery protection, and a trimmed output voltage. Other voltage options are soon to be made available. Housed in a TO-220 package, the LM294OCT-5.0 sells for $0.95 in lots of 100 or more.—**National Semiconductor Corp.**, 2900 Semiconductor Drive, Santa Clara, CA 95051.

CMOS and TMOS technologies combined

The *SMARTpower II* device is a Motorola innovation that combines the best qualities of high-speed CMOS logic and high-current TMOS vertical power structuring into a single IC.

The MPC2005 can handle up to 15 amperes of continuous anode current, but is also capable of discharging capacitors with peak currents to 150 amps. When voltages exceed 6.2 volts or the junction temperature rises above 125°C, the device trips and removes the voltage from the system.

The MPC2005 can protect voltage-sensitive systems and memories on 5-volt buses from overvoltage transients and extreme temperatures that can damage the system. The device dissipates extremely low amounts of power in the off state, hence, it can be used to protect temperature sensitive devices since its junction temperature is essentially the same as that of the case.

The device includes a pin that can be used to set the trip-point to a level other than the pre-set 6.2 volts. A capacitor can be connected to the pin to change the delay time of the trip voltage. A single MPC2005 can replace three resistors, an SCR, and an IC. Priced at $4.50 in lots of 100 and up, it is available from **Motorola Semiconductor Products**, P.O. Box 20912, Phoenix, AZ 85036. **R-E**

ANTIQUE RADIOS

RICHARD D. FITCH

Servicing your antique radio

TO MANY OF YOU WHO HAVE GROWN up in this age of transistors and integrated circuits, the vacuum tube is a total stranger. And even some of us "older guys," have forgotten much about that old friend. But if you expect to get your antique radio working, you have to know a little something about the "antiques" inside it. In this month's column, we'll show you how to check tubes, and give you some other pointers to help you get your old radio back into action.

Testing tubes

Back in the early days of radio, any good radio repairmen kept a complete stock of tubes in his repair kit. To complement his tube assortment, the repairmen usually carried a tube tester, much like the ones shown in Fig. 1. Such units could test about 100 tubes of various size and pin configurations. The tester came with a tube chart on a single card that told the user how to set the various switches to test different tube types.

When restoring old radios, a tube tester is a handy instrument to have around, but it isn't absolutely necessary. Continuity checks can be used to see whether

FIG. 1

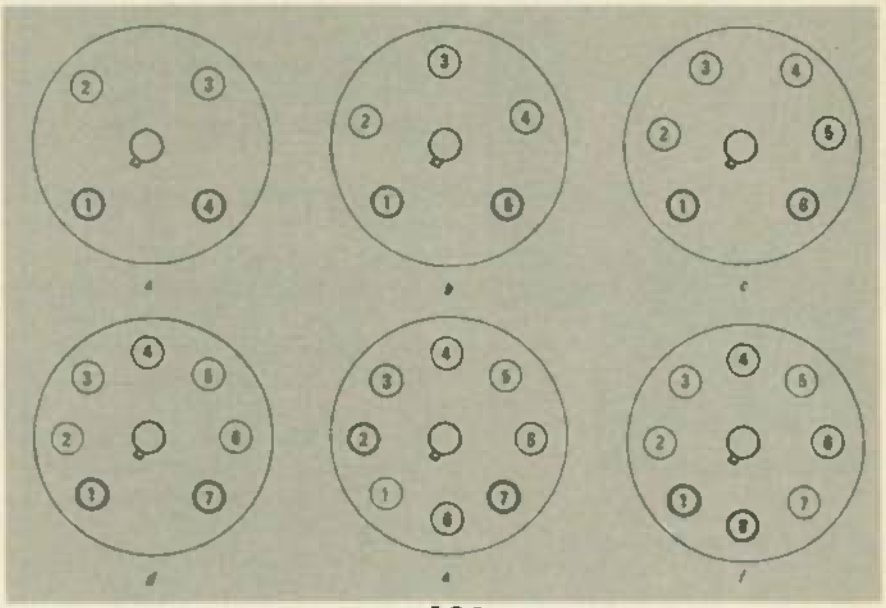

FIG. 2

the tubes are usable. Such a test can tell you if the tube should be discarded, but not necessarily if it is good, and certainly not whether it's weak.

Checking the continuity of old radio tubes can be done with an ohmmeter or simple continuity tester. Before you start removing the tubes, however, check to see if there is a tube-placement diagram either inside the cabinet or beneath it. A diagram can at least cut down on the problems that you are likely to encounter. If no placement diagram is found, you can make your own as you remove the tubes.

A word of caution: Make sure that the set is turned off and unplugged before removing any chassis component (the reason for that is obvious). Test all or as many components as you can with your ohmmeter or continuity tester. Figure 2 shows some of the most popular vacuum-tube pin configurations. The pins shown in bold are the filament pins.

Using your ohmmeter, check for continuity of the tube filament. If there is continuity between the two filament pins, that portion of the tube is probably OK. Then check to see that there is infinite resistance (no continuity) between the other pins (elements). If continuity exists between two tube elements, or between a filament and an element, the tube is shorted, therefore it should be discarded. A shorted tube can knock out several other components.

There are, of course, components other than tubes in an old radio. Most of those, such as resistors, capacitors, and transformers, you are familiar with—they function just like their modern day counterparts. Their appearance, though, may be slightly different.

One of those differences in appearence should be noted here. Modern resistors use the banded color-coding scheme that we are all familiar with. Older units do not use banding, but they do make use of the same coding scheme. On those older units, the main body-color represents the first digit, the color of the tip of the resistor is the second digit, and the multiplier is signified by the color of a dot or band at the middle of the unit.

Also, the leads on older tubular electrolytic capacitors used a color-code, of sorts. In those, the black lead was usually negative, while the colored lead was positive.

Beginning in the early 1930's, some manufacturers have followed a standardized wiring color code. If applicable, that information might be found on the parts-location diagram. Be aware, however, that colors fade with time, and any repairs in the intervening years may have lead to different-color wiring being used. Thus, the knowing the wiring color code used in your set is likely not to be a great help, and it could be a hindrance (due to fading, those "tan" or "brown" wires may very well have started out being wires of a quite different color).

Troubleshooting the audio

Dust, corrosion, dampness, and time take their toll on old radios, and any one of those factors can cause your radio to fail to operate satisfactorily.

Operational antique radios have a wonderful tone that's quite unlike that of any of today's sets. If the volume in your set is OK, but the sound is horrible, all is not lost; it is often possible to restore your radio's good sound quality.

Hum is probably the most common problem found in the audio of old radios. It is most often caused by age and non-use. While an audible hum is present in all old sets, it should not be loud enough to be heard when the set is tuned to a station. An audible hum doesn't necessarily mean that there's a serious problem.

Scratchy sounds, during tuning, can almost always be traced to the plates of the tuning capacitor. The wafer-thin plates should mesh, but never touch. Dust can build up between the plates and cause distortion. Clean between the plates with a brush or vacuum cleaner.

Bent plates or foreign objects between the plates (paper clips, coins, etc.) are common problems in old radios that have been lying idle for many years. Corrosion on the trimmers can cause distortion or off-frequency problems.

Distortion in superheterodyne radios can often be traced to the IF transformers. Corrosion or damaged mica in the trimmers can upset the frequency and send assorted noises through the loudspeaker. Make sure that the metal transformer-shielding is firmly attached to the chassis.

Sometimes you'll hear a crackling sound coming through the loudspeaker, which may be due to arcing in the IF. To find out if that's what is happening, just turn off the lights, "crank" up the set, and look down the little hole on top of the IF shield. If you see sparks, you've found the trouble.

All the parts in the speaker assembly play an important part in the quality of the sound produced by old radios, including the diameter of the speaker cone. Torn speaker cones—a common occurrence to old radios—can be repaired with speaker cement. Of course, you can use tape to temporarily patch the cone, but tape can dry out and peel off, or cause distortion.

An off-center voice coil can cause a scratching noise whether the set is being turned on or off. The coil can be checked by lightly pressing the cone to see if its movement is smooth. If not, the speaker is probably damaged. That may have been caused by warping due to dampness, or by the speaker being dropped. On some early sets, the "spider" (the flat, springy object that holds the apex of the speaker's cone) can be adjusted to compensate for poor-quality sound. If there are no adjustments possible, then the speaker must be replaced. R-E

SERVICE CLINIC

JACK DARR

Testing capacitors

HOW MANY TIMES HAVE YOU WISHED that you had a good capacitor tester, but talked yourself out of buying one, figuring that it isn't needed often enough to justify the expense? Well, the fact is, if you have a scope on your workbench, you *have* the best capacitor checker there is at your disposal!

A scope, like the one in Fig. 1, can instantly tell you whether any capacitor in the set that you are working on is doing its job. And it doesn't matter whether the unit is a 4000µF electrolytic or a teeny-weeny ceramic capacitor.

FIG. 1

How, you may ask, do you use a scope to test capacitors? Easy! With the scope's vertical gain-control set for greatest sensitivity, touch the probe tip to the hot terminal of the capacitor and observe the scope trace. Most of the time you can use the standard low-capacitance probe to do that test, though there are times when a demodulator probe can be used to good advantage.

Checking capacitors

To test capacitors using a scope, you must first know what job the unit was put in the circuit to do. In TV sets, generally speaking, capacitors fall into three basic groupings—bypass, coupling, and filter.

Bypass capacitors are used to filter out the AC component of a signal. Such capacitors are always grounded at one end. But, what about filters?—they too are grounded at one end. Well, you might say that a filter capacitor is nothing more than an over-sized bypass capacitor. Filter capacitors are used to remove the hum and RF from a circuit by passing those signals to ground.

Coupling (or blocking) capacitors are usually found in circuits where both AC and DC voltages are present, or where some component of the input signal must kept from the following stage. A good example of where a coupling capacitor might be used is in multistage amplifiers. In such applications, the capacitor is placed between the individual stages to block DC or some other undesirable component of the signal voltage, while passing only the AC or desired signal.

One thing to keep in mind is that no matter what the capacitor's function, you'll be looking for the absence or presence of a signal. If the capacitor is a bypass, for example, there should be no AC signal on the hot lead (the end connected to positive). If you see anything at the positve terminal other than a nice straight line, you've found a problem. On the other hand, if the unit is used as a coupler, there should be signals at both ends of the capacitor.

An undesired signal on the hot end of a bypass means that the unit is open. If you see any signal, bridge the old capacitor with another known to be good, and watch the scope to see if the signal disappears. If it does, the test is conclusive; the bypass is open.

Defective bypass capacitors can cause such problems as feedback, oscillation, streaks and wriggles on the screen, and many others too numerous to mention. And since (as we've already said) a filter is just a big bypass capacitor, the same testing method can be used to catch problems that we often fail to associate with filter capacitors. Unlike bypasses, however, filters usually do pass some ripple voltage; the amount of that ripple is usually shown on the schematic and is almost never more than 1.5-volts P-P.

Filter capacitors do a lot of the RF bypassing in the B+ return circuit. If the capacitor develops a high power-factor, it ceases to be a good RF bypass. Such problems do not always show up when using a standard capacitor tester to check the component, unless your tester has a power-factor test. However, a scope catches it every time—just look for signals (RF, IF, or even audio) on the hot end of the component.

Such signals can cause a feedback loop, which then leads to a myriad of different problems, like those mentioned. A high-power factor means that the AC series resistance of the capacitor has gone up, and that is where the problems come in. Now, instead of shunting (passing to ground) the undesired signal, the signal is blocked from ground by the increased resistance. However, if there is no perceptible signal on the hot side of the capacitor, even at the highest gain level of your scope, the capacitor is OK.

There will be times when the problem is not really in the capacitor itself. For example, some time ago, I worked on a set in which the IF was oscillating. I checked the screen bypass capacitor on the second IF, and found signals on the screen grid. Figuring that that was the problem, I replaced the 0.05µF screen bypass capacitor. But after putting in the new unit, there still was oscillation.

My next thought was that it must be a bad ground connection. (The ground lead of the original bypass went all the way around the socket, to a solder lug on the other side.) While poking around with a small screwdriver, the oscillation stopped. I had accidentally grounded the lead of the capacitor right at the end of the case.

The long ground lead evidently had enough inductance at 45 MHz to cause the oscillation. Grounding it right at the end of the case did the "trick." The original capacitor was perfectly good. The only thing I couldn't figure out was how the set had worked fine for so long (it was by no means new).

So, remember: The next time you get a TV set with mysterious wriggles or beats in the picture, reach for your scope. It's a great time saver, so use it! R-E

SERVICE QUESTIONS

REPLACEMENT NOT AVAILABLE

In one of your "Service Clinic" articles, it was mentioned that subbing a V.S. 23JS6 replacement tube for a Toshiba brand is not advisable in sets that use 280 volts on the cathode. But since I couldn't get a Toshiba tube, I put in a V.S. replacement anyway. However, it blew out within three months. Any ideas?—M.G., Maywood, NJ

My thought is to remove the filament connections to 23JS6 tube, and in place of those connections, put a 40-ohm, 15-watt resistor (so much for keeping the series-filament string intact). Then replace the 23JS6 tube with a 6JS6, heated from a separate 6.3-volt AC, filament transformer. The cathode will have less tendency to break down with no ground return.

SHADED RASTER

The Sears set that I've been working on has a black bar running down the left side of the screen. I've tried replacing the blanking diode, but that hasn't helped. Adjusting the brightness and contrast controls, moves the bar. I'm sending you my voltage readings to look over; hopefully you can see something that I've missed.—R.G., Quebec, Canada

The voltages that stick out like a sore thumb are those at the collectors of the three color outputs—they're too low! Capacitor C251 (a 200-volt filter), if open, will lower the 200-volt supply and also cause a shaded raster (which is what I think you have).

Now as to your question about replacing the blanking diodes: Whenever working around the horizontal frequency, it's important to use fast-acting diodes, such as the GE511. R-E

PEST REPELLERS

continued from page 62

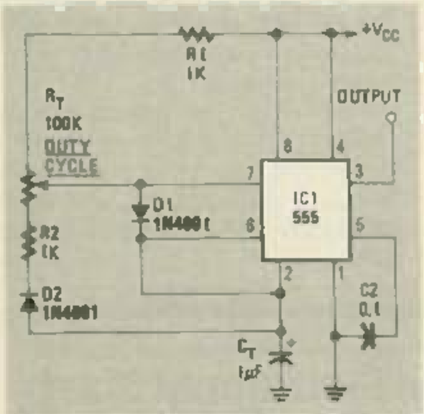

FIG. 4—IF YOU WISH TO VARY the duty cycle while keeping the frequency constant, replace the timing resistors with a single potentiometer.

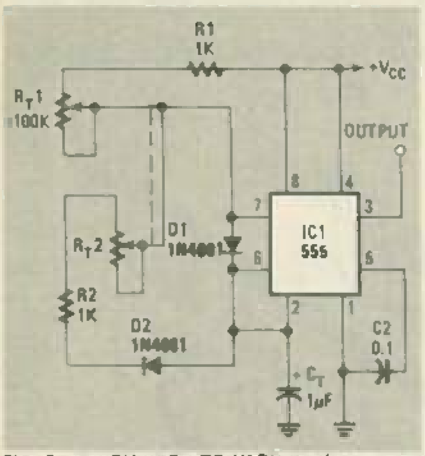

FIG. 5—IF YOU WISH TO VARY the frequency, but keep the duty constant, at about 50%, the 555 circuit can be modified as shown.

equal at all times.

Returning to our basic circuit, the power amplifier, IC3, may be any convenient type with response reaching into the ultrasonic region. You might consider using a low-power IC amplifier such as the Sprague ULN3705 or 3784B, or the National LM380, LM383, or LM384.

The output transducer may be an inexpensive tweeter. Piezoelectric types should be given special preference. You'll find several approriate transducers listed in the catalogs put out by many of the mail-order firms advertisitg on the back pages of this magazine.

When experimenting with ultrasonic frequencies, be aware that if the frequency is too close to the audible range, the signal may be annoying, and possibly painful, to house pets and some people—particularly girls and young women. Due to the nature of ultrasonics, those effected may not be aware of the source of this discomfort. So, be alert to the condition of those around you when you are experimenting. R-E

TACH/DWELL METER

continued from page 57

Finally, the three input leads may be installed. Ideally, they should be color-coded, to aid in their identification. Use a red lead for the connection to +12 volts and use a black lead for the connection to ground. Use a white lead for the signal input from the points.

Because you are probably going to be using the meter in a rough environment, be careful with your construction practices. For example, use strain reliefs for the power and signal-input wires, and mount the switches in easy-to-get-at locations. After you calibrate the instrument, use a dab of fingernail polish to hold the potentiometer in place.

Calibration and operation

To calibrate the meter, a squarewave generator with an output of at least 10 volts peak-to-peak is needed. It should be set to 100 Hz and the signal fed to the input of the meter. The meter should be set at the eight cylinder, high-tach (rpm x 100) range. Adjust R9 until a readout of 1500 is obtained. Check the settings of the other cylinder settings. The six-cylinder setting should produce a reading of 2000, and the four-cylinder setting should produce a reading of 3000 rpm.

To check the low-tach range (rpm x 10) set the generator to 30 Hz. The readings should now be: 450, 600, and 900 for the eight-, six-, and four-cylinder settings, respectively. No calibration of the Dwell function is necessary.

You're now ready to use your meter the next time you want to tune up your car. Consult the owner's manual or shop manual for your car (or the information sticker under the hood) for the specifications for your car and the proper way to adjust the points and engine rpm. Then just connect the red lead to the positive battery terminal, the black lead to ground, and the input lead to the output of the breaker points (or, where applicable, the output of the electronic ignition system). R-E

"Brilliant, Master but is it a marketable application of VLSI technology?"

HITECH IBM PC/XT

continued from page 46

The system we'll describe uses several multi-function adapter cards. That will allow us to leave open 5 of the 8 expansion slots. From a standpoint of comparison, the IBM PC XT without the addition of any monitor or display adapter card(s) already has 3 of the available 8 slots in use. The addition of the color graphics and monochrome display adapter cards will increase the load to an additional 2 slots leaving only 3 available slots for any accessories and expansions you might have in mind. The suggested parts listing and cost for the system is described in Table 5.

Note that our computer uses a parallel printer port rather than the RS-232C port present on the IBM PC XT. That doesn't mean that *you* have to. We made that choice because we already had a parallel printer on hand, and because we were using a plug-in modem card. But the combination floppy-disk controller/printer-port board is available in either configuration. One of the advantages of putting your own computer together is that you can control the selection and actual configuration of options for it.

Figure 3 shows the basic internal arrangement of the case. The case is of all metal construction with the needed brackets for mounting the drive(s) welded into position. The areas reserved for both the floppy drive(s) and the hard disk drive are supplied with pop-out plastic panel covers (front) which will be removed as the respective drives are installed

The first phase of construction will deal with the motherboard as shown in Fig. 4. During these steps we will:

- Configure DIP Switch SW1
- Locate and install the ROM
- Locate the power input connector
- Locate the RAM area and expand to 256K if desired.
- Locate power connector JP1

Position the board on your work surface with the expansion slots facing up and to your left. We will be setting configuration DIP Switch located near U20 on the PC board. Because of the possible variations in physical appearance of this switch, refer to Fig. 5 for guidance as to switch positions and settings. Your switch may or may not have the ON position marked. If it does not, ON will be in the position of the arrow. A ball-point pen might be useful in setting this switch.

We'll tell you how to assemble and configure your computer next time. But before we go, let's mention that the parts listed in Table 5 can be obtained from: HiTech International, Dept. RE, 1180 Miraloma Way, Suite M, Sunnyvale, CA 94086. (408) 738-0601. R-E

MARKET CENTER

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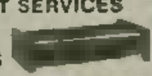

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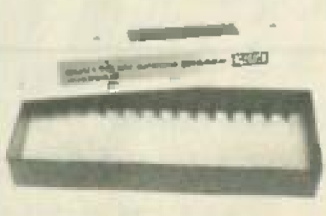

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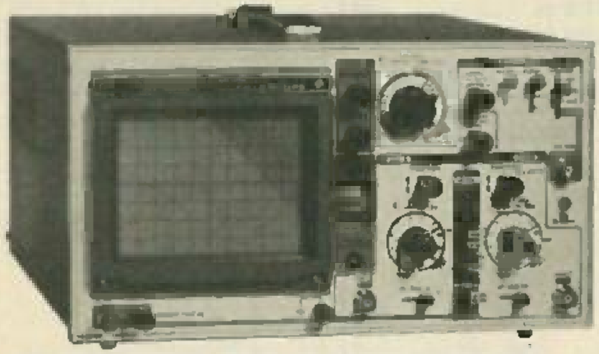

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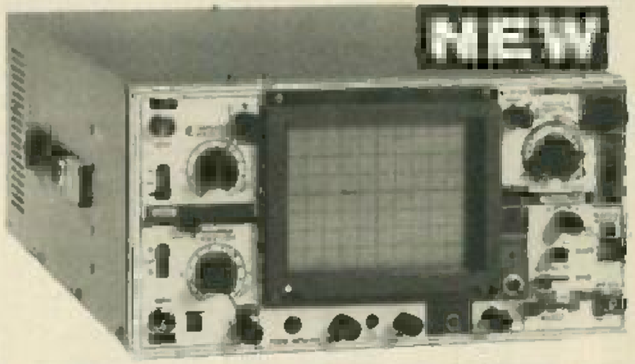

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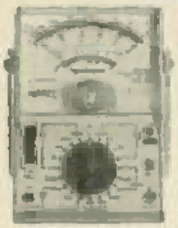

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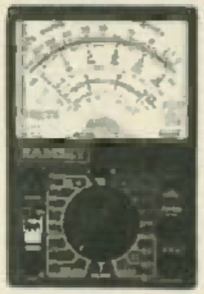

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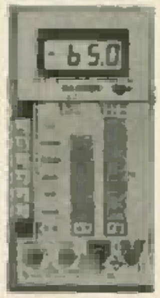

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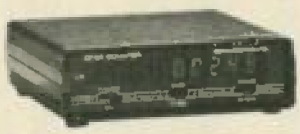

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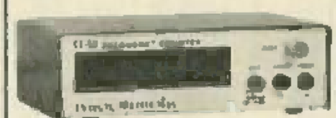

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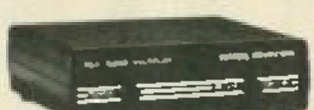

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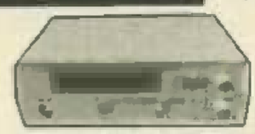

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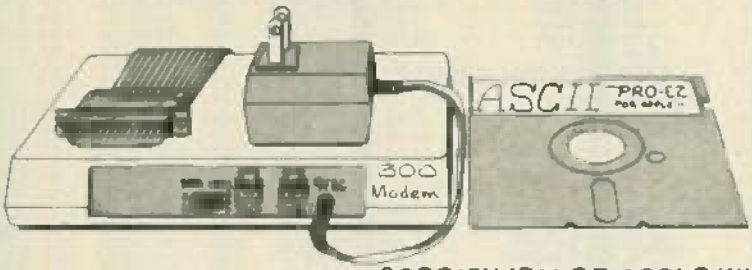

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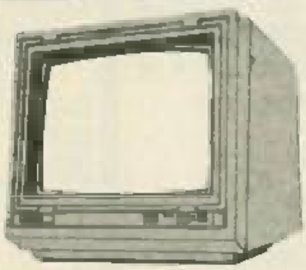

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74LS02	.25	74LS160	.69
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74LS76	.39	74LS259	2.75
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74LS136	.39	74LS377	1.39
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7400

7400	.19	7492	.50
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7402	.19	74100	1.75
7403	.19	74107	.30
7404	.19	74116	1.55
7405	.25	74121	.29
7406	.29	74122	.45
7407	.29	74123	.49
7408	.24	74125	.45
7409	.19	74126	.45
7410	.19	74132	.45
7411	.25	74145	.60
7413	.35	74148	1.20
7414	.49	74150	1.35
7416	.25	74151	.55
7417	.25	74153	.55
7420	.19	74154	1.25
7421	.35	74155	.75
7425	.29	74157	.65
7427	.29	74159	1.65
7430	.19	74161	.69
7432	.29	74163	.69
7437	.29	74164	.85
7438	.29	74165	.85
7442	.49	74166	1.00
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7475	.45	74193	.79
7476	.35	74194	.85
7483	.50	74259	2.25
7485	.59	74367	.65
7489	2.15	74368	.65
7490	.35	74393	1.35

74S00

74S00	.32
74S02	.35
74S04	.35
74S05	.35
74S08	.35
74S10	.35
74S11	.35
74S20	.35
74S32	.40
74S37	.88
74S74	.50
74S86	.50
74S112	.50
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PS-ASTEC	PS-3
MODEL AA 12110	ASTEC AA11190
+12V @ 2A	+5V @ 4A
-12V @ .1A	+12V @ 2.5A
+5V @ 2.5A or 5A if 12V not used	-5V @ .25A
	-12V @ .30A
19.95	39.95

IC SOCKETS

	1-99	100
8 pin ST	.13	.11
14 pin ST	.15	.12
16 pin ST	.17	.13
18 pin ST	.20	.18
20 pin ST	.29	.27
22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39
64 pin ST	4.25	call

ST=SOLDERTAIL

8 pin WW	.59	.49
14 pin WW	.69	.52
16 pin WW	.69	.58
18 pin WW	.99	.90
20 pin WW	1.09	.98
22 pin WW	1.39	1.28
24 pin WW	1.49	1.35
28 pin WW	1.69	1.49
40 pin WW	1.99	1.80

WW=WIREWRAP

16 pin ZIF	4.95	call
24 pin ZIF	5.95	call
28 pin ZIF	6.95	call

ZIF=TEXTOOL
(Zero Insertion Force)

DISKETTE FILE

$8.95 IF PURCHASED WITH 50 DISKETTES OR MORE
$9.95 if purchased alone

- SMOKED ACRYLIC CASE WITH SIX INDEXED DIVIDERS
- RUGGED, HIGH QUALITY CONSTRUCTION
- HOLDS 70 5¼" DISKETTES, WITH ROOM TO SPARE

NASHUA DISKETTES 5¼" SOFT SECTOR

DOUBLE SIDED, DOUBLE DENSITY WITH HUB RINGS

BULK PACKAGED IN FACTORY SEALED BAGS OF 50. INCLUDES DISKETTE SLEEVES AND WRITE PROTECT TABS. IDEAL FOR SCHOOLS, CLUBS, AND USERS GROUPS. THIS IS A SPECIAL PURCHASE. SO QUANTITIES ARE LIMITED. 5 YEAR WARRANTY.

$1.39 ea.	$1.49 ea.	$1.59 ea.
QTY 250	QTY 100	QTY 50

5¼" DISK DRIVES

TANDON TM100-2	DS/DD	159.95
SHUGART SA400L	SS/DD	199.95
MPI B52	DS/DD	109.95
TEAC FD55B ½ Ht.	DS/DD	129.95
TEAC FD55F ½ Ht.	DS/Quad	139.95

8" DISK DRIVES

SIEMENS FD200-8	DS/DD	180.00
SIEMENS FD100-8	SS/DD	129.00

BEST SELLING IDC CONN.

RIBBON HEADER SOCKETS

IDS 20	2.25	IDS 40	1.99
IDS 26	1.39	IDS 50	2.25
IDS 34	1.59		

RIBBON EDGE CARDS

IDE 20	2.25	IDE 40	3.80
IDE 26	2.65	IDE 50	3.95
IDE 34	2.75		

LIGHT EMITTING DIODES

JUMBO	1-99	100-up	DISPLAYS		
RED	.10	.09	MAN-72	CA .3"	.99
GREEN	.18	.15	MAN-74	CC .3"	.99
YELLOW	.18	.15	FND-500	CC .5"	1.49
			FND-507	CA .5"	1.49

D-SUBMINIATURE

DESCRIPTION		ORDER BY	CONTACTS 9	15	25	37
SOLDER CUPS	MALE	DBxxP	1.19	1.59	1.90	2.85
	FEMALE	DBxxS	1.50	1.85	2.25	3.90
RT. ANGLE PC SOLDER	MALE	DBxxPR	1.65	2.20	3.00	4.83
	FEMALE	DBxxSR	2.18	3.03	3.00	6.19
IDC RIBBON CABLE	MALE	IDBxxP	2.95	3.90	4.75	6.95
	FEMALE	IDBxxS	3.25	4.29	5.25	7.95
HOODS	BLACK	HOOD-B	---	---	.99	---
	GREY	HOODxx	.89	.99	.99	1.09

MOUNTING HARDWARE-$1.00
ORDERING INSTRUCTIONS: INSERT # OF PINS INTO "xx"

9000

9334	2.50
9368	3.95
9602	1.50

INTERSIL

ICL7107	12.95
ICL7660	2.95
ICL8038	3.95

DIP SWITCHES

4 position	.85
6 position	.90
7 position	.95
8 position	.95

TRANSISTORS

2N2222	.25	PN2907	.13
PN2222	.10	2N3055	.79
2N2905	.50	2N3904	.10
2N2907	.25	2N3906	.10

DISCRETE

1N751	5.1v zener	.25
1N759	12.0v zener	.25
1N4148	(1N914) switching	25/1.00
1N4004	400PIV rectifier	10/1.00
KBP02	200PIV 1.5a bridge	.45
4N33	OPTO-ISOLATOR	1.75

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
25	.45	4.00	1.32	11.80
34	.61	5.40	1.65	14.50
50	.89	7.50	2.50	22.00

36 PIN CENTRONICS

CEN36 MALE SOLDER CUP	7.95
IDCEN36 MALE RIBBON CABLE	6.95
IDCEN36F FEMALE RIBBON CABLE	8.95

VOLTAGE REGULATORS

7805T	.75	7915T	.85
78M05C	.35	7805K	1.39
7808T	.75	78H05K	9.95
7812T	.75	7812K	1.39
7815T	.75	7912K	1.49
7824T	.85	78L05	.69
7905T	.85	79L05	.79
7912T	.85	79L12	.79

C, T=TO-220, K=TO-3, L=TO-92

CMOS

4001	.25	4027	.48	4066	.39	4538	1.95
4002	.25	4028	.69	4069	.29	4543	1.19
4011	.25	4029	.79	4070	.35	4553	5.79
4012	.25	4040	.75	4071	.29	4584	.75
4013	.38	4042	.69	4081	.29	74C00	.35
4015	.39	4046	.85	4082	.29	74C04	.35
4016	.39	4047	.95	4093	.49	74C14	.59
4017	.69	4049	.35	4503	.65	74C74	.65
4018	.79	4050	.35	4511	.85	74C906	.95
4020	.75	4051	.79	4518	.89	74C922	4.49
4023	.29	4053	.79	4520	.79	74C923	4.95
4024	.65	4060	.89	4528	1.19	74C926	7.95

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CIRCLE 113 ON FREE INFORMATION CARD

CIRCLE 75 ON FREE INFORMATION CARD

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