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*Information Radio for Real Life Adventure*



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## HANDS-ON REPORTS

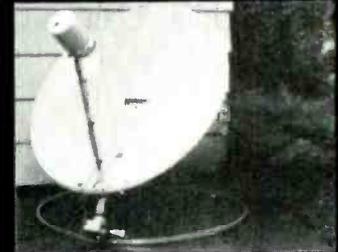
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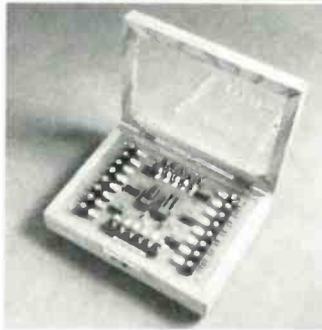
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# Hands-on Electronics®

The Magazine for the Electronics Activist!

## The winner is....

...Walter W. Schopp of Livermore, California for his construction article "Digi-lyzer IC Tester" that appeared in the August, 1987 issue of **Hands-on Electronics**. The Digi-lyzer offers rapid IC checking of most logic-type IC's available to the experimenter.



Schopp's Digi-lyzer

For those of you who do not recall, I ran a contest for the best article published in this magazine in 1987. The prize is an IBM compatible computer, which we have shipped to the winner and he is probably *playing* with it now.

## Lets do it again....

...and offer another computer. Why a computer? You have seen the advertisements, especially those on television, that say that report writing for school and office is simpler and has improved the potential of the individual using a computer. This is also true for the professional and amateur writer. Word processing programs, spelling checkers, thesaurus, and other writing aids such as simple desk-top publishing programs are must items for writers today.

## So get busy....

...and start producing those exciting manuscripts about features and projects that are related to our exciting hobby. The topics come easy. For example, there are topics on shortwave listening, project building, scientific developments, amateur radio, computers and software, scanners, television, satellites, odd-ball semiconductors....I could go on and on. But, if I do, and go beyond this editorial page, I'll be entering the contest.

## Start writing today....

...and maybe I'll be announcing your name next year in the February issue. You can make it so if you begin today!

Julian S. Martin, KA2GUN  
Editor

# STAFF

Volume 5, No. 2  
February 1988

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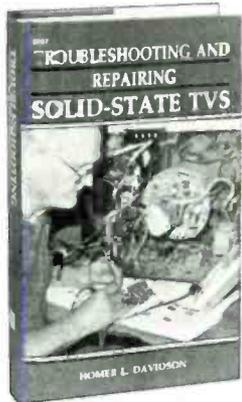
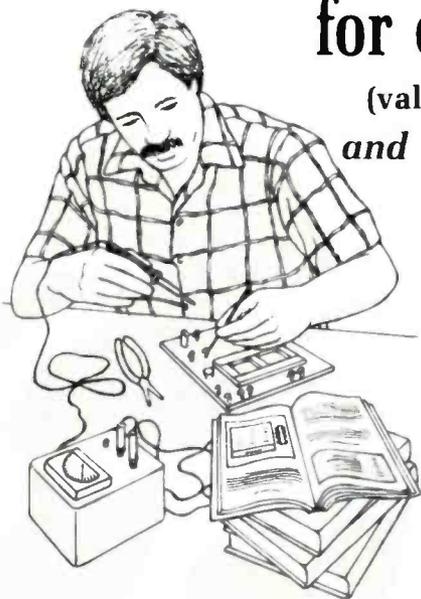
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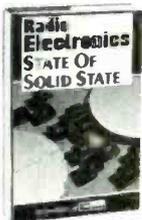
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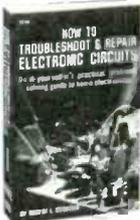
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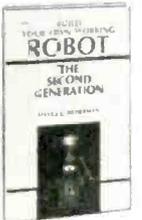
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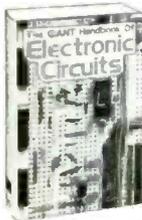
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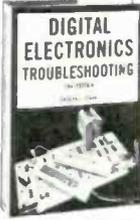
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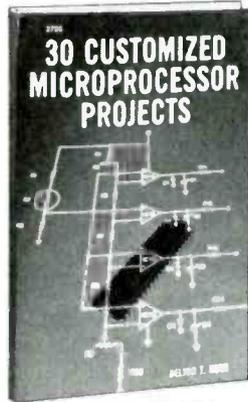
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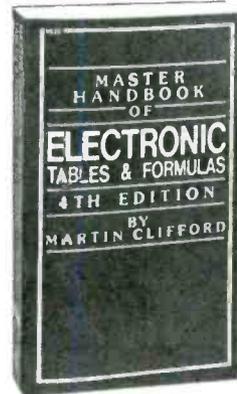
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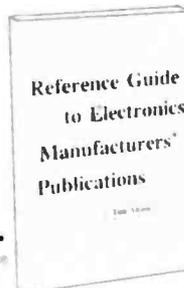
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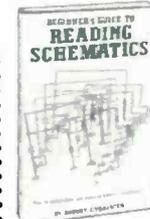
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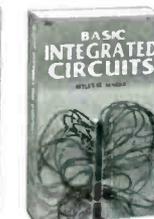
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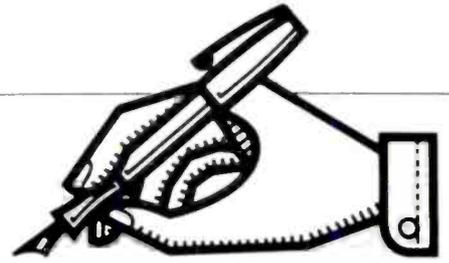
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# LETTER BOX



**Hands-on Electronics, 500B Bi-County Boulevard, Farmingdale, New York 11735**

## No Critic Here

I subscribe to a number magazines, ranging from Consumer Reports to Science (the journal of the American Academy for the Advancement of Science). Frankly, **Hands-on Electronics** is turning out to be one of the ones I most enjoy receiving. I just got the November issue and for some reason decided to write and say, "You people are doing a great job." Beautiful and extremely useful magazine, more like an investment than a subscription.

—R.A., Otter Rock, OR

*Thanks for the kind words of praise. There is something wrong with your letter, though: it's all praise. We at Hands-on Electronics want complaints too.*

*We are in a wonderful situation here; we get to distribute information on our hobby. Almost all of us here are hobbyists just like you, and we want to produce a magazine that we would spend our own hard-earned bucks for. Many readers like yourself tell us we do just that, but complain a little more and maybe we can out-do ourselves!*

## Idle Hands

I was wondering if you had some kind of project that I could build with my hands like the one the man is doing in the enclosed picture. I need that kind of training, not just a book. Books do help, but I need some projects too. If you can help me with this it would help me more in the field of electronics.

—D.B., Los Angeles, CA

*The photo you sent us was from one of our advertisements. You know how to write us so why are you holding out? Subscribe. Look at this issue, it's loaded with projects; nuff said.*

## Picture Perfect

In the November issue, concerning the article on the Flashmate, the miniature output transformer has one lead that is not connected. Not the NC lead but the one below it. Where does it go to? Further, doesn't the polarity of the transformer matter? I found the unit will

work if the green lead is connected to the collector of Q1 and the white lead to ground.

The ASA setting for some of the the switch positions are also wrong. The positions for R8–R13 should correspond to ASA settings of 64, 100, 125, 200, 400, and 800, respectively. According to the Parts List, the values of R12–R14 should be 10K, 5K, and 5K, respectively. Also, the value of R6 (27K) is not given on the schematic diagram.

Shouldn't the power switch (mistakenly labeled S1 and not S2) be between the battery (drawn as a capacitor) and the rest of the circuit?

I made all the above changes in the circuit and got it to work fine, so I think the answer to all my questions is "yes." Thanks for giving me a project to cover both my hobbies.

—S.S., Idleburg, PA

*You're more than welcome, and you are correct in all you say. Just so our other readers know what we're talking about, here's a revised schematic with all the corrections. Thanks for the help.*

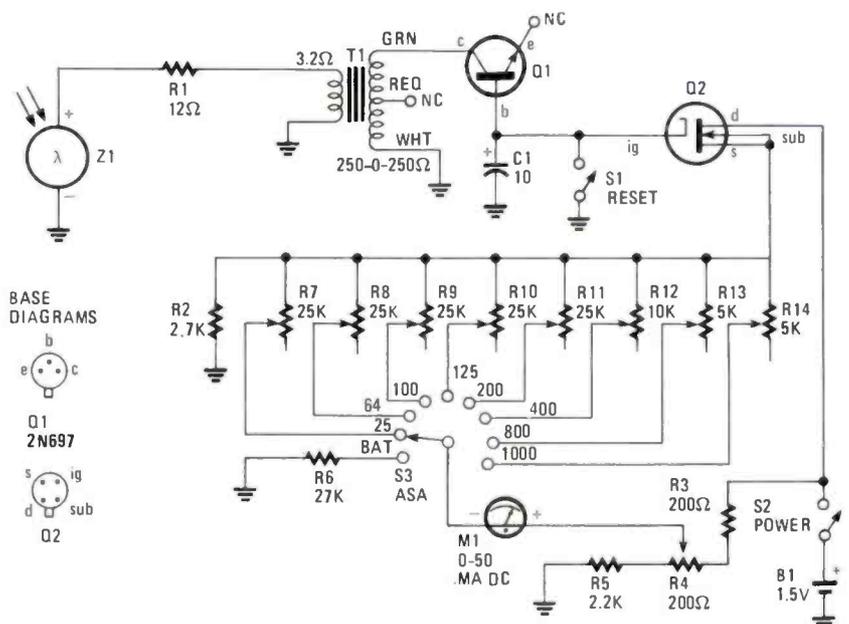
## Washed Out

I own and operate a self-service carwash, out of which I get much enjoyment. A few months ago, after my dollar bill changer was broken into, I decided that it was time for a steel plate over the changer and a burglar alarm to boot. Looking through some of your older magazines, I decided on the Dick-Smith alarm (featured on pages 62–65, of the January/February, 1986 issue).

I purchased the kit from Dick-Smith and built a 12-Volt DC power supply from Radio Shack parts. It worked great on the bench! After all of the guts were mounted in a box and the installation complete inside the pump house it doesn't work properly. I have tried several basic fixes, but being the novice that I am, I still can't get my act together.

When the unit is switched on it triggers itself 50% of the time. Dick-Smith recommends that a 33μF or 47μF capacitor be soldered across the supply rail of the 555 timer to prevent this, well—it helped some, but not completely.

Another problem (or maybe part of the first problem) is that fluorescent light



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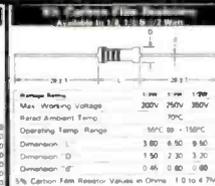
Part No.	Description	Price
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7402	74LS02	1.10
7403	74LS03	1.10
7404	74LS04	1.10
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4096	4096 CMOS	1.10
4097	4097 CMOS	1.10
4098	4098 CMOS	1.10
4099	4099 CMOS	1.10
4100	4100 CMOS	1.10

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Part No.	Description	Price
100	100 T1 I.C. Socket	1.10
101	101 T1 I.C. Socket	1.10
102	102 T1 I.C. Socket	1.10
103	103 T1 I.C. Socket	1.10
104	104 T1 I.C. Socket	1.10
105	105 T1 I.C. Socket	1.10
106	106 T1 I.C. Socket	1.10
107	107 T1 I.C. Socket	1.10
108	108 T1 I.C. Socket	1.10
109	109 T1 I.C. Socket	1.10
110	110 T1 I.C. Socket	1.10
111	111 T1 I.C. Socket	1.10
112	112 T1 I.C. Socket	1.10
113	113 T1 I.C. Socket	1.10
114	114 T1 I.C. Socket	1.10
115	115 T1 I.C. Socket	1.10
116	116 T1 I.C. Socket	1.10
117	117 T1 I.C. Socket	1.10
118	118 T1 I.C. Socket	1.10
119	119 T1 I.C. Socket	1.10
120	120 T1 I.C. Socket	1.10
121	121 T1 I.C. Socket	1.10
122	122 T1 I.C. Socket	1.10
123	123 T1 I.C. Socket	1.10
124	124 T1 I.C. Socket	1.10
125	125 T1 I.C. Socket	1.10
126	126 T1 I.C. Socket	1.10
127	127 T1 I.C. Socket	1.10
128	128 T1 I.C. Socket	1.10
129	129 T1 I.C. Socket	1.10
130	130 T1 I.C. Socket	1.10
131	131 T1 I.C. Socket	1.10
132	132 T1 I.C. Socket	1.10
133	133 T1 I.C. Socket	1.10
134	134 T1 I.C. Socket	1.10
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136	136 T1 I.C. Socket	1.10
137	137 T1 I.C. Socket	1.10
138	138 T1 I.C. Socket	1.10
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140	140 T1 I.C. Socket	1.10
141	141 T1 I.C. Socket	1.10
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143	143 T1 I.C. Socket	1.10
144	144 T1 I.C. Socket	1.10
145	145 T1 I.C. Socket	1.10
146	146 T1 I.C. Socket	1.10
147	147 T1 I.C. Socket	1.10
148	148 T1 I.C. Socket	1.10
149	149 T1 I.C. Socket	1.10
150	150 T1 I.C. Socket	1.10



### DISC CAPACITORS

Part No.	Cap.	Volts	Price
100	100 pF	50V	0.05
101	100 pF	100V	0.05
102	100 pF	200V	0.05
103	100 pF	300V	0.05
104	100 pF	400V	0.05
105	100 pF	500V	0.05
106	100 pF	600V	0.05
107	100 pF	700V	0.05
108	100 pF	800V	0.05
109	100 pF	900V	0.05
110	100 pF	1000V	0.05
111	100 pF	1100V	0.05
112	100 pF	1200V	0.05
113	100 pF	1300V	0.05
114	100 pF	1400V	0.05
115	100 pF	1500V	0.05
116	100 pF	1600V	0.05
117	100 pF	1700V	0.05
118	100 pF	1800V	0.05
119	100 pF	1900V	0.05
120	100 pF	2000V	0.05
121	100 pF	2100V	0.05
122	100 pF	2200V	0.05
123	100 pF	2300V	0.05
124	100 pF	2400V	0.05
125	100 pF	2500V	0.05
126	100 pF	2600V	0.05
127	100 pF	2700V	0.05
128	100 pF	2800V	0.05
129	100 pF	2900V	0.05
130	100 pF	3000V	0.05
131	100 pF	3100V	0.05
132	100 pF	3200V	0.05
133	100 pF	3300V	0.05
134	100 pF	3400V	0.05
135	100 pF	3500V	0.05
136	100 pF	3600V	0.05
137	100 pF	3700V	0.05
138	100 pF	3800V	0.05
139	100 pF	3900V	0.05
140	100 pF	4000V	0.05

### TANTALUM CAPACITORS

Part No.	Cap.	Volts	Price
100	100 pF	50V	0.05
101	100 pF	100V	0.05
102	100 pF	200V	0.05
103	100 pF	300V	0.05
104	100 pF	400V	0.05
105	100 pF	500V	0.05
106	100 pF	600V	0.05
107	100 pF	700V	0.05
108	100 pF	800V	0.05
109	100 pF	900V	0.05
110	100 pF	1000V	0.05
111	100 pF	1100V	0.05
112	100 pF	1200V	0.05
113	100 pF	1300V	0.05
114	100 pF	1400V	0.05
115	100 pF	1500V	0.05
116	100 pF	1600V	0.05
117	100 pF	1700V	0.05
118	100 pF	1800V	0.05
119	100 pF	1900V	0.05
120	100 pF	2000V	0.05
121	100 pF	2100V	0.05
122	100 pF	2200V	0.05
123	100 pF	2300V	0.05
124	100 pF	2400V	0.05
125	100 pF	2500V	0.05
126	100 pF		

operation, pump motors, and changer operation trigger the unit. Can you help me? I have spent much time wiring the bay money boxes, Coke machines, towel box, pump-house door, and bill changer. I used all magnetic reed switches. It's a beautiful installation; it just doesn't work!

—J.W., Ashland AL

*There are lots of things you could try. First, put the trigger circuit in a metal box to cut down the RF interference. Second, try using shielded cable to all your switches. Also, be sure your power supply has a large output capacitor across it (on the order of 1000- $\mu$ F), and that it is well regulated. Last but not least, try bringing the power supply voltage down to 9 volts. You may be providing too much current to the circuit making it unstable in it's new RF-filled environment.*

### Hooked

I have been reading your publication now since about 1982, and enjoying every issue. I have always just thrown any inserts out though, because they make the magazine open up to advertisements. In the September issue 1987, your subscription card just happened to be stuffed in page 21, which had an ad for McGraw-Hill NRI schools in which I am enrolled. The two connected and I can see I am a Hands-on hobbyist for life. Please accept my subscription—payment enclosed.

Some of my favorites are: New Products, Antique Radio, Gadgets, Understanding Decibels, Beginners Guide to Fiber Optics, and anything I can get on construction. Stay low on computer stuff—if one wants to hear and play with computers let them buy computer magazines of which there are a multitude.

I like the building of and understanding of what it is I make. Keep it simple and keep the Fact Cards (your best addition in years) coming!

—F.M., Cheiveres, Belgium

*Our magazine must really travel to get to you! We're happy to know it travels well. Don't worry about the computer stuff; we may print a software review, or an upgrade article here and there, but you'll never see "How to Build a Clone From the Gates Up."*

### Money Mercenary

The statement, "Modemize! Let no one else's work evade your eyes!" goes well in lending authority to a column. May I make a suggestion?

If you cite the origin: "to paraphrase Tom Lehrer," the phrase would be called to the attention of Lehrer fans. Since there are certainly a number of

electronics hobbyists among the Lehrer types, me included, there should be a number of new subscriptions resulting from their having your magazine called to their notice.

That should, of course, work for other contemporary quotes. Sounds mercenary, I know, but the more money you make, the better I'll get paid if I can sell you more articles, Ho, Ho!

—Lou Hinshaw, Tulsa OK

*Chortle, chortle! Very funny Mr. Hinshaw. On a more serious note, we like your work a lot and want more (which should please your wallet and our readers). Anyone else wanting to break into big-time publishing (without a crow bar), or just to share some ideas, is invited to send us their manuscript(s).*

### Flash in the Pan

In your September 1987 issue, there are several problems with the article about the Digital Capacitance Meter. Allow me to enumerate them.

First, the template, page 68, is not full-scale, as mentioned in the caption.



"Cough!"

That can be quite a problem, as blowing it up can cause distortion.

Second, the schematic shows pins 3, 4, 5 and 16 of ICs U10, U12, and U14 all connected together, while the template and the larger blue-line drawings do not include pins 4 and 5 of U14.

Third, in the first full paragraph on p. 66, the third sentence reads, "In other words, when R5 is 20 ohms, the count is the capacitance in microfarads." That should also be corrected to be, "In other words, when 5R is 20 ohms," etc.

Instead of using the FND-507 7-segment displays, I chose the more readily available Radio Shack model #276-1656. That particular display has the pins on the long sides, rather than across the top and bottom, as the template would suggest. So you would need to change the the template there.

As an aside, Q1, Q2, Q3 could also be

2N3906, also readily available at Radio Shack, as opposed to running all over trying to find others.

—D.N., San Diego, CA

*Thank you for the corrections.*

### Grounded in Fact

Just a comment on the article entitled Grandpa's Radio on page 31, in the October 1987 issue. It should be rather obvious that when arm of potentiometer R4 is moved to ground, the B+ supply point is directly connected to B- which might cause some interesting problems if a novice (inexperienced) built the project as presented.

—D.H., New London, CN

*By Jove, you're right. The grounded terminal on the potentiometer should be floating, or the device will sink.*

### Trigger Happy

The Flashmate article was of great interest to me. Have you ever printed an issue on how to make a photo strobe trigger? If so, what year and month?

This is my first issue and I like it a lot!  
—S. W., Columbus, OH

*As a matter of fact we did (which is ridiculous for me to point out because if we didn't, there would be no point in printing your letter). The Super Strobe from the March 1987 issue could be triggered by a variety of events, and the trigger circuits are included. If you prefer something more straightforward in operation, try modifying the Variable Strobe Light in the pages of the February 1987 issue.*

### Can't Find a VT

Years ago, if you can remember, vacuum tubes had VT numbers that made life easier. Today, I can't find a vacuum tube anywhere, or almost anywhere. For example: I need a dou-diode 6H6 to completely restore an RCA "Volt-ohmst" vacuum-tube voltmeter. I could use two silicon diodes (which I am doing for now), but that's not right. Where can I get a 6H6?

—G.Y., Charlestown, VA

*I know the frustration you face. When restoring a unit, you want to use either antique parts or an exact modern replacement. Yes, you can buy a 6H6 vacuum-tube from International Components Corporation, 105 Maxess Road, Melville, NY 11747; Tel. 800/645-9154 or 516/293-1500. Their minimum order is fifty dollars, so get a copy of their sales bulletin and gang up your orders. Maybe you can get some friend's orders together.*



# NEW PRODUCTS

## Radio Catalog

MFJ Enterprises, Inc., will send you free their latest 24-page Amateur Radio Catalog that has over a hundred products!

In it you'll find the most reliable and affordable antenna tuners, filters, keyers, packet radio controllers, computer interfaces, dummy loads, antenna switches, speaker wattmeters, noise bridges, antenna bridges, antenna current probes, tuning indicators, antennas, converters, amplifiers, preselectors, a microphone equalizer, code practice oscillators, frequency standard, clocks, Morse code tutor program, computer products, video products, power strips, RFI chokes and many other unique and useful accessories that are available only from MFJ.



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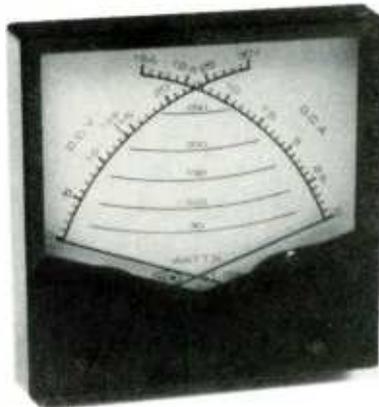
To get your free copy call toll-free 800/647-1800 or 601/323-5869 or write MFJ Enterprises, Inc., P.O. Box 494, Mississippi State, MS 39762.

## Volt/Amp/Watt Meters

Named the Model APM-70W Series of analog panel meters, they perform the functions of three separate meters. The APM-70W meters are capable of reading DC Volts, Amps, and Watts off of a single dial face. The meters are constructed with two separate meter movements within the same case thereby allowing continuous and independent readings of DC voltage and current.

Where the volt and ammeter needles intersect, DC power consumption can be read directly off the calibrated dial face, greatly simplifying the simultaneous monitoring of all power-load parameters.

Panel space requirements are minimized considerably by using only one meter in place of three. Meter size is 2 3/4-in. with a behind-the-panel depth of only 7/8-in. All three APM-70W models measure 0 to 30VDC. Current measuring



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ranges are 0-5 Amps DC, 0-15 Amps DC, and 0-30 Amps DC. The meters are rated for 80, 250, and 500 Watts.

The retail price for the APM-70W is \$29.30. For more information contact: DI Products, Inc., 95 E. Main St., Huntington, NY 11743.

## Technical Supplies

Contact East's latest catalog contains many new and innovative items for service engineers, manufacturing engineers, technicians, and electronic hobbyists. A full selection of test instruments, the latest in static and contamination protection, inspection aids, data and telecommunication equipment, electronic adhesives, soldering supplies. Contact East's line of tool kits and a section devoted to precision



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hand tools, are just some of the products featured in this issue

The wide selection of products is augmented with an easy ordering system, discounted pricing, and same-day shipment policy.

To receive your free, full-color copy, plus a complementary year's subscription, write to: Contact East, P.O. Box 786, North Andover, MA 01845; Tel. 617/682-2000.

## Audio/Video Preamp From dBx

The CX1 Audio/Video Preamplifier can control up to nine different audio and video sources including a television monitor-receiver, VCR, VDP, FM/AM tuner, CD player, two audio recorders, and turntables with MM and MC cartridges. Three variations of digitally-processed audio ambience, plus high-separation Pro Logic Dolby Surround Sound, are other major features.



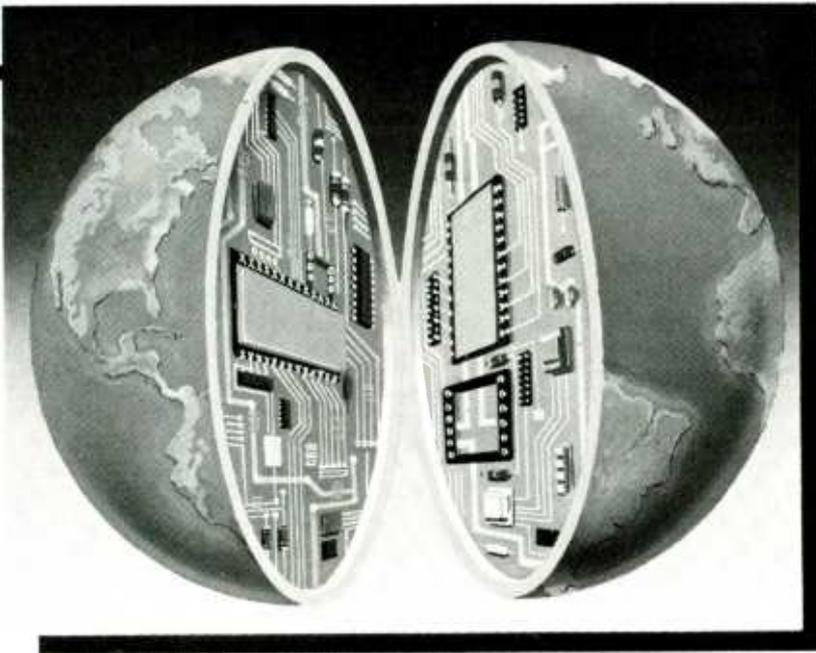
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A single knob selects any source for recording by any of the three possible recorders. That feature simplifies dubbing between two audio tape decks or two VCRs. Outputs are provided for a video monitor and also for front and rear audio channels.

The volume control consists of ganged, precision-stepped variable resistors that maintain less than 1 dB channel difference over the entire operating range. Sub-level controls permit separate adjustment of both center and rear channels.

The bass control can be switched to operate at either of two turnover frequencies, 120 and 300 Hz. The 120-Hz position, is also ideal for bringing up the low end of smaller loudspeakers. The 300-Hz position is useful for room equalization.

The CX1's treble control also offers a choice of two modes. The unique *tilt* mode, introduces a gentle upward or downward tilt to the entire frequency spectrum above 200 Hz. The downward tilt counteracts the overly bright sound of some CDs and speakers. A second treble control mode boosts or attenuates frequencies above 4 kHz.



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## NEW PRODUCTS SHOWCASE

A soundstage control allows the listener to blend the front stereo channels until mono is achieved. Turning the control the other way adds varying amounts of L-R and R-L difference signals to the front channels, increasing the apparent width of the stage.

The dBx CX1 preamp provides four different digitally processed surround sound modes; Dolby Surround with Pro Logic and three ambience modes, each individually engineered for the highest possible performance.

The CX1 audio-video preamplifier will be sold through the select network of dBx dealers at a suggested retail price of \$1,500. For more information contact dBx, at P.O. Box 100C, Newton, MA 02195.

### Second Skin Keyboard Protectors

The Second Skin is a highly flexible ultra-thin, transparent membrane that protects your keyboard from damage due to dirt, dust, liquids, and other environmental contaminants.



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Some of its features are: it won't interfere with keying ease or sensitivity; it eliminates downtime due to costly keyboard cleaning; the transparent plastic film allows clear visibility of all keyboard key markings; each model is manufactured to exactly match the contours of your specific keyboard; it resists abrasion, tearing, and cracking; self-adhesive areas for easy and quick attachment; 22 models available with more to be released soon; and custom tooling is available.

The suggested retail is \$24.95 and is available through the Tech-cessories network of dealers and distributors. For more information contact Tech-cessories, 3421 Helena Drive, Lake Worth, FL 33461; Tel. 305/439-0909.

### Mobile Security System

The PAS-250 offers protection with an ultrasonic sensor system that blankets the interior of a car with inaudible sound waves. If an intruder breaks into the car the force field is interrupted, immediately activating the PAS-250's 12-dB, very loud, electronic siren.

The PAS-250 incorporates several levels of protection. The system features ei-



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ther passive or active arming. Passive arming allows the driver to activate the security system automatically by shutting off the ignition; when the ignition is turned on again, the system automatically is deactivated. For the driver who prefers to arm the system manually, the PAS-250 also offers active arming.

Both models incorporate two types of sensors: shock and current. The shock sensor triggers the alarm when the car is physically jarred; the current sensor sets off the alarm when electrical devices in the car are activated (e.g. the dome light, glove box light or trunk light). Pin switches in the hood and trunk also trigger the alarm if either hatch is lifted when the system is armed.

Under active arming, the PAS-250 features starter/fuel pump lockout, which prevents engine start-up.

The system includes adjustable entry delay, which enables the driver to set the amount of time to enter the car before the alarm is activated. That can be set for anytime between one and 20 seconds. Exit delay (the time allowed to exit the vehicle after arming the alarm) is fixed at 30 seconds.

The PAS-250 features an LED status indicator which enables the driver to set the amount of time to enter the car before the alarm is activated. It can be set for anytime between one and 20 seconds. Exit delay, or the time allowed to exit the vehicle after arming the alarm, is fixed at 30 seconds.

The PAS-250 features an LED indicator which can be mounted on the dashboard or door. When the system is armed, the light blinks to let the driver—and any possible intruders—know the security system is activated.

The alarm cycle for both systems lasts 30 seconds, unless intrusion continues. If activated, the 120-dB electronic siren sounds and the parking lights flash. The security system is automatically rearmed after the alarm shuts off.

The PAS-250 includes complete wiring, harness and installation hardware and comes with a one-year warranty.

For more information on the product write to Pioneer Electronics Inc., P.O. Box 1720, Long Beach, CA 90901-1720.

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### Temperature Controller

An adjustable temperature controller for soldering irons, woodburning tools, and other devices with heating elements where variable temperatures are desired is available from Hot Tools, Inc.

The Hot Tool Dial-Temp Controller is compatible with any soldering iron, woodburning tool, or other device which uses a heating element from 15 to 1600 watts. Simply plug the device into the controller, plug the controller into any 110-VAC outlet, and set the dial anywhere between low to high as desired.



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Incorporating a grounded 3-prong plug and plug receptacle, the Hot Tool Dial-Temp has a 15-A capacity. Applications include electronics assembly, carving, feathering, and soft shadowing with a woodburning tool, laboratory instruments and hot plates, stained glass and crafts.

The Hot Tool Dial-Temp Controller sells for \$27.50. For more information contact: Hot Tools Inc., 24 Tioga Way, P.O. Box 615, Marblehead, MA 01945; Tel. 617/639-1000.

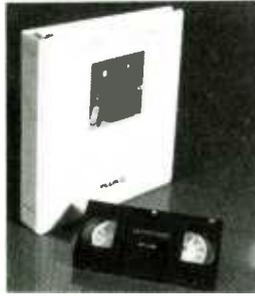
### Course for DMM Use

Here's a video training product designed to maximize the usefulness and safety of Fluke's 70 Series of handheld digital multimeters (DMMs).

The product, titled "70 series Solutions," is intended for industrial or vocational training applications. In addition to the 15-minute video tape, it includes numerous classroom tools such as overhead transparencies, a 100-page Instructors Guide, and 25 Student Workbooks.

The training emphasizes "hands-on" exercises. A minimal amount of theory is presented. Instead, examples of how to make a wide variety of basic measurements accurately and safely are given by demonstration. Many of the unique features of the 70 Series DMMs are also explained.

Subject matter includes: AC and DC Voltages and how to measure them; making sine wave (RMS), non-sine wave, and composite voltage measurements; current and how to measure it; resistance and how to measure it; preventing damage to the meter or circuit during test; why a meter indicates in-circuit resistance that is different than what's indicated by the resistor color code; testing and troubleshooting of



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diodes and transistors; identifying and avoiding safety hazards; measuring voltage in high-resistance circuits; using 70-series features like the audible continuity test and Autorange; Touch Hold and Range Hold; testing the meter's internal fuse; interpreting meter range and other displays.

The U.S. list price for 70 Series Solutions is \$225. For more information, contact John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, WA 98206; Tel. 800/443-5853.

### Antistatic Wristwatch

Ordinary antistatic protection wristbands have one big disadvantage: they are not always on-hand when they are needed to handle some sensitive components or assemblies.



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The Spirig 3S-Watch combines elegance and permanent on-hand availability of antistatic protection. The watch and wriststrap are made of a durable special plastic. The electrical contact to the wearers skin is made by a stainless steel inlay within the wriststrap to guarantee 100% reliable contact. The watch can be entirely washed with a detergent to remove any traces of grease or other contaminants which could interfere with contact. The coiled cord is connected to the wriststrap by a detachable snap contact with a megohm resistor incorporated within the mold. Cord contacts of other systems like 3M or Somco do connect to the 3S-Watch.

The 3S-Watch is available in a gents and a ladies model and price including the coiled cord is \$59.50.

## Employers

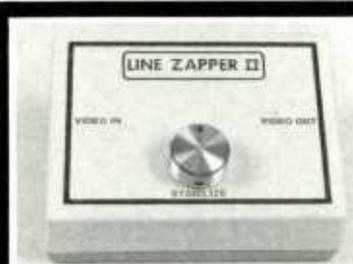
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This unit works like a video watchdog, and when it sees an interfering signal it zaps it, giving you a normal, clean signal at its output.

The complete kit is only \$59.95 plus \$4.00 shipping (not recommended for the beginner). Available assembled and tested at \$99.95 ea. plus \$4.00 shipping and comes with 1 year warranty.

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This new circuit works with Hamlin, Sylvania, Eagle, and Terrold (not for tri-mode) systems. Decodes In-band, Out-band, AM or FM reference signal (must be used with a downconverter). 40 page gated pulse theory booklet \$15.00 (IPFD-1P), PC board \$15.95 (IPFD-1B) or complete educational kit including book, PC board, case and parts (IPFD-1K) only \$47.00 plus \$4.00 shipping.

Please allow 6 weeks for delivery. Canadian orders please add \$2.00 extra for shipping. MC and Visa accepted.

ELEPHANT ELECTRONICS  
P.O. BOX 41865  
PHOENIX, AZ 85080  
(602) 581-1973



For further information write to Solder Absorbing Technology Inc., 144 Oakland Street, Springfield, MA 01108; Tel. 800/628-8862.

### Data Generator

Someone saw the great need for a versatile tool for testing printers, CRT's, modems, and designed and manufactured the data generator, model 232DG. The data generator outputs ASCII data in various combinations of line length, baud rate, parity, number of stop bits, and word length. The output may inhibit via Data Terminal Ready (pin 20), or Request to Send (pin 4), or by X-on and X-off. The status of Clear to Send (pin 5), Data Set Ready (pin 6), and Carrier Detect (pin 8) all may be controlled by using the various switches.

The B&B data generator in the ASCII mode produces all of the printable ASCII characters including space; a 2716 prom is used to store those characters and may be reprogrammed for custom test patterns or used for sending messages.

The unit in the U-U-Mode outputs the letter U constantly. That is a square wave at one-half the selected baud rate and represents a good worst-case test. The Output Switch will allow you to output data on pin 2 or pin 3. The 232DG uses a 9-volt battery (not included with data generator).



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Also, an optional AC power supply is available that could be utilized to replace the battery.

The Model 232DG RS-232 data generator retails for \$199.95 and the Model 232PS Optional AC Power Supply for \$14.95.

For more info write: B&B Electronics Mfg. Co., 1500 Boyce Memorial Drive, P.O. Box 1040, Ottawa, IL 61340; Tel. 815/434-0846.

### Surge Arrester

These High-Tech Arrestors protect transmitters, transceivers, receivers, base stations, etc., from any harmful damage caused by lightning surges, transients, etc.



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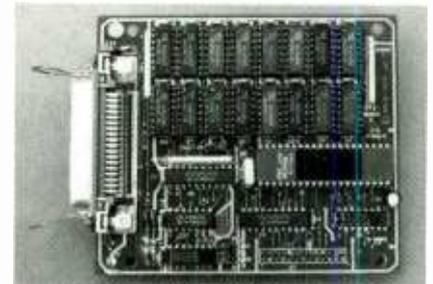
The units utilize a gas-filled discharge element, and a secondary stage to provide double protection to the equipment. The units restore themselves time and time again for repeated use.

The "High-Tech Arrestors" divert unwanted surges (such as lightning) away from the equipment to a safe ground.

Rated up to 2000 watts for transmitters, they are available with UHF, BNC and N type connectors. Prices for the units start at \$29.95. For more information contact Spi-Ro Manufacturing, Inc., P.O. Box 1538, Hendersonville, NC 28793.

### Epson Printer Buffer

Image Technology Inc. now offers an inexpensive, large-capacity print buffer that mounts inside your Epson printer. The buffer allows you to transfer data to the printer at computer speed and get back to work immediately while the printer operates at its own pace. It's much more economical than buying a faster printer to increase productivity.



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Some benefits: it works just like Epson's optional buffer but has much more capacity and costs less; it simply plugs inside your printer, no wires or controls required; it works automatically every time you print, one board provides 64K, 128K, 256K or 512K (300+ pages); it fits most Epson dot-matrix parallel printers; it is warranted for one full year; it is always expandable to 512K.

The unit comes as three different kits: 0K bytes for \$109.00 (you furnish the DRAM chips); with 256K at \$133 (includes 8 256K RAM chips); or 512K for \$157 (includes 16 256K RAM chips).

For more information contact: Image Technology, Inc., 8150 S. Akron St., Suite 405, Englewood, CO 80112; Tel. 303/799-6433.

### A defense against cancer can be cooked up in your kitchen.

There is evidence that diet and cancer are related. Follow these modifications in your daily diet to reduce chances of getting cancer:

1. Eat more high-fiber foods such as fruits and vegetables and whole-grain cereals
2. Include dark green and deep yellow fruits and vegetables rich in vitamins A and C.
3. Include cabbage, broccoli, brussels sprouts, kohlrabi and cauliflower
4. Be moderate in consumption of salt-cured, smoked, and nitrite-cured foods
5. Cut down on total fat intake from animal sources and fats and oils.
6. Avoid obesity.
7. Be moderate in consumption of alcoholic beverages.

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<p><b>RECHARGEABLE NI-CAD BATTERIES</b></p> <table border="1"> <tr><td>AAA SIZE 1.25V 180mAh</td><td>\$2.25</td></tr> <tr><td>AA SIZE 1.25V 500mAh</td><td>\$2.00</td></tr> <tr><td>AA WITH SOLDER TABS</td><td>\$2.20</td></tr> <tr><td>C SIZE 1.2V 1200mAh</td><td>\$4.25</td></tr> <tr><td>SUB-C SIZE SOLDER TABS</td><td>\$4.25</td></tr> <tr><td>D SIZE 1.2V 1200mAh</td><td>\$4.25</td></tr> </table>	AAA SIZE 1.25V 180mAh	\$2.25	AA SIZE 1.25V 500mAh	\$2.00	AA WITH SOLDER TABS	\$2.20	C SIZE 1.2V 1200mAh	\$4.25	SUB-C SIZE SOLDER TABS	\$4.25	D SIZE 1.2V 1200mAh	\$4.25	<p><b>MINI PUSH BUTTON</b></p> <p>S.P.S.T. RED momentary. Push to make. CAT# MPB-1 10 for \$3.25</p>
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### Multi-function CD Player

New functions differentiate the Revox Signature CD player. Those include a Previous mode which allows the previously played track to be repeated; an Index control that provides direct numerical access to indices on a CD via the remote control, and remote/direct level control of the Signature's variable level output.

The commemorative Signature CD player features 16-bit quadruple oversampling and a large LCD panel which constantly keep users informed of the CD players' operating status.



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The limited edition Signature CD player can be random-access programmed with up to 19 selections for playback in any desired sequence. Sections of a specific musical selection can be played at will, with fast access and search time from any starting point. Start up from Pause is just 0.6 seconds.

Three newly-developed large-scale integrated circuits (SAA 7210, SAA 7220, TDA 1541) are responsible for all demodulation, error correction, basic and enhanced interpolation, digital and phase-linear filtering, as well as 16-bit digital-to-analog conversion.

New adaptive error correction selects the best error correction strategy (from 60 possibilities) to greatly improve performance on dirty or damaged discs.

Suggested list price is \$1,600 including remote control module. For additional information contact: Revox Hi Fi Products, Studer Revox America Inc., 1425 Elm Hill Pike, Nashville, TN 37210.



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### CD Rings

What is it? The Sims CD Ring is an inexpensive and ingenious means of producing cleaner and harmonically fuller sound from all CD players.

Each ring is made of a rubber-like compound, and attaches to the back side of any CD with an easy-to-use centering device. Using centrifugal force, the ring flattens the rotating disc. That in turn reduces rotational flutter and allows the laser to read more bits of information.

The rings sell for \$19.95 for a package of 15, and are available through the Sims distributors. For more information write to: Sims Vibration Dynamics, 2797 152nd Avenue, N.E., Redmond, WA 98052.

### Industrial Soldering Iron

Designated the New SA-8 Series, these irons are slim, lightweight production-quality irons. With a silicone-rubber heat guard allowing the grip to remain at a constant low temperature, the SA-8 series make a definite statement in quality and comfort.

Maximum operator control and accuracy is achieved by the short distance from grip to soldering surface which speeds up the soldering process. The short heat-up time and efficient temperature recovery assure the operator of quick and easy handling of all the usual soldering applications.



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The irons offer: highly accurate temperature stability which prevents damage to boards and components, quick heat up time with rapid temperature recovery, silicone rubber heat guard which provides operator comfort and a positive grip for safety, long-life corrosion-resistant tip, grounded tip for CMOS safe soldering.

The SA-8 Series solder irons have a maximum equivalent rating of 30, 40 and 50 watts. All irons have a three wire grounded power cord. Prices start as low as \$24.95.

For more information contact: O.K. Industries Inc., 4 Executive Plaza, Yonkers, NY 10701; Tel. 800/523-0667 or 914/969-6800 (in New York). *over*

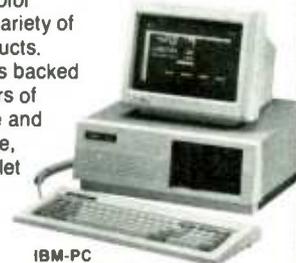


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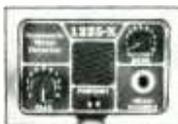
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### Metal Detector

The 1225-X is Fisher's answer to many requests for a lower-priced detector with top performance and no frills. The 1225-X goes just as deep and rejects trash just as well as the higher priced 1235-X. In fact it's almost equal to the \$500 1265-X model, but it doesn't have a lot of extra features. For example the 1225-X doesn't have built-in recharge circuitry, dual discrimination modes nor is it convertible to a body mount. It is however, a silent running, slow-motion VLF-discriminator with a no-motion pinpoint mode and the ability to work well in mineralized soil.



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The 1225-X has only two knobs and a push button, weighs only 3.1 pounds and like all Fisher "X" detectors, is backed by a Five Year Limited Warranty. Suggested list price is \$299.95. For a free 1225-X spec sheet, write: Fisher Research Laboratory, Dept. HOE, 1005 1 Street, Los Banos, CA 93635.

### Terminal Node Controller

The Heathkit HK-232 Pack-Kit Multi-Mode TNC kit is a hard working addition to an expanding Amateur Radio line. It's ideally suited for Novice Amateur Radio Operators who now have digital privileges, for amateurs already involved in Packet Radio who desire a product with multi-mode capabilities, or for amateurs interested in Packet, a new mode.

The Pack-Kit TNC takes the challenge out of getting into RTTY, lets users run CW at speeds from 5 to 99 words-per-minute and works on AMTOR, ASCII, HF, and VHF Packet.

It can even decode Weather Facsimile pictures onto an Epson-compatible printer. The Multi-Mode TNC works Packet error-free in both HF (300 baud) and VHF (1200 baud or up to 9600 baud with an external modem).

Adding the HK-232 to a radio and computer lets the amateur get on the air in every mode. It connects to the radio's PTT line, speaker output and microphone input for interchangeable VHF and HF operation. The same connections work for all other modes including CW.

Amateurs can connect both their HF and VHF rigs at the same time which allows switching between VHF Packet



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and copying a WIAW RTTY bulletin on 40 meters with the push of a button.

A Signal command causes the Pack-Kit to determine current RTTY, ASCII, or AMTOR mode for the signal the amateur is listening to. It also presets baud rate, mode, and will invert the signal if necessary. All the user does is type "OK."

No special software is required to operate the HK-232 Pack-Kit TNC. It can be used with any modem communication package you may already have or an optional program written specifically for the HK-232 and a Heathkit/Zenith PC or PC-compatible computer. It connects to a terminal or computer through a standard RS-232 serial port at baud rates from 300 to 9600.

The retail price for the 232 is \$279.95. For more information about the HK-232 Multi-Mode TNC, write to Heath Company, Dept. 150-945, Benton Harbor, MI 49022. In Canada, write to Heath Company, 1020 Islington Ave., Dept. 3100, Toronto, Ontario, M8Z 5Z3.

### VHF Antenna Tuners

MFJ Enterprises, Inc. is introducing two dual band VHF antenna tuners that cover both the 144-MHz and the new Novice 220-MHz bands. They both handle 300 watts PEP and match a wide range of impedances for coax-fed antennas. Both are built into rugged all-aluminum cabinets and are painted eggshell white with a black top.

The MFJ-921 has a built-in SWR/Wattmeter, measures 9 x 2 x 3-in. and retails for \$69.95.



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The MFJ-920 measures a compact 4-1/2 x 3-in. and retails for \$49.95

Both the MFJ-921 and the MFJ-920 come with a one year unconditional warranty.

For additional information contact MFJ Enterprises, Inc., at P.O. Box 494, Mississippi State, MS 39762; Tel. 800/647-1800 or 601/323-5869.

# BOOKSHELF

## IBM PC Shareware: PC-File, PC-Write, PC-Talk and ExpressCalc

By John R. Ottensmann

As the prices of personal computing systems fall, more and more people are discovering just how useful microcomputers are—at work, at school, and at home. But the PC itself is just the beginning. In order for personal computers to be able to perform useful work, they must first be equipped with software—such as programs for word processing or data management. However, unlike the prices for microcomputers, the cost of software is high—and rising.

This book describes a software concept called shareware. Shareware is of-



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fered to the public free of cost—users are actually encouraged to take copies of the programs and share them with others. If users like the programs, they are asked to send voluntary contributions to the programs' developers. In exchange for these very modest contributions, users are entitled to copies of the

most current versions of the programs, the complete, printed documentation, and the right to acquire updates of the programs free or at reduced cost. This user-supported software offers an affordable alternative to high-priced commercial programs.

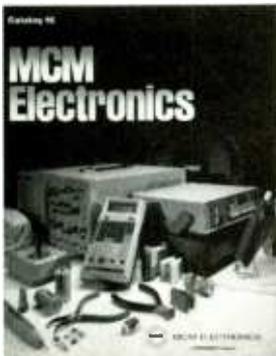
Four programs have emerged for use on IBM PCs and compatibles, which together constitute a low-cost, comprehensive set of software tools that will fill most of the needs of the average computer user:

PC-File—a database manager for information storage and retrieval; PC-Write—a word-processing program that is quick and responsive, allowing easy text editing and flexible formatting; PC-Talk—a communications program that

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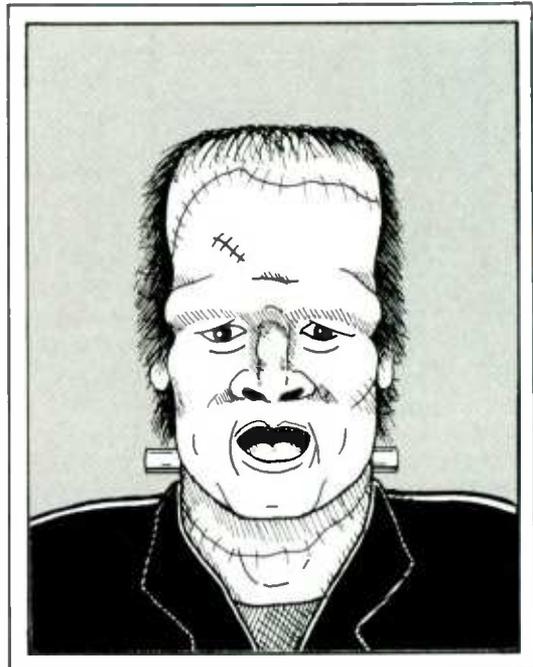
Whether you're working on small jobs or real "monsters," chances are you've had to make do from time to time with parts or components that were *almost* right! Often, finding a substitute that works takes extra time...and renders disappointing results. So stop turning your customers' beauties into ghouls. Order your FREE copy of MCM's 160-page catalog today. You'll find a huge inventory of nearly 10,000 in-stock items that can be shipped to you in record time under some of the most flexible payment terms in the industry. If Dr. Frankenstein could have ordered from MCM, "Frankie" might have looked — and acted — a whole lot different!



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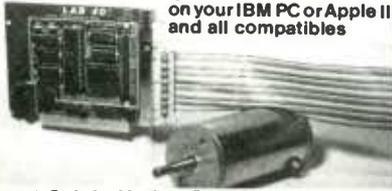
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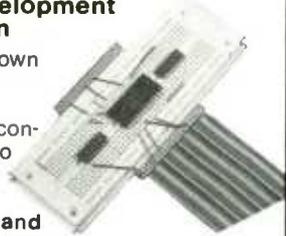
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enables the PC to interact with remote computers, such as electronic bulletin boards; and ExpressCalc—an electronic spreadsheet program for data analysis.

Those high-quality programs are covered in detail in four separate chapters, and a fifth chapter addresses using the programs as an integrated package. The PC-DOS operating system for IBM PCs is also discussed, and an opening chapter provides a general background on user-supported software, with complete information on how to obtain these useful programs. The book also includes an index for easy reference and many detailed illustrations.

With this much-needed addition to the surprisingly scarce documentation currently available, everyone can tap into this economic and attractive source of microcomputer software.

*IBM PC Shareware: PC-File, PC-Write, PC-Talk and ExpressCalc* contains 256 pages, and costs \$15.60 in paperback from Tab Books Inc., Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

### Using Xywrite III By John Sladek

From beginning steps to advanced applications, *Using Xywrite III* quickly brings you up to speed on ZyQuest's word processing software for the IBM PC and PC-compatibles. Operating instructions for both XyWrite II and XyWrite III are thoroughly described.

Begin with basic writing, editing, formatting, and printing. As you work through sample applications and exercises, Sladek discusses such sophisticated features as: windows, footnotes, indexing, mail merge, math functions, column formats and programming character sets.



"Another computer malfunction!"



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Learn how to create customized Xywrite features that enable you to change startup and help files, the printer file, and the keyboard. You'll also find an entire chapter on programming Xywrite and four chapters on printing techniques.

*Using ZyWrite III* covers everything you need to know for complete ZyWrite mastery.

The book contains 374 pages, costing \$17.95 from Osbourne/McGraw-Hill, 2600 10th St., Berkeley, CA 94710; Tel. 415/548-2805.

### The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects By Gordon McComb

A unique collection of tested and proven project modules that can be mixed and matched to create a wide range of highly intelligent and workable robot creatures.

Probably no other area of electronics generates more enthusiasm and interest in hobbyists than does personal robotics—and it is no wonder. Building a



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working robot from a collection of inanimate solenoids, wires, motors, and assorted electronic odds and ends can be a thrilling experience. But—until now—most books on designing and building a robot have concentrated on making just one model automation, with very little leeway for individual creativity.

This book is different. Gordon McComb, writing in a clear, lively style, takes a "cookbook" approach to building robots. That is, readers will build each "ingredient" separately, which they

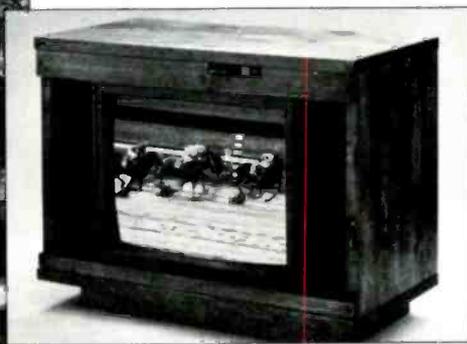
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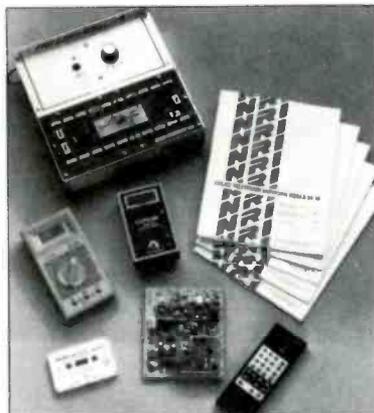
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**BOOKSHELF**

may then mix and match to create their own unique projects. The 99 different robot components described in this ingenious guide can be combined in an almost endless variety of intelligent and workable robots of all shapes, sizes, and abilities. Rolling robots, talking robots, robots that vacuum, serve drinks, teach the kids, protect the house against fire or intruders, anything is possible using these projects and a little imagination.

Projects are geared to beginning and intermediate hobbyists, and include schematics, parts lists, diagrams, and detailed instructions for constructing each of the essential building blocks of the typical personal robot: the body and frame; power and locomotion; appendages; eyes, ears, and mouth; navigators; and electronic control. How they are all put together is up to the reader, but McComb has included four complete designs, as well as several alternatives. And there are complete lists of sources for electronic and mechanical parts, lists of tools and equipment, a handy guide for matching up TTLs and ICs, a bolt and drill bit chart, and computer program listings for additional control switches for the finished droids.

This is a fascinating guide for lay readers that emphasizes fun while it teaches the basic principles of robotics. And it is a practical guide for hobbyists that enables them to create inexpensive, custom designed, intelligent robots at home.

*The Robot Builder's Bonanza: 99 Inexpensive Robotics Projects* contains 336 pages at \$14.60 in paperback from Tab Books Inc., P.O. Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

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Technical managers, computer science students, and all other advanced beginners will find this book, based on the author's successful course material, to be an quality overview of computer architecture and communications. Beginning with a general introduction, Neil Willis first defines the basic concepts of computer systems: processors, memory, peripherals, backing store, logic gates, and communications. Then the structure of a simple processor system is explained, covering file store, machine codes, the CPU, interrupt mecha-



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nisms, and input/output. The final chapters rounds out the text with a discussion of computer networks, first defining them, and then introducing possible topologies, the ISO OSI reference model, physical transmission, protocols, and routing.

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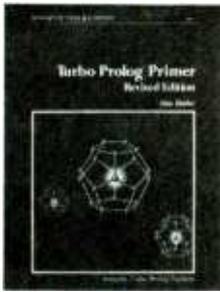
Highlights include: Basic Concepts of Computer Systems, Digital Logic and Integrated Circuits, Peripherals, File Store, Numbers and Character Codes, Memory, Machine Codes and Addressing Techniques, The Central Processing Unit (CPU), Interrupts, Data Transfer, Computer Systems, Data Transmission, Communication Protocols, and Network Types.

*Computer Architecture and Communications* has 288 pages costing \$16.60 paperback. It is available from Tab Books Inc., P.O. Box 40, Blue Ridge Summit, PA 17214; Tel. 717/794-2191.

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 By Dan Shafer

This is an introductory text for both new and experienced programmers who want to explore the power of Prolog and expand their knowledge of artificial intelligence and expert systems.

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in Turbo Prolog differs from programming in other, more traditional languages such as Pascal or C. Prolog Toolbox, detailing how its routines can be helpful in developing programs.

Topics covered include: getting to know Turbo Prolog, the Turbo Prolog Editor, the structure of a Turbo Prolog Program, making logical connections, creating a full Turbo Prolog Program, arithmetic and structures in Turbo Prolog, strings and type conversion, screens and windows, sound and graphics, databases in Turbo Prolog, controlling the program flow, and compiler directives.

No. 22615, *Turbo Prolog Primer, Revised Edition*, retails for \$19.95 and is available at bookstores, electronics distributors or direct from the publisher SAMS, 4300 W. 62nd Street, Indianapolis, IN 46268; tel. 317/298-5400.

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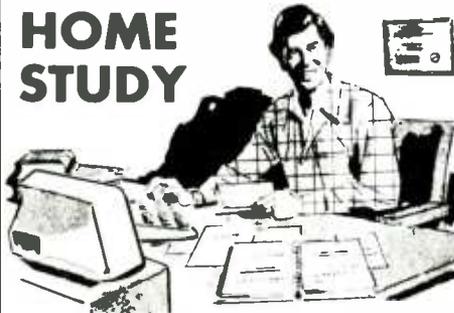
explained in the book is Intelligent Assistant, Q & A's natural language interface. Intelligent Assistant allows Q & A users to issue commands or ask questions in plain English, rather than in code. Another feature readers will learn how to use is Q & A's programming language, which enables users to write short programs that will execute lengthy commands at a single keystroke. Q & A also includes a word processor, ideal for generating mailing labels and form letters, and a spelling checker, that will

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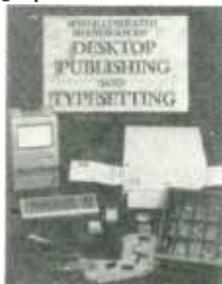
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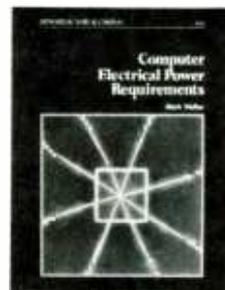
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No. 22561, *Computer Electrical Power Requirements* retails for \$19.95 and is available at bookstores, electronics distributors or direct from the publisher, SAMS, 4300 West 62nd Street, Indianapolis, IN 46268. Tel. 800/428-SAMS.

## Turbo C Programming for the IBM

By Robert Lafore

This tutorial contains 608 pages of information, examples, exercises, and questions and answers for beginning and

(Continued on page 89)

The Electronic Industries Association/Consumer Electronics Group has recently completed the first in a series of videocassette training tapes.

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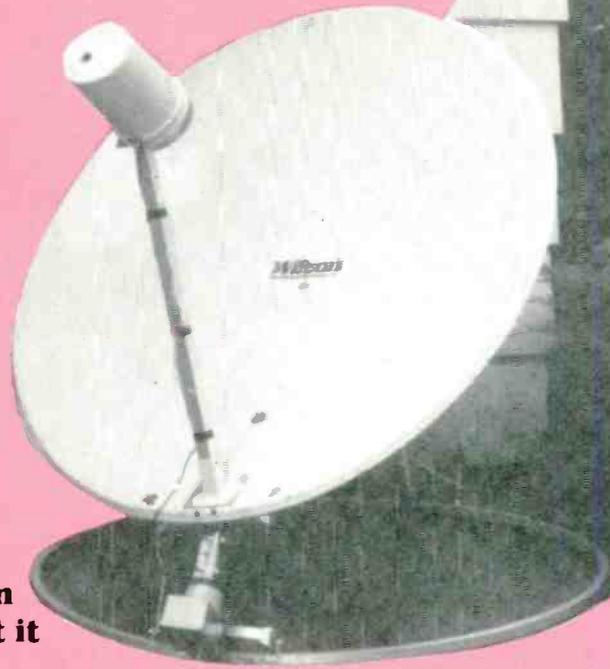
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# REMOTE TVRO DISH POSITIONER

**Remote-positioning satellite dishes are costly, but you can take an inexpensive immobile unit and convert it**

By Sam Allen



**W**HEN I BOUGHT A RING-MOUNT DISH ANTENNA, I was attracted by the low price, ease of setup, and portability. I thought that I could live with the manual positioning, since the programming I wanted was all on one satellite. But once I started watching satellite TV, I found programs all over the Clarke Belt that I wanted to watch. After a few late night trips out to the dish to move it to a new satellite, I decided that a remote positioner was a necessity.

The design I finally came up with uses readily available parts and is easy to bolt together. The heart of the positioner is

an ordinary TV antenna rotator. The directions given here are for a Wilson dish, but most other ring mount dishes are similar.

## Getting Started

First, disconnect the dish from the ring at the pivot ears. To do this, remove the upper pin from the elevation strut and the two bolts that attach the dish to the ring.

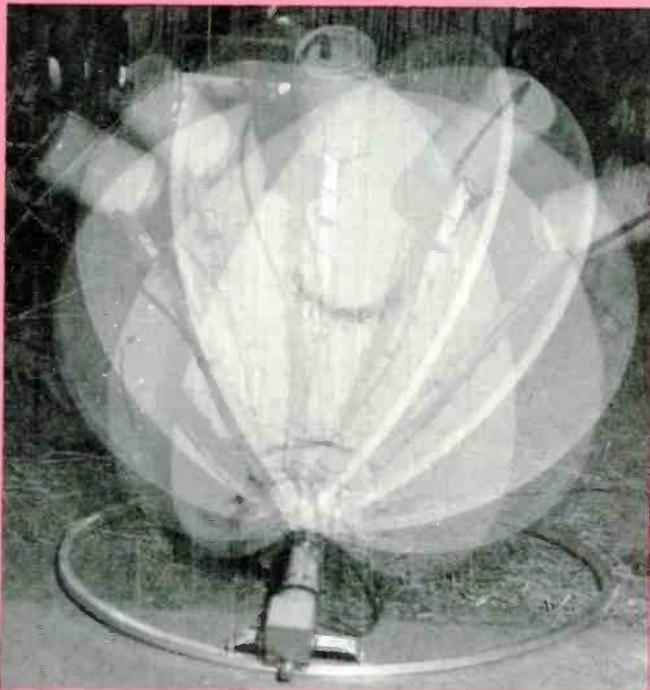
To avoid making modifications to the rotator, I chose to make the attachment points as much like a standard TV antenna mast as possible.

You'll need two pieces of 1-in. square aluminum tubing about 16-in. long, see part B in Fig. 1 (letters refer to part labels on plans.) You can get it from a local shop that repairs RV's and campers. You could also salvage some from an old TV antenna with a square boom, as long as it is heavy-duty enough.

Flatten the ends of the square tubing in a vice and bend 90 degrees. Make the bends so that the right angle ends will slip between the ears on the dish or ring. Drill holes in the flat ears on the square tubing. Line up the holes with the holes in the ears on the dish or ring. Now bolt one piece of square tubing to the ring and one to the dish. The tubing should be placed on the dish so that one flat face is resting against the rear of the dish edge.

## Clamping the Rotator

Next cut a piece of 1-1/4-in. dia. antenna mast or EMT 6-in. long for use as section C. Attach that piece of mast to the square tubing on the ring. I used a "U" bolt clamp, part E, salvaged from an old TV antenna. You can buy a similar one from Radio Shack (#15-826). The one I used has a steel reinforcement to keep the aluminum tubing from crushing as the bolts are tightened. The Radio Shack version lacks that feature, so you may want to add some large washers. Center the clamp on on section B and drill holes through the square tubing for ends of the "U" clamp. Another "U" clamp is used on the dish. Attach it to the square tubing in exactly the



The dish will rotate like crazy with a rotator because most rotators swing more than 360 degrees. That is more than enough to cover the full horizon plus.

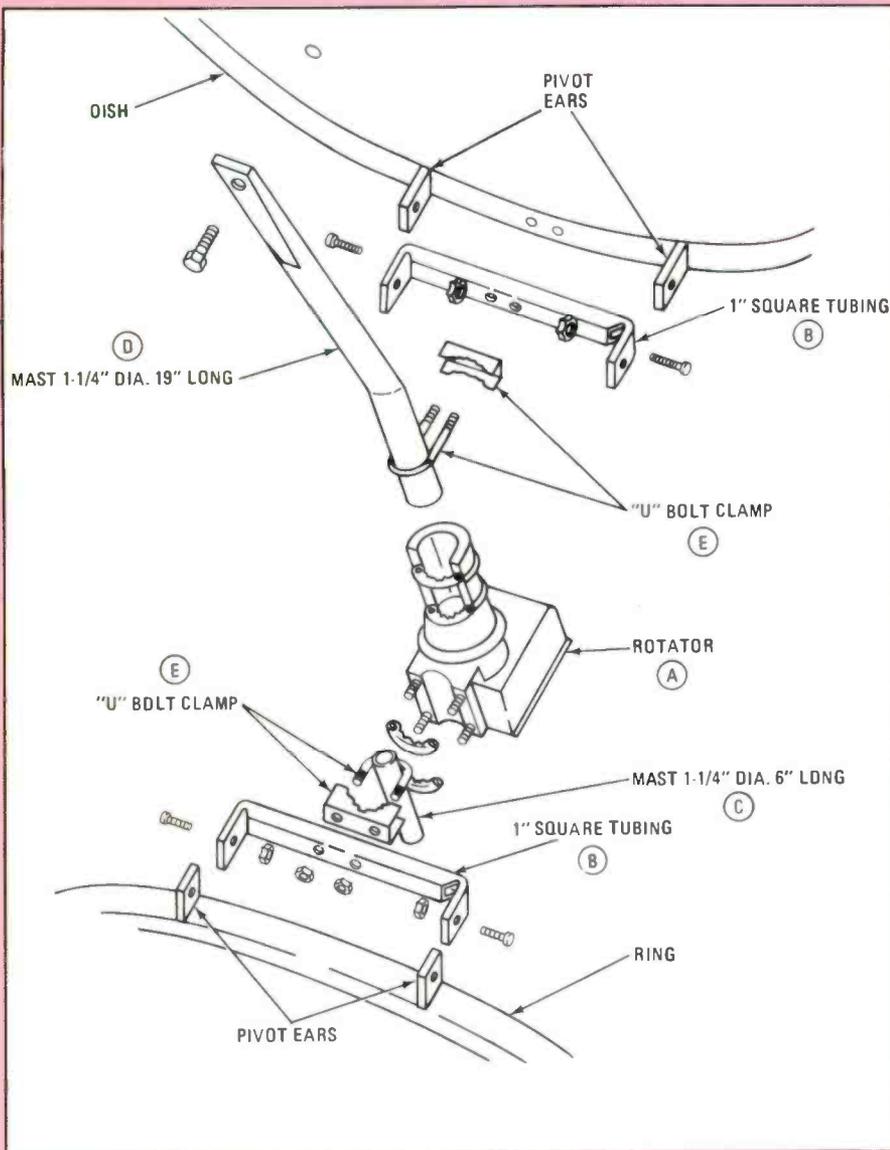


Fig. 1—The letters in this assembly diagram are supplied for reference purposes only; they do not indicate the order of assembly. Also, they are not used to indicate individual parts (note that there are two part B's and two part E's). You should of course attach the least cumbersome parts together first. Imagine trying to mount the dish and rotor assemblies onto the ring as a complete unit after putting them together. You may like to try putting the "U" bolts through their proper holes and attaching their nuts first, sliding the pieces of tubing into position afterward.

same way except that the holes are also drilled through the edge of the dish.

### Dish Attachment

Another piece of 1-1/4-in. dia. TV-antenna mast D is attached to the dish as section D. On the Wilson dish there is a bolt hole about 14-in. from the edge that is used for a brace on the feedhorn arm. The mast should be about 19-in. long so that it will reach that hole and still have 5-in. protruding from the edge of the dish to attach the rotator.

Flatten the end of the mast and drill a hole so that it can be bolted to the dish with the feedhorn arm brace bolt. Next make a slight bend in the mast at a point about 8-in. from the other end. The bend should be about 30 degrees.

To check the angle, temporarily bolt it in place on the dish with the "U" clamp. Place a long straight board across the front edge of the dish at the top and bottom. The end of the mast that extends past the edge of the dish should be parallel with that board; if it's not, remove the mast and adjust the bend. When the angle is correct, bolt the mast permanently to the dish. The ends of the "U" clamp should extend through to the front of the dish. That will clamp the square tubing and mast tightly to the dish. If the bolt supplied with the clamp is



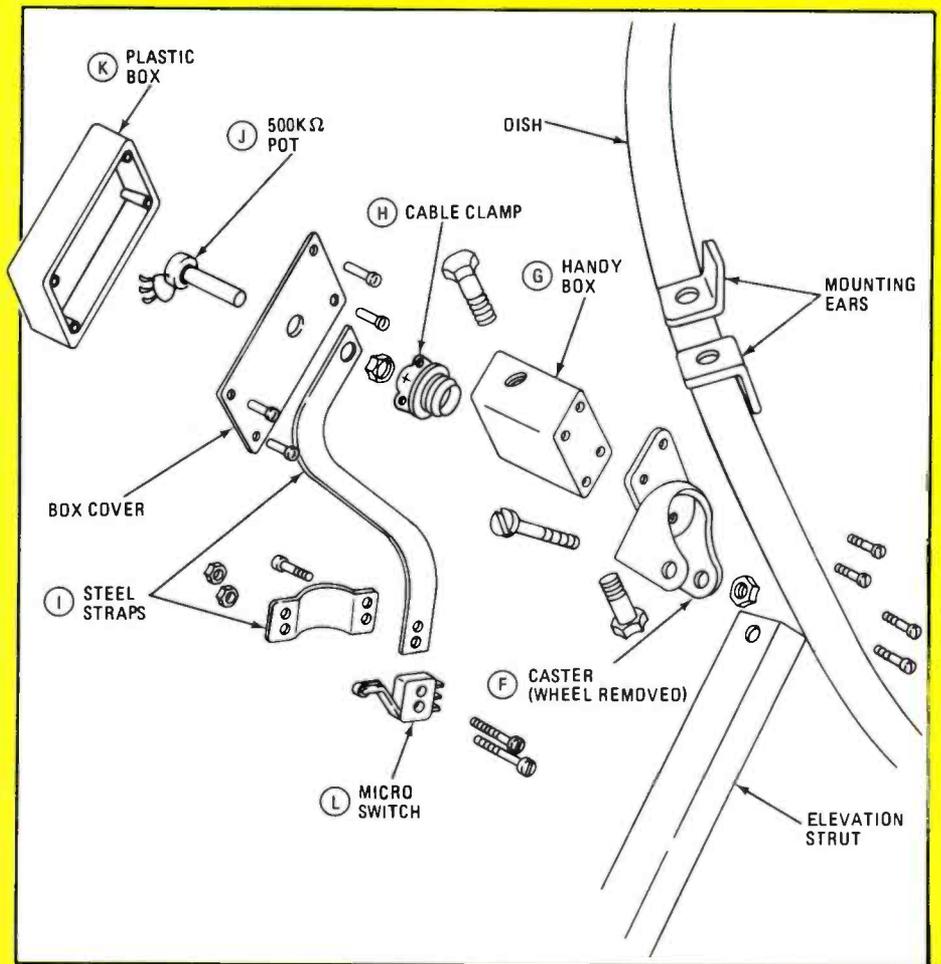
Attaching the TV antenna rotator to the dish is simplified by using a standard TV-antenna mast and clamps.

not long enough, you can buy a longer one at any local hardware store.

### Using Bearings

A bearing at the top of the dish where it attaches to the elevation strut (see Fig. 2) is needed for the dish to rotate. A

**Fig. 2**—This view of the caster assembly is what you would see if you sat on the ground near the ring to look up at the elevation strut. The cable clamp should be positioned to allow easy access to its adjustment screws. You will tighten them only after the dishes extreme position has been reached in order to calibrate the 500K potentiometer (J). If the caster mount is too large for a comfortable fit on the elevation strut, try padding the space by placing washers on both sides of the strut. Do the same if there is any space between the handybox and mounting ears. The steel strap for the microswitch can be bent afterward to position the cutoff switch.



ball-bearing furniture caster (denoted part F) is used for that purpose. The bearing is important to the operation of the system, so don't skimp here; buy a quality caster with a ball bearing swivel. Also look for one that has a nut on the wheel axle. The wheel is not used, so it's easier to remove it if the axle can be unscrewed.

Remove the wheel and bolt the caster to the bottom of an electrical outlet box, part G. Get the type known as a handy box; it is about 2-in. wide  $\times$  4-in. high  $\times$  1-3/4-in. deep; it doesn't have any cable clamps, and it has a knockout in the center of each end. About half way up the sides of the box drill 1/4-in. dia. holes that will line up with the holes in the ears on the top of the dish. Be sure to drill the holes in a solid section of the box, not one of the knockouts.

### Box Attachment

Place the box over the ears with the caster facing down and attach it with bolts. If the box is wider than the spacing of the ears, use washers to fill the space between the inside of the box and the mounting ear. Use the same number of washers on each side so that the box will be centered. Use a separate bolt for each side. You can reach inside the box with an open-end wrench to tighten the bolt.

Clamp the rotator, A, to the small section of mast, C, on the ring. Put the mast, D, attached to the dish into the top of the rotator and temporarily tighten the clamps. The elevation strut fits into the caster, F, in place of the wheel. Attach it by running a bolt through the axle holes in the caster and through the hole in the top of the strut.

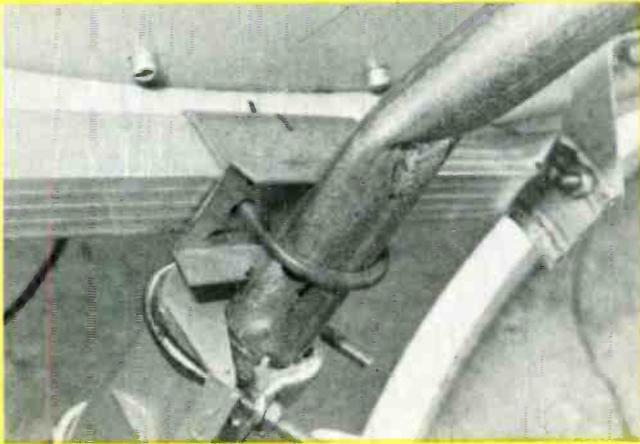


The rotator clamps to a short piece of 1-1/4-in. diameter mast. The mast is attached to a piece of square tubing with a "U" clamp. The ends of the square tubing are flattened and beat to fit between the ears on the ring mount.

### Rotator/Dish Alignment

Loosen the rotator clamps on the dish mast slightly so that the dish can be turned by hand. Move the dish to the extreme east and west positions while watching the caster to make sure that the bearing is operating correctly and nothing interferes with the movement of the dish. While the clamps are still loose on the dish mast, use the control to rotate the rotor to the extreme west position.

Hold the dish to keep it from turning too far. Now rotate the dish to the extreme west position and tighten the clamps.



Another piece of square tubing is bent to fit between the ears on the dish. A 19" long section of mast is attached to the square tubing with a "U" bolt clamp. The mast is bent to about 30 degrees 5" up from the end.

### Cutoff Switch

I started using the system at this point, but as I used it, I found that it needed further refinement. The rotator is designed to turn a full 360 degrees; however, the dish would be ruined if it rotated that much. To stop the rotator, install a limit switch made from a microswitch (part L) mounted on a steel strap (section I). Solder wires to the common and NC terminals. Attach the switch to the strap with small machine screws. Weatherproof the switch with heat-shrink tubing, tape or silicon chalk. Rotate the dish to the extreme east position and place the strap on the elevation strut so that the switch touches the back of the dish. Drill holes in the strut and attach the strap with sheet metal screws. The strap can be bent to make minor adjustments of the limit switch position.

I wired the switch in series with one of the wires to the rotator; the only problem with this simple solution is that it disables the rotator until you manually move the dish away from the switch. Since I rarely run the dish all the way to the

limit, that isn't a big problem. A more elegant solution might be to run another conductor to the control switch to allow you to reverse the dish after it has reached the limit.

### Satellite Position

Originally I planned to use the indicator on the rotator control to locate the satellites, but I found that it just wasn't accurate enough. I solved that problem by adding a 500K-ohm potentiometer, J, to the upper-bearing assembly on the dish to sense the dish position. Use a potentiometer with a long shaft and mount it in a plastic weatherproof box (K). A piece of steel strap, I, about 10-in. long is used to hold the it stationary. You can buy steel strap with pre-punched holes at most hardware stores.

Drill a hole in the end of the strap or use a pre-punched hole and place it on the potentiometer shaft before the nut, then put the nut on the potentiometer and tighten it. Remove the top knobout in the handy box. Install cable clamp H in the hole. Put the shaft of the pot in the clamp, but leave the clamp loose for now. Bend the steel strap until it can be attached to the elevation strut. Use sheet metal screws to attach it. You can even use the same screws that attach the limit switch.

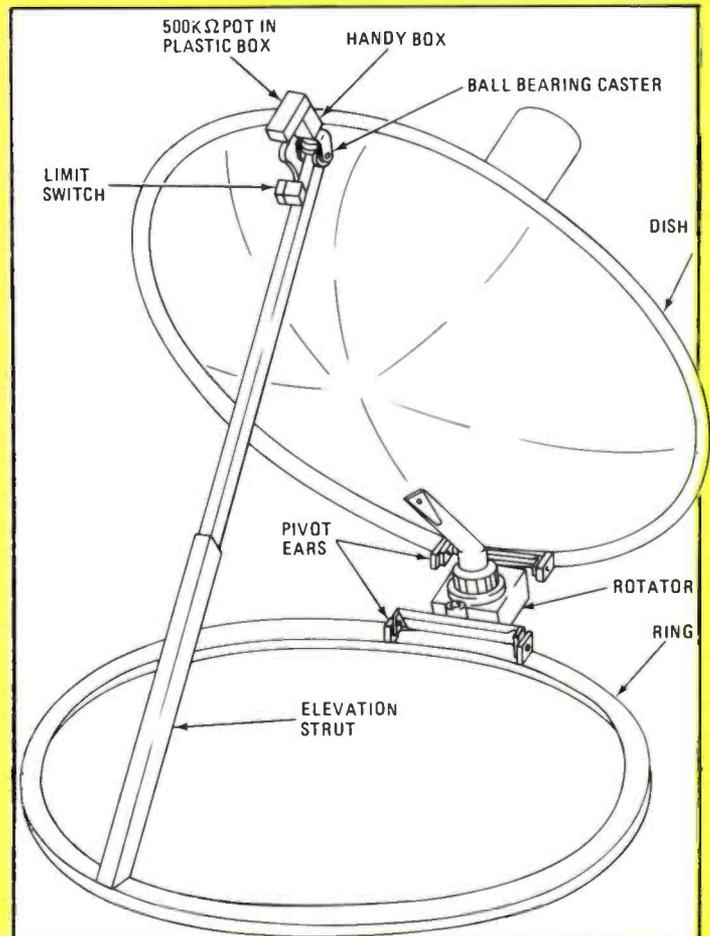


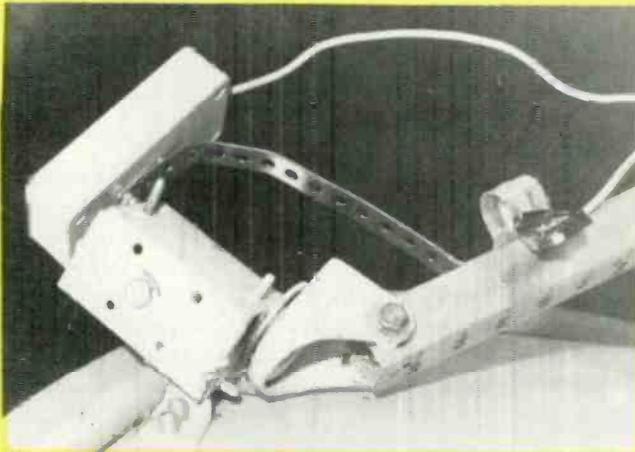
Fig. 3—After assembly, the positioning fun begins. The first thing you'll need to adjust is the elevation. Try to get it back to the angle it was originally in.

- PARTS LIST  
FOR THE REMOTE POSITIONER**
- A—TV antenna rotator (Radio Shack #15-1225)
  - B—1-in. square aluminum tubing, two pieces 16-in. long
  - C—1-1/4-in. Dia. steel mast, 6-in. long. (Radio Shack #15-842)
  - D—1-1/4-in. Dia. steel mast, 19-in. long. (Radio Shack #15-842)
  - E—"U" bolt clamp, two required. (Radio Shack #15-826)
  - F—Furniture caster with ball bearing swivel
  - G—Electrical outlet box, (Handy Box)
  - H—Cable clamp for Handy Box
  - I—Steel strap, two required, one 10-in. long, one 2-in. long
  - J—500K-ohm potentiometer
  - K—Plastic box (Radio Shack #270-220)
  - L—Microswitch SPDT, lever type with roller (Radio Shack #275-017)

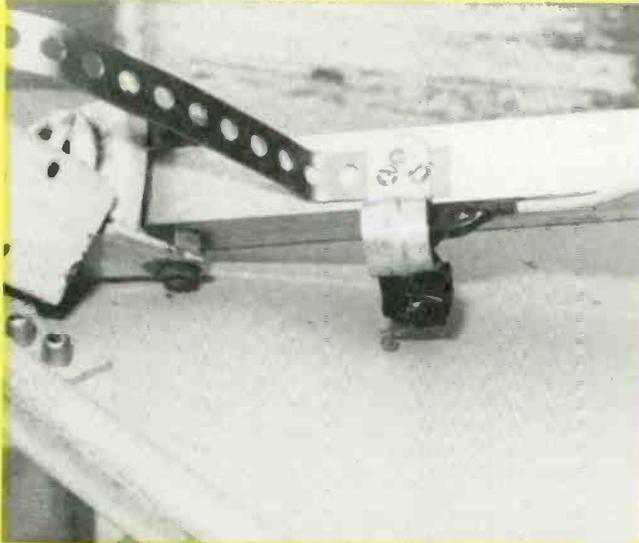
**ADDITIONAL PARTS AND MATERIALS**  
6—Hex-head bolts 1-in. long, 1/4-in. Dia.; 20 nuts and lock washers 2-pan-head, sheet metal screws 1/2-in. long #8 type; 2 round-head machine screws 1/2-in. long with 2-56 nuts; Cable for rotator and position indicator: OHM meter tape, heat-shrink tubing, silicon caulk, wire, etc.

### Adjusting the Pot

Attach an ohmmeter to the potentiometer and adjust the pot until it reads zero; that is usually slightly before the shaft



The upper bearing assembly is made from an electrical outlet box and a furniture caster with the wheel removed. The box shown here uses internal cable clamps, but experience showed that a "Handy Box" with knockouts for an external clamp would make installing the position sensing pot easier. The plastic box at the top of the assembly houses the pot. The shaft is inserted in a cable clamp on the Handy Box, and the perforated steel strap holds the pot stationary while the dish rotates.



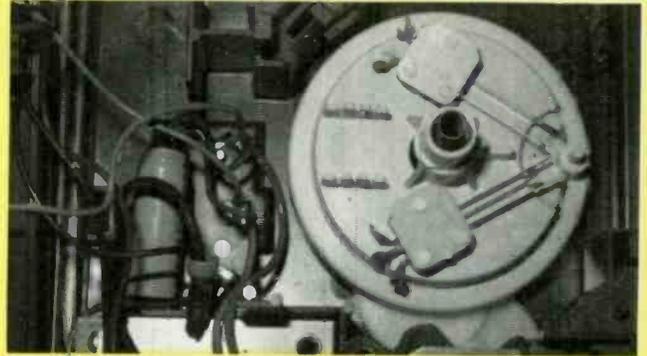
A microswitch is used as an eastern-direction limit switch. When the dish reaches the extreme east position the switch opens the rotator switch. The built-in limit of the rotator is used for the extreme west.

stops. Setting the pot with the ohmmeter will enable you to read the dish position from the beginning of the arc without a dead spot. Rotate the dish to the extreme west position. Now tighten the cable clamp onto the shaft of the pot. As the dish rotates, the pot should remain stationary and the shaft rotates with the dish.

Run a two-conductor cable from the pot into the house. The simplest way to read the dish position is to connect the leads from the pot to an ohmmeter. Make a note of the ohm reading for each satellite. Turn off the meter after the dish is positioned to save on batteries. Of course you could design a lot more sophisticated readout if you like. It could be a digital display or a meter with the satellite positions simply marked on the face.

### The Controller

The controller I used wasn't designed for the fine control



This interior view of the controller shows how the DPDT switch was added. The light colored round assembly on the right is the original control switch.

needed to position a satellite dish. I added a spring return, center off DPDT switch and found that I could better control the movement better.

The dish is set up almost the same way it was before modification. Before starting to aim the dish, use the control to position it in the center so that it lines up with the ring as it did originally. Instead of aiming at a particular satellite, aim the dish due south. Adjust the elevation to the proper angle for your latitude. A local dealer can tell you that angle.

The angle mark on the dish may be a little off after the modification, so if you can, find out how much correction the scale needs. Initial setup will be easiest if you can see the TV from the dish. Put the TV in a window or bring it outside. Put the receiver on scan and move the rotator control until you see indications of a signal, then switch off the scan and tune in the transponder. Jog the control back and forth slightly until you get the best signal, then readjust the elevation angle for strongest signal.

Now use the control to move the dish to other satellites. If you can get a few satellites that are close to the first one but not the ones farther away, the dish probably isn't aligned due south. Rotate the ring a small amount and try again. If you get even fewer satellites, rotate the ring in the opposite direction. Once you are getting a signal from most of the satellites, you can fine tune the position.

Use the control to rotate the dish to Satcom F3R. Adjust the elevation until you get the best signal. Next position the dish on Satcom F4, readjust the elevation angle; note the old angle and the new angle. Now set the elevation half way between the two previous angles. Turn the ring about 1/4-in. to get the best signal. Next move the dish back to Satcom F3R. Make a note of the present elevation, then adjust to see if the signal can be improved. If the signal was already at its strongest, leave the dish at that setting. If you had to readjust the angle, then return to Satcom F4 and repeat the process until you are satisfied with the adjustment. With the dish properly positioned, you should be able to find all of the satellites from horizon to horizon. It may take awhile to get the dish positioned correctly the first time, but once you have the technique figured out, it's not too hard to set it up in several other locations.

If you will be using the dish in the same location repeatedly, you can place stakes in the ground to line up with marks on the ring. That way you can be set up in a few minutes.

You will be able to enjoy many hours in front of the family tube pulling in those long range signals. A few seconds adjusting the rotator is all it takes. Enjoy your hobby and happy planetary viewing. ■

# BUILD A MAXWELL INDUCTANCE BRIDGE



Those inductors of yours need never mystify you again. With this project you can know their exact value.

By C. Hall

□ HERE IS A SIMPLE, INEXPENSIVE INSTRUMENT YOU CAN build to measure those unmarked RF chokes, torroids, audio chokes, and power-supply filter chokes that are practically given away at electronics flea markets. It reads values directly, without mathematical calculations, from 500 microhenries to 90 henries. To make it work you'll need a 1,000 Hertz sinewave oscillator to energize the bridge, and a pair of headphones to listen for the null that occurs when the bridge is balanced. If you haven't got a 1 kHz oscillator, don't worry there are plans for one following.

## Electrical Theory

The bridge may be thought of as two voltage dividers, each being connected across the oscillator, with the headphones connected between the two outputs of the voltage dividers (see Fig. 1). One voltage divider is made up of  $R_A$ ,  $R_B$ , and  $C_B$ ; the other voltage divider consists of  $R_C$ ,  $R_D$ , and  $L_D$ . In order for a null to occur in the headphones, the voltage and phase angle at the output of one voltage divider must be exactly equal to the voltage and phase angle at the output of the other voltage divider. Those voltages and phase angles

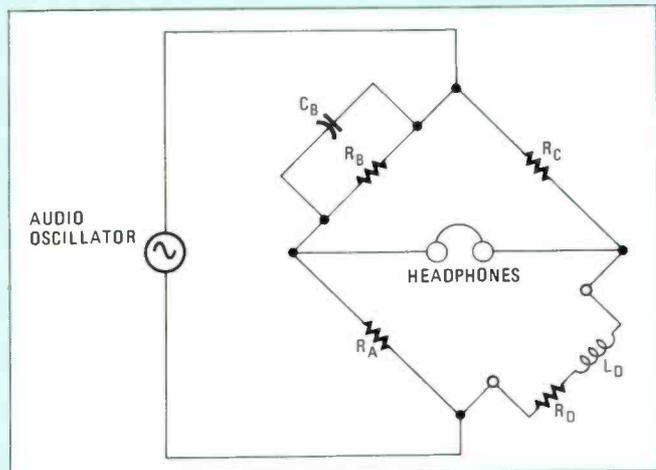


Fig. 1—The maxwell bridge has been around for a long long time, but it's more than adequate for inexpensive inductance measurements. Its accuracy is up there too.

become equal when the components of the bridge are adjusted so their values satisfy the following two equations:

$$L_D = R_A R_C C_B$$

To calculate the "Q" calibration points for  $R_B$  you can use the following equation:

$$Q = \omega C_B R_B$$

However, no calculations are necessary to determine  $L_D$  and Q if we chose our parts wisely.

## How it Works

Figure 1 shows a schematic of the basic Maxwell bridge circuit. The  $L_D/R_D$  leg of the bridge is the unknown inductor being measured, and its internal DC resistance. Resistors  $R_A$  and  $R_C$  are variable and calibrated directly in inductance;  $R_A$  is varied in steps by a range switch, and  $R_C$  is a calibrated potentiometer. Resistor  $R_B$  is variable and can be calibrated directly in values of Q (quality factor), provided the oscillator frequency remains fixed at some specified value.

When the unknown inductor is connected to the bridge as shown,  $R_A$ ,  $R_B$ , and  $R_C$  are adjusted until the audio oscillator's tone in the headphones dips to a null and cannot be heard. The bridge is then said to be balanced.

The inductance value is read from the dials of  $R_A$  and  $R_C$ , and the Q of the inductor is read from the dial of  $R_B$ .

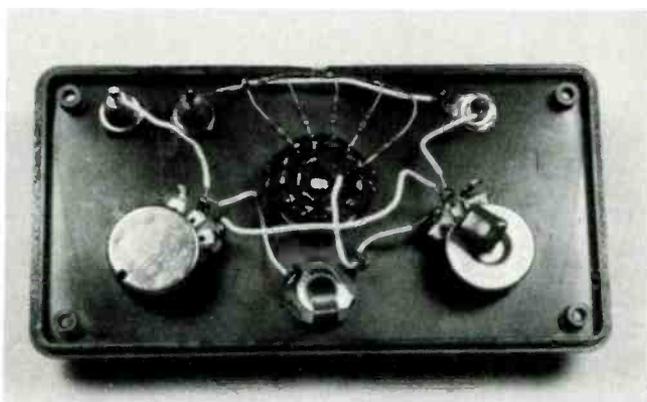
From the previous equations, we see that balancing the bridge is independent of frequency, so the exact frequency of the audio oscillator is of no particular concern, except that it has to be in the audible range of the ear so you can hear it in the headphones, but you have to know what the frequency is if you want to calibrate  $R_B$  with values of Q.

The value of  $C_B$  is selected to be compatible with the resistance values of the bridge and the range of inductance to be measured, according to the equations for balance. The exact value of  $C_B$  affects the accuracy of the bridge, so you don't want to use a 0.1- $\mu$ F capacitor that has a -20 to +80% tolerance, or guaranteed minimum value (GMV) tolerance. Try to get a capacitor having a tolerance of  $\pm 10\%$  or less.

For more information on bridges, see *Electronics Measurements*, by F.E. Terman and J.M. Pettit, pages 69-73.



The binding posts in the upper left-hand corner of the Inductance Bridge are used to connect the inductor under test to the circuit. You can use simple alligator clips to test inductors in circuits as long as you take their accompanying components into account.



All the components for the bridge can fit onto the back cover. Note that all the switch positions for S1 are not used. You may fill them with other resistors to extend the units range or to place capacitors in parallel with C1.

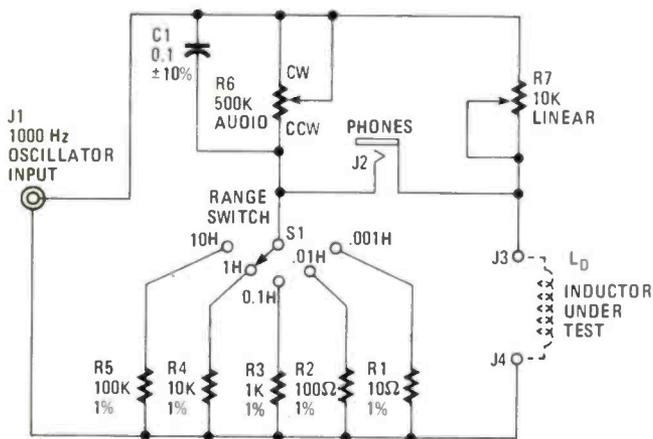


Fig. 2—This ingenious little device doesn't need a power supply, only a 1kHz sinewave source. The toughest parts to get are the precision resistors, available all over.

### Selecting the Parts

Figure 2 is a schematic of my version of the Maxwell bridge. Resistors  $R_B$  and  $R_C$  are denoted as R6 and R7 respectively. Capacitor  $C_B$  is marked as C1, and S1 (the range switch) allows you to select different values of  $R_A$  from R1 through R5.

RCA phono jack, J1, receives the output of a 1000 Hz sinewave oscillator. You can't get a good null unless the

### PARTS LIST FOR THE INDUCTANCE BRIDGE

#### Resistors

(All fixed resistors are 1/4-watt, 1% precision metal-film units.)

- R1—10-ohm
- R2—100-ohm
- R3—1000-ohm
- R4—10,000-ohm
- R5—100,000-ohm
- R6—500,000-ohm potentiometer (audio taper preferred)
- R7—10,000-ohm potentiometer, linear taper

#### ADDITIONAL PARTS AND MATERIALS

- C1—0.1- $\mu$ F, 5-WVDC, capacitor, with 10% or better tolerance
- J1—Phono jack
- J2—Phone jack
- J3, J4—5-way binding posts
- S1—Rotary switch, 1 pole, 12 position (Radio Shack 275-1385) Plastic box enclosure 6 x 3-3/16 x 1-7/8 inches, knob for switch, dials (2 required).

oscillator waveform is a fairly good sinewave. The amplitude of the sinewave should be on the order of five to ten volts peak-to-peak. Jack J2 is the phone jack for the headphones, which may be either high- or low-impedance type.

Jacks J3 and J4 are 5-way binding posts to which the inductor to be measured is connected. The 1% resistors are available from Radio Shack in a kit of 50 resistors. Resistor R7 is a 10,000-ohm linear-taper potentiometer. Resistor R6 should be a 500,000-ohm audio-taper potentiometer; linear taper will work, but it's not as easy to adjust at low Q values. If you can't get a 500K unit, use a 1 MEG, not a lower value; if R6 is too low, you can't get a null with high-Q inductors. Capacitor C1 should be as near to 0.1- $\mu$ F as possible. Ideally, if you have access to a commercial digital capacitance meter, you should select a capacitor whose value is within 1% of 0.1- $\mu$ F. I settled for one that was marked for 5% tolerance.

All the parts are mounted in a Radio Shack plastic case measuring 6 x 3-3/16 x 1-7/8 inches. The dials, which are calibrated for L and Q, are from available WW II surplus military equipment.

### Calibration

Calibration of the L and Q dials is with an ohmmeter; a digital type will give the most accurate calibration, but an analog type may be used. Table 1 shows the calibration

Table 1—RESISTOR CALIBRATION VALUES

$R_B$		$R_C$			
OHMS	Q	OHMS	L	OHMS	L
0	0	500	.5	7000	7
1.6K	1	1000	1	8000	8
4.8K	3	2000	2	9000	9
16K	10	3000	3	9500	9.5
48K	30	4000	4		
160K	100	5000	5		
320K	200	6000	6		

marking required on the dials versus the resistance setting of the pot for each marking. Connect the ohmmeter across the pot, adjust the pot until the ohmmeter reads the desired value, then mark the pot's dial according to Table 1. Mark the

(Continued on page 94)

# DATE CALCULATION SOFTWARE

Did you know that November 11, 1918, Armistice Day for WWI, was on a Monday and that there are 192 days between last Christmas to July 4th this year?

By James Tarchinski

□IT ALL STARTED, AS MANY COMPUTER PROGRAMS DO, with a simple question. In this case the question, which came from a trivia game, was: On what day of the week was the Declaration of Independence signed? If there were a computer handy at the time I might have gotten it right. With DATE-CAL.BAS I'll never again get that type of question wrong. Well, almost never.

DATE-CAL.BAS (which is short for Date Calculations) is a BASIC program that performs two types of calculations. First, you can use it to determine the number of days between any two dates. The second feature allows you to determine the day of the week that any given date has fallen on or will fall on.

## Programming Considerations

Although the program is designed for the IBM PC series of computers, it is easily modifiable to run on any machine that

has the BASIC language. Memory requirements are very small so this software does not offer any problems.

There is only one restriction on the dates that this program can deal with (remember, I said almost never): they must fall in or after the year 1590 A.D. Unless you have a very, very, very old grand aunt, the software shouldn't cause you any headaches.

## Operation

Table 1 is a printout of DATE-CAL.BAS. Type it into your computer and save it to disk by executing the save command:

After typing RUN to start executing the program, you should see the main menu appear. Here you can select which type of calculation you would like to perform. By keying 1, you can obtain the days between two dates; or by keying 2, the day of the week for a given date.

If you select the first option, number of days between

Table 1—Date Calculation

```

100 * DATE CALCULATIONS
110 * BY JAMES E. TARCHINSKI
120 *
130 FOR I = 1 TO 7 : READ DS(I) : NEXT
140 DATA SUNDAY, MONDAY, TUESDAY, WEDNESDAY, THURSDAY,
FRIDAY, SATURDAY
150 *
160 WIDTH 80 : KEY OFF : COLOR 7 : CLS
170 COLOR 6 : PRINT "DATE CALCULATIONS PROGRAM" : COLOR 7
180 PRINT : PRINT
190 PRINT "WOULD YOU LIKE TO CALCULATE?": PRINT
200 PRINT "1) NUMBER OF DAYS BETWEEN TWO DATES":
PRINT
210 PRINT "2) THE DAY OF THE WEEK FOR A GIVEN":
PRINT " DATE": PRINT
220 PRINT "YOUR CHOICE ('RETURN' TO EXIT):":
230 INPUT "", AS
240 IF AS = "" THEN CLS : END
250 IF AS < "1" OR AS > "2" THEN PRINT CHR$(7)::
GOTO 230
260 IF AS = "1" THEN GOTO 390
270 *
280 * *** DAY CALCULATION ***
290 QS = "PLEASE ENTER THE DATE:":
300 GOSUB 520
310 DW = V - 7 * (INT(V / 7))
320 IF DW = 0 THEN DW = 7
330 PRINT : PRINT
340 PRINT "THIS DATE IS ON A: "; DS(DW); " "
350 LOCATE 22: PRINT "PRESS ANY KEY...":
351 AS=INKEYS : IF AS="" THEN 351
360 GOTO 160
370 *
380 *
390 * *** NUMBER OF DAYS ***
400 *
410 QS = "PLEASE ENTER THE FIRST DATE: "
420 GOSUB 520:V1 = V
430 QS = "PLEASE ENTER THE SECOND DATE: "
440 GOSUB 520:V2 = V
450 PRINT : PRINT
460 PRINT "THERE ARE ";V2 - V1;" DAYS BETWEEN THESE":
PRINT "TWO DATES. (";(V2-V1) / 365.25;" YEARS.)"
470 PRINT : PRINT : PRINT
480 PRINT "PRESS ANY KEY...":
481 AS=INKEYS : IF AS="" THEN 481
490 GOTO 160
500 *
510 *
520 * *** INPUT DATE ROUTINE ***
530 *
540 CLS
550 COLOR 6 : PRINT QS: COLOR 7
560 PRINT
570 PRINT "USE THE FORM: MM.DD,YYYY": PRINT
580 INPUT "DATE: ";M,D,Y
590 FLAG = 0: PRINT
600 IF M < 0 OR M > 12 OR D < 0 THEN FLAG = 1
610 IF (M = 4 OR M = 6 OR M = 9 OR M = 11) AND
D > 30 THEN FLAG = 1
620 IF (M = 1 OR M = 3 OR M = 5 OR M = 7 OR
M = 8 OR M = 10 OR M = 12) AND D > 31 THEN FLAG = 1
630 IF M = 2 AND D > 29 THEN FLAG = 1
640 IF FLAG < > 0 THEN PRINT "INVALED MONTH/DAY
SPECIFICATION.": GOTO 560
650 IF M = 2 AND D = 29 AND Y < > 4 * INT(Y / 4)
THEN PRINT Y;" IS NOT A LE
AP YEARI": GOTO 560
660 IF Y < 1590 THEN PRINT "ALL DATES MUST BE
AFTER THE YEAR 1590.": GOTO 560
670 *
680 * CALCULATE 'V'
690 *
700 IF M > 2 THEN GOTO 730
710 V = 365 * Y + D + 31 * (M - 1) + INT
((Y - 1) / 4) - INT(.75 * (INT((Y - 1) / 100) + 1))
720 GOTO 740
730 V = 365 * Y + D + 31 * (M - 1) - INT
(.4 * M + 2.3) + INT(Y / 4) - INT(.75 * (INT(Y / 100) + 1))
740 RETURN
    
```

**TABLE 1—EXPLANATION OF THE BASIC PROGRAM**

Line No.	Function(s)
100—150	Initialize the program
160—270	Main Menu—select program option, either (1) days between dates, or (2) day-of-the-week calculations
280—380	Perform selection (2), day-of-the-week calculations
390—510	Perform selection (1), days between dates calculations
520—740	Subroutine to enter date and calculate 'V', the number of days from a given reference date
550—560	Print screen title
570—580	Enter date
590—640	Check entered date to make certain it is valid, if not (i.e. if FLAG-1), an error message is printed on line #640
650	Check for leap-year
660	Check to be certain that the date entered is after A.D. 1590 (this program is not valid before 1590).
670—740	Calculates 'V', the number of days between the entered date and a given reference date.

dates, the software will prompt you to enter two dates. Be sure to enter them with the earliest date first, or the program will produce a negative answer. Also, be sure to enter them in the format shown on the screen:

MM,DD,YYYY  
06,27,1929

If you don't enter the dates correctly, the screen will either direct you to do it again (correctly), or the program may crash.

To check this part of the program enter the dates May 26, 1961 (5.26.1961) and July 20, 1969 (7.20.1969). The computer should return an answer of 2977 days. That is the length of time between President Kennedy's speech calling for a "peo-

pled" Moon landing and the day when astronauts from Apollo 11 actually set down on the Sea of Tranquility.

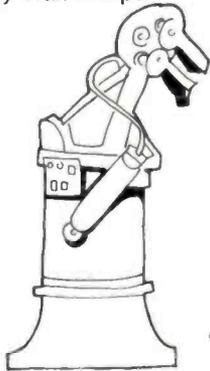
If you select the second option (2) of the main menu, the day of the week for a given date, the program will prompt you to enter a date. After doing this, the computer will then produce the answer on the screen. As a check, you may want to enter December 7, 1941 (12.7.1941) which, of course, fell on a Sunday.

Table 2 offers a group breakdown of the BASIC program's logical steps. Refer to it should you have troubles after inputting.

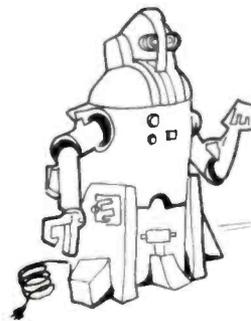
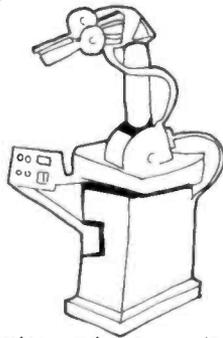
Incidentally, for those of you who play trivia games, July 4, 1776, fell on a Thursday. ■

## MACHINE TALK

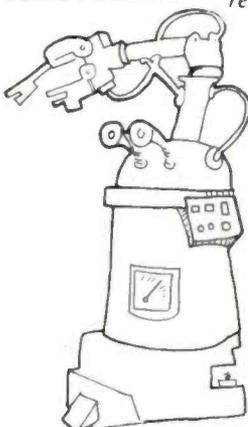
By Walt Philips



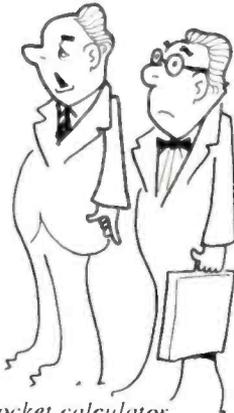
"I don't know about you, but I'm ready for a hot-lube recess."



"It replaced ten men, but it took twenty technicians to install it."



"It started out as a pocket calculator, and then it sort of got out of hand."



"It's amazing what we can do with one arm."



# POWER PLAY



**Once you've put this power supply on your workbench, you'll need no other!**

By Sidney E. Buck

□ ANYONE WHO IS INTO ELECTRONICS, WHETHER FOR FUN or for profit, is sure to have several low-current power supplies, outputting various voltages, lying around the test bench. How many small bench power-supplies do you have? (I have five, only one of which outputs up to 1 ampere of current.)

Having grown weary of switching power supplies each time that a different voltage or current level was needed, I decided to put together a supply that could output from zero to around twenty-five volts and provide up to one ampere of current, plus supply a *spritz* of negative voltage whenever needed.

What's that...you say already have a power supply that can handle all of your power-supply needs? Big deal! Even if you

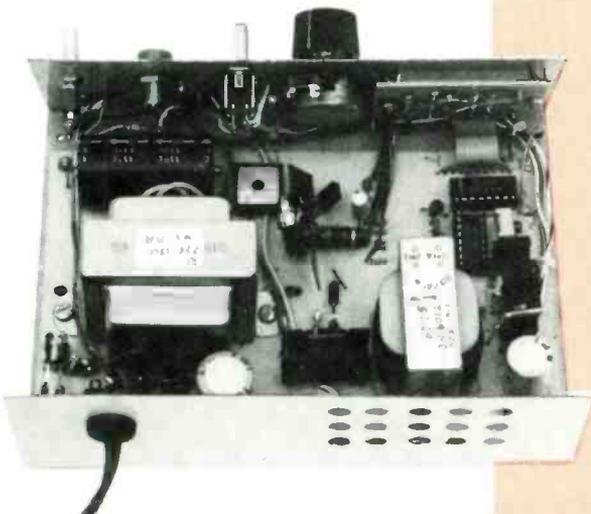
have a "universal" power supply, you still have to hook up an ammeter to monitor current, which means breaking the circuit to keep track of the load current. And things are further complicated if, like most other hobbyists, you only have one meter—a multimeter (either digital or analog; it really doesn't matter). To simplify the bench setup, a digital display was incorporated into the Power Play, enabling you to check voltage and current (without breaking the circuit) levels.

## Keep it Simple

The Power Play is a rather simple circuit built around commonly available components, as revealed by the schematic diagram shown in Fig. 1. The heart of the circuit is the power-supply section (precisely two power supplies), based on ordinary 3-terminal regulators—two 7805 5-volt regulators and an LM317 adjustable regulator. Two of the regulators (U1 and U2) supply outboard power for testing and experimenting.

The LM317 adjustable regulator is continually variable from 1.2 to 30 volts (as measured between 0-30V and GND), meaning that it is necessary to provide a little squirt of negative voltage to force the adjustable output to the zero level. That's accomplished by feeding the output of U2 through D3 and D4, for a two-diode voltage drop (about 1.4 V), which, when fed through D2 to the output of U1, cancels out the regulators "idling" voltage. The other half of the outboard power-testing power supply (U2) has its positive output connected as ground, with what would normally be the ground return line used as the negative-voltage output. In other words, U2's output is used as a positive ground, and the negative output of BR2 fed through as a negative voltage. The level between the positive (GND) and the -5/-10 terminals is clamped to 5-volt (without respect to the regulator's configuration).

The third regulator (U3) provides power for the display elements. The display's power supply (consisting of U3, a 7805, 5-volt regulator fed from a .5-A bridge rectifier) is



The author chose to assemble the circuit on printed-circuit board. But, since this is suppose to be a junkbox circuit, use whatever material (PC board or perfboard (either the plain Jane, or copper-clad type)—you have on hand.

nothing more than your basic 3-terminal regulator circuit. Its regulated output is filtered by C10 (a 2200- $\mu$ F capacitor) and fed to U4 (a CA3162E AD converter). U5 (a CA3161E 7-segment decoder/driver) and finally, the display units, DISP1-DISP3.

The output of U1, sampled across R3 (a 1-ohm resistor), is fed to the input of the A/D converter U4 at pins 10 and 11. The voltage across a 1-ohm resistor is a direct measure of the current through the device. S1, a 4-pole, double-throw switch, is used to alternate the meter readings between voltage and current. If a four-pole, double-throw switch bothers you, just consider that the alternative is using four separate

single-pole, double-throw switches which would otherwise have to be set individually, each section doing a different job.

### Putting It Together

The author chose to assemble the circuit on printed-circuit board. But, since this is suppose to be a junkbox circuit, use whatever material—PC board or perfboard (either the plain Jane, or copper-clad pre-etched type)—you have on hand. And so, no etching pattern is shown because of the certainty that your parts are of different shapes and sizes—besides, designing a power supply means doing it yourself. That's where the fun is!

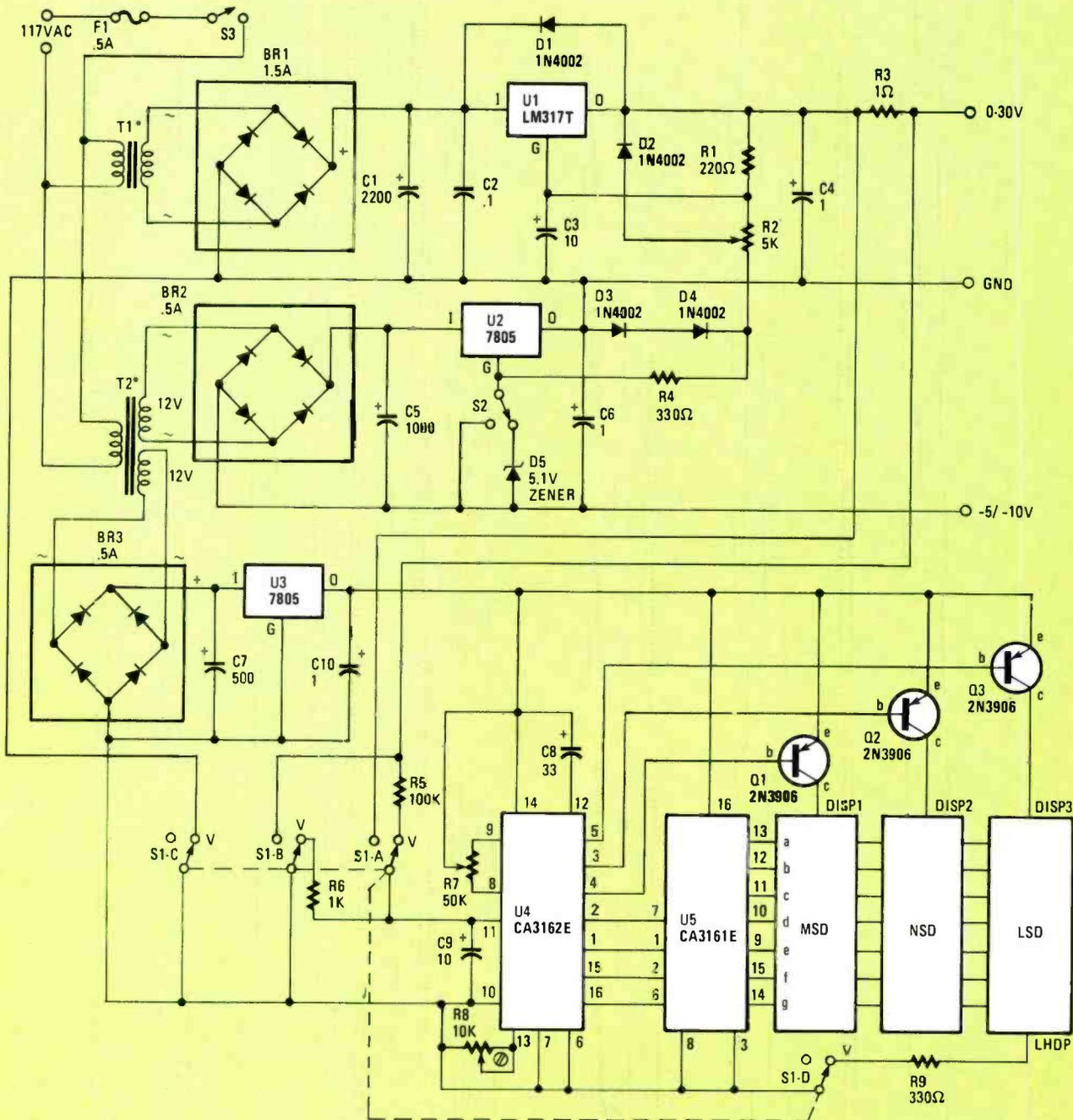


Fig. 1—Power Play is a rather simple circuit built around commonly available components. At its heart is the power-supply section (actually two power supplies), based on ordinary 3-terminal regulators—two 7805 5-volt regulators and a LM317 positive adjustable regulator. Two of the regulators (U1 and U2) supply outboard power for testing and experimenting. The third regulator (U3) provides power for the system's display elements.

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## Hands-On Electronics.

### 61 Hands-on Electronics FactCard

### 4047: Low Power Monostable Astable Multivibrator

**APPLICATIONS**

- Frequency discriminators
- Timing circuits
- Time-delay applications
- Envelope detection
- Frequency multiplication
- Frequency division

**ABSOLUTE MAXIMUM RATINGS**

V<sub>DD</sub> DC Supply Voltage -0.5 to +18V<sub>DC</sub>  
V<sub>IN</sub> Input Voltage -0.5 to V<sub>DD</sub> + 0.5V<sub>DC</sub>  
T<sub>S</sub> Storage Temperature Range -65° to +150°C  
P<sub>D</sub> Package Dissipation 500 mW  
T<sub>L</sub> Lead Temperature (Soldering, 10 seconds) 260°C

**RECOMMENDED OPERATING CONDITIONS**

V<sub>DD</sub> DC Supply Voltage 3 to 15V<sub>DC</sub>  
V<sub>IN</sub> Input Voltage 0 to V<sub>DD</sub>V<sub>DC</sub>  
T<sub>A</sub> Operating Temperature Range  
CD4047BM -55°C to +125°C  
CD4047BC -40°C to +85°C

**FEATURES**

- Wide supply voltage range 3.0V to 15V
- High noise immunity 0.45V<sub>DD</sub> (typ.)
- Low power TTL compatibility fan out of 2 driving 74L or 1 driving 74LS

**SPECIAL FEATURES**

- Low power consumption: special CMOS oscillator configuration
- Monostable (one-shot) or astable (free-running) operation
- True and complemented buffered outputs
- Only one external R and C required

### 62 Hands-on Electronics FactCard

### 4051, 4052, 4530: Analog Multiplexer/Demultiplexer

**ABSOLUTE MAXIMUM RATINGS**

V<sub>DD</sub> DC Supply Voltage -0.5Vdc to +18Vdc  
V<sub>IN</sub> Input Voltage -0.5Vdc to V<sub>DD</sub> + 0.5Vdc  
T<sub>S</sub> Storage Temperature Range -65° to +150°C  
P<sub>D</sub> Package Dissipation 500mW  
T<sub>L</sub> Lead Temperature (soldering, 10 seconds) 260°C

**RECOMMENDED OPERATING CONDITIONS**

V<sub>DD</sub> DC Supply Voltage +5Vdc to +15Vdc  
V<sub>IN</sub> Input Voltage 0V to V<sub>DD</sub> Vdc  
T<sub>A</sub> Operating Temperature Range  
4051BM/4052BM/4053BM -55°C to +125°C  
4051BC/4052BC/4053BC -40°C to +85°C

**FEATURES**

- Wide range of digital and analog signal levels: digital 3-15V, analog to 15V<sub>pp</sub>
- Low "ON" resistance: 80Ω (typ.) over entire 15V<sub>pp</sub> signal-input range for V<sub>DD</sub>-V<sub>EE</sub> = 15V
- High "OFF" resistance: channel leakage of ±10 pA (typ.) at V<sub>DD</sub> - V<sub>EE</sub> = 10V

### 63 Hands-on Electronics FactCard

### ICL7126: 3½-Digit A/D Converter

**FEATURES**

- Guaranteed zero reading for 0 Volts input on all scales
- True polarity at zero for precise null detection
- 1pA typical input current
- True differential input and reference
- Direct LCD display drive—no external components required.
- Pin compatible with the ICL7106
- Low noise—less than 15μV p-p
- On-chip clock and reference
- Low power dissipation guaranteed less than 1mW
- No additional active circuits required
- Evaluation Kit available (ICL7126EV/KIT)
- 8,000 hours typical 9 Volt battery life

**ABSOLUTE MAXIMUM RATINGS**

Supply Voltage (V+ to V-) 15V  
Analog Input Voltage (either input) (Note 1) V+ to V-  
Reference Input Voltage (either input) V+ to V-  
Clock Input TEST to V+  
Power Dissipation  
Ceramic Package 1000mW  
Plastic Package 800mW  
Operating Temperature 0°C to +70°C  
Storage Temperature -65°C to +160°C  
Lead Temperature (Soldering, 60 sec) 300°C

# 61 Hands-on Electronics FactCard

## 4047: Low Power Monostable Astable Multivibrator

### STATIC ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS			LIMITS at 25°C (Typ.)	UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)		
Quiescent Device Current, I <sub>DD</sub> Max.	—	0.5	5	0.02	μA
	—	0.10	10	0.02	
	—	0.15	15	0.02	
Output Low (Sink) Current I <sub>OH</sub> Min.	—	0.20	20	0.04	mA
	0.4	0.5	5	1	
	0.5	0.10	10	2.6	
Output Voltage: Low-Level, V <sub>OL</sub> Max.	1.5	0.15	15	6.8	mA
	4.6	0.5	5	-1	
	2.5	0.5	5	-3.2	
Input Current I <sub>IN</sub> Max.	9.5	0.10	10	-2.6	μA
	13.5	0.15	15	-6.8	

CHARACTERISTIC	CONDITIONS			LIMITS at 25°C (Typ.)	UNITS
	V <sub>O</sub> (V)	V <sub>IN</sub> (V)	V <sub>DD</sub> (V)		
Output Voltage: Low-Level, V <sub>OL</sub> Max.	—	0.5	5	0	V
	—	0.10	10	0	
	—	0.15	15	0	
Output Voltage: High-Level, V <sub>OH</sub> Min.	—	0.5	5	5	V
	—	0.10	10	10	
	—	0.15	15	15	
Input Low Voltage, V <sub>IL</sub> Max.	0.5, 4.5	—	5	—	V
	1.9	—	10	—	
	5, 13.5	—	15	—	
Input High Voltage, V <sub>IH</sub> Min.	0.5, 4.5	—	5	—	V
	1.9	—	10	—	
	5, 13.5	—	15	—	

# 62 Hands-on Electronics FactCard

## 4051, 4052, 4530: Analog Multiplexer/Demultiplexer

### ELECTRICAL CHARACTERISTICS

CHARACTERISTIC	CONDITIONS				LIMITS at 25°C (Typ.)	Units
	V <sub>IN</sub> (V)	V <sub>EE</sub> (V)	V <sub>SB</sub> (V)	V <sub>OC</sub> (V)		
Quiescent Device Current, I <sub>DD</sub> Max.				5	0.04	μA
				10	0.04	
				15	0.04	
				20	0.08	
ON Resistance R <sub>ON</sub> Max.	0	0	5	470	Ω	
	0	0	10	180		
	0	0	15	125		
	0	0	15	5		
Δ ON Resistance Δ R <sub>ON</sub>	0	0	5	10	Ω	
	0	0	10	10		
	0	0	15	5		

CHARACTERISTIC	CONDITIONS				LIMITS at 25°C (Typ.)	Units
	V <sub>IN</sub> (V)	V <sub>EE</sub> (V)	V <sub>SB</sub> (V)	V <sub>DD</sub> (V)		
Off Channel Leakage Current	0	0	10	±0.01	nA	
	0	0	15	±0.01		
	0	0	20	±0.01		
	0	0	10	±0.01		
All Channels OFF (Common OUT/IN) Max.	0	0	15	±0.01	nA	
	0	0	20	±0.01		
Output, C <sub>out</sub>				30	pF	
	CD4051			18		
	CD4052	-5	-5	5		9
	CD4053					0.2
Feedthrough, C <sub>out</sub>					pF	

# 63 Hands-on Electronics FactCard

## ICL7126: 3½-Digit A/D Converter

### ELECTRICAL CHARACTERISTICS

Characteristics	Conditions	Typ	Units
Zero Input Reading	V <sub>IN</sub> = 0.0V Full Scale = 200.0mV	±000.0	Digital Reading
Ratiometric Reading	V <sub>IN</sub> = V <sub>REF</sub> V <sub>REF</sub> = 100mV	899/1000	Digital Reading
Rollover Error	-V <sub>IN</sub> = +V <sub>IN</sub> = 200.0mV	±0.2	Counts
Linearity	Full Scale = 200mV or Full Scale = 2.000V	±0.2	Counts
CMRR	V <sub>CM</sub> = ±1V, V <sub>IN</sub> = 0V Full Scale = 200.0mV	50	μV/V
Noise (Pk - Pk)	V <sub>IN</sub> = 0V Full Scale = 200.0mV	18	μV
Leakage Current @ Input	V <sub>IN</sub> = 0V	1	pA

Characteristics	Conditions	Typ	Units
Zero Reading Drift	V <sub>IN</sub> = 0 0°C < T <sub>A</sub> < 70°C	0.2	μV/°C
Scale Factor, Temperature Coefficient	V <sub>IN</sub> = 199.0mV 0°C < T <sub>A</sub> < 70°C	1	ppm/°C
Supply Current	V <sub>IN</sub> = 0 (Noise 5)	50	μA
Analog COMMON Voltage	205kΩ between Common & pos Supply	2.8	V
Temp Coeff of Analog COMMON	25kΩ between Common & pos Supply	80	ppm/°C
Pk-Pk Segment Drive Voltage	V <sub>+</sub> to V <sub>-</sub> = 9V	5	V
Pk-Pk Backplane Drive Voltage	V <sub>+</sub> to V <sub>-</sub> = 9V	5	V

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## PARTS LIST FOR THE POWER PLAY

### SEMICONDUCTORS

- BR1—1.5-A, 100-PIV fullwave bridge rectifier  
BR2, BR3—.5-A, 100-PIV, fullwave bridge rectifier (or four 1N4002 rectifier diodes)  
D1—D4—1N4002 1-A, 100-PIV, rectifier diode  
D5—5.1-volt Zener diode  
DISP1—DISP3—7-segment common-anode LED displays  
Q1—Q3—2N3906 general-purpose PNP silicon transistor  
U1—LM317T positive adjustable regulator, integrated circuit  
U2, U3—7805 positive, 5-volt fixed regulator, integrated circuit  
U4—CA3162E analog-to-digital (A/D) converter, integrated circuit (Jameco Electronics)  
U5—CA316E 7-segment decoder/driver, integrated circuit

### RESISTORS

(All resistors are 1/4-watt, 5% units, unless otherwise noted.)

- R1—220-ohm  
R2—5000-ohm potentiometer  
R3—1-ohm, 2-watt  
R4—330-ohm

- R5—100,000-ohm  
R6—1000-ohm 1%  
R7—50,000-ohm trimmer potentiometer  
R8—10,000-ohm trimmer potentiometer  
R9—330-ohm

### CAPACITORS

- C1—2200- $\mu$ F, 50-WVDC electrolytic  
C2—1- $\mu$ F, 35-WVDC tantalum  
C3, C9—10- $\mu$ F, 35-WVDC electrolytic  
C4, C6, C10—1- $\mu$ F, 35-WVDC tantalum  
C5—1000- $\mu$ F, 16-WVDC electrolytic  
C7—500- $\mu$ F, 16-WVDC electrolytic  
C8—0.33- $\mu$ F, 16-WVDC tantalum

### ADDITIONAL PARTS AND MATERIALS

- F1—0.5-A fuse, type 3AG  
S1—4PDT toggle switch (Dick Smith Electronics)  
S2—SPDT toggle switch  
S3—SPST toggle switch  
T1—32-volt, 1-A secondary, stepdown transformer  
T2—Dual 12-volt, 180-mA secondary, stepdown transformer (Digi-Key) Printed-circuit or perfboard materials, enclosure, IC sockets, fuse holder, line cord, spacers, dry-transfer letters/numbers, wire, solder, hardware, etc.

We'll look at the assembly in terms of perfboard construction. Start by tentatively arranging the major parts in an orderly manner following the flow of the schematic as much as possible. Install sockets for the IC's on the board, and place a dot next to pin 1 of each socket. Marking pin 1 helps to keep down confusion when wiring. Now, following the schematic diagram in Fig. 1, begin installing the support components one at a time, and connecting them at the proper points as you go along. When soldering, keep in mind that semiconductors are thermally sensitive; too much heat and they'll self-destruct.

Once all of the circuit-board assembly is completed, prepare the enclosure that is to house Power Play. Keep in mind that the LED display board, potentiometer R2, three jacks, and three switches will be mounted on the front panel. All of the parts will require a certain amount of clearance, so mount the taller items such as radial electrolytic capacitors and voltage regulators with heat sinks in the rear.

In addition, it will be necessary to build a display board if you don't have a suitable multiplexed display tucked away in your parts bin. When both boards are complete, check out the voltmeter by placing all of the S1 contacts that apply to the

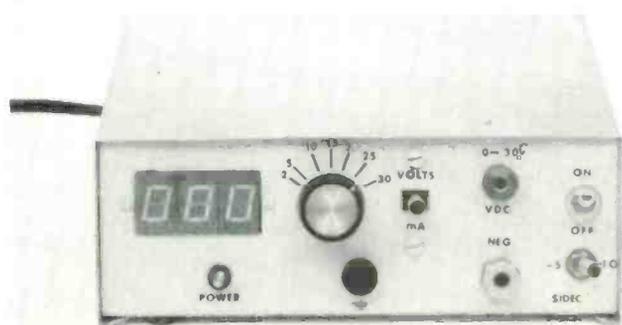
switch in the voltage position. Power it up (with a 5-volt supply) and short pins 10 and 11 of U4 together. All three digits and the decimal point should light.

If not, check all the usual things again—polarity of the diodes and capacitors, solder bridges, bad solder joints, bad wiring, and flux residue, all of which can make things go haywire. When all displays light, adjust R7 until you get a reading of zero point zero, which may be a little touchy.

Then connect a separate power supply to the system positive and ground outputs, along with a voltmeter of good accuracy, and adjust R8 until the readout matches the standard. Use a voltage of 15 to 20 volts for calibration. That's all there is to it until everything is all buttoned up when you may need to tweak R7 and R8 again.

Before leaving you to your own devices, a couple of words of caution may be in order. First, take special care to properly insulate, separate, and isolate the incoming AC line voltage. It can be very dangerous. Don't fail to install a .5-A fuse in the transformers' primary circuit. Also, remember that heat sinks are necessary especially on U1, which needs a fairly large one.

Having gone to all that trouble, it seems a shame not to doll it up a little with Dry-Transfer Lettering. Another idea that may prove to be highly gratifying is the use of one of Radio Shack's "new" super bright LED's for a pilot light. When hooked up to the voltmeter's 5-volts supply bus along with a 330-ohm current-limiting resistor, it really is bright. ■



Once all of the assembly is completed, and the circuit board mounted securely within its enclosure, the project can be greatly enhanced through the application of Dry Transfer Lettering to indicate various switches and controls.

# WIND WITCHER



Listen to mother natures gentle song with this hot-wire sensor electronic chime.

By Charles D. Rakes

□ MOTHER NATURE'S MUSICAL SYMPHONY IS WRITTEN IN her gentle breezes and gale force winds to be lost forever in time, but that need not be the case if you build our motionless *Wind Witcher* to decode and play Mother's soothing melodies as she drifts by. I'm sure that you have had, at one time or another, a wind chime that clattered away as the breezes blew by, that rendered a wind-motion melody of sorts. And, if Murphy's law prevails at your abode as he does at ours, the good sounding chimes usually end up on the ground in pieces after the first spring storm blows through.

## Chiming in

Our *Wind Witcher* does not use any fragile, free-swinging objects to produce it's own unusual music, but operates on the seldom utilized effect of cooling a heated wire by moving air and measuring the resistance or voltage change across it to indicate the strength of flow.

Most any heated conductor will display the effect, but to a

much lesser degree than either tungsten or platinum, which are the best materials to use. Don't take out a loan to purchase the material yet, because you can have a ready-made hot wire

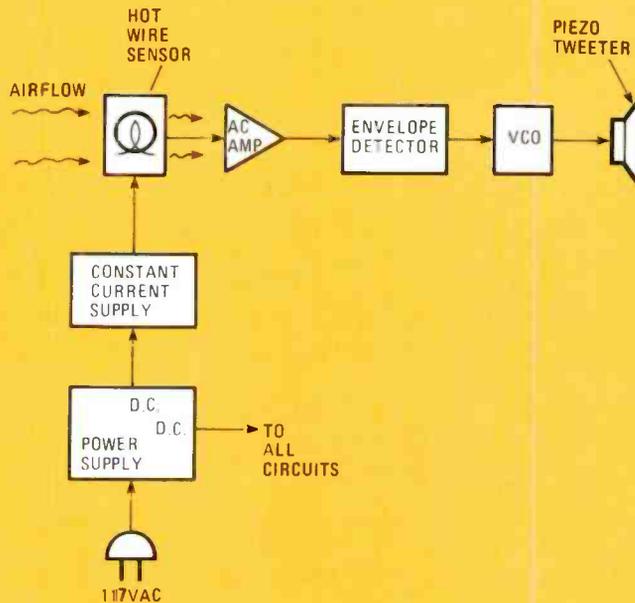


Fig. 1—The action of the *Wind Witcher* is simple. Power is supplied to the bulb element by a constant-current source so the variation in its resistance can be measured as voltage. The varying voltage is then amplified and sent to an envelope detector that averages the AC signal. The average signal controls a VCO which then outputs to the tweeter.

for less than a buck. A #53 incandescent indicator lamp will do just fine with a simple modification. That's to break the glass bulb without getting cut or destroying the filament in a single blow. More about that later.

### How it Works

Take a gander at the witcher's block diagram in Fig. 1, and you will begin to see how the circuit sings when the wind blows.

As the air moves over the sensor, its resistance varies, due to the cooling effect of the breeze. Since the sensor is fed by a constant-current source, as the sensor's resistance varies, the voltage across it varies also. That alternating voltage is fed to a low-frequency amplifier where it is boosted up. The output is fed to a circuit that produces a low-frequency varying voltage in step with the air currents passing over the sensor.

A voltage-controlled oscillator takes hold of the detector's output and sings along with the varying voltage and a piezo tweeter conveys the music to the outside world.

### The Circuit

The circuit's energy appetite is provided for by a twelve-volt regulated power supply (see Fig. 2). The bridge provides full-wave rectification which the input capacitor, C1, then smooths out for the regulators use.

A constant-current source has its output controlled by taking the constant voltage that would appear at the junction of R1 and D1, and applying it to Q2. Transistor Q2 then biases Q3 with a current developed from the difference in voltage between the reference voltage at its base and its collector

voltage. In this way, Q3 will follow any swings in voltage, effectively limiting current flow to a specific value. The constant-current source also provides protection against a high-current burnout when power is first applied.

The varying voltage across I1 is then fed to U1-a via C3, R2, and R16. The signal is amplified there  $\times 200$  and fed to the envelope circuit which is a voltage doubler composed of D2, D3, C4, and C5.

A two opamp voltage-controlled oscillator is composed of U1-b, U1-c, and their supporting components. It is fed the voltage across C5 which controls its oscillating frequency, which is fed to the piezo tweeter SPKR1.

### Building Your Own

The complete circuit is built on a 4  $\times$  4-1/2-in. piece of perfboard, with a corner cut-out to clear the power transformer, see photo. A 2-7/8  $\times$  5-5/8  $\times$  5-1/8-in. plastic cabinet houses the components with the sensor and tweeter mounted on the top of the case, and the sensitivity control and power switch on the front panel.

Neither the circuit or the mechanical layout is critical so build to suit, but keep the sensor protected and located at a high point on the enclosure for the best performance. If you want to copy our model just follow the layout shown in the photos and wire to match the circuit in Fig. 2.

### Breaking the bulb

The glass bulb on a #53 lamp can be removed in the following manner. Wrap a tissue loosely around the glass and place the covered bulb between the jaws of a small bench vise. Carefully crank the vise inward until you hear the glass

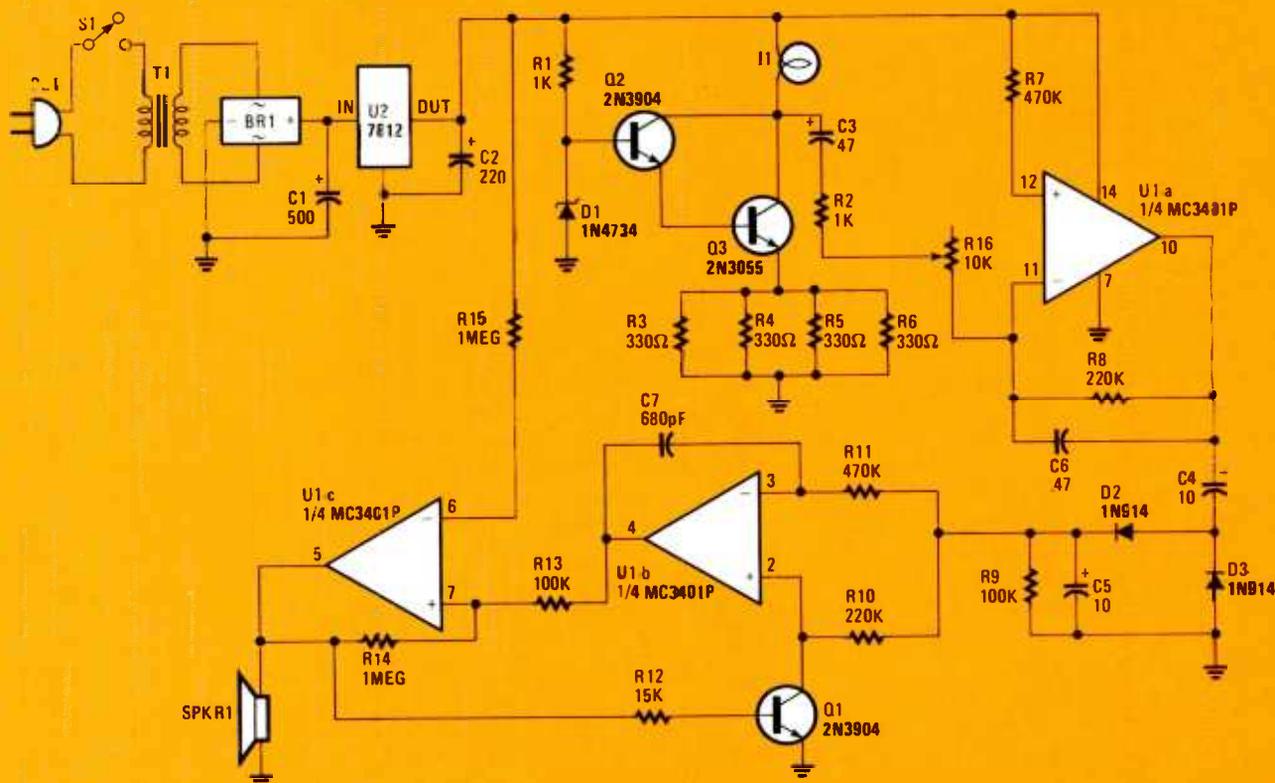


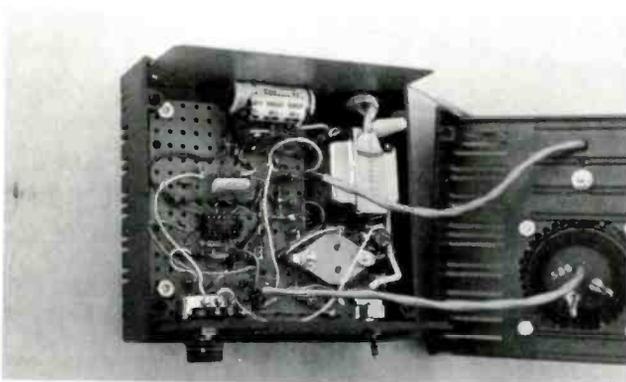
Fig. 2—Don't let the paralleled resistors R3-R6 throw you. They are paralleled so that you can adjust the total value of their resistance by snipping one out of the circuit.



Here's a close-up view of the bulb filament. Notice that the film container cap is secured by the bayonet socket hardware. Make sure you remove all the little fragments of glass.

implode. Position the tissue over a waste basket and let the tissue and glass pieces fall into it. Inspect the filament for damage. If it's okay place in a safe location until you are ready to put it in place.

A bayonet lamp holder is mounted in the lid of a 35mm plastic film container on the top of the cabinet with 6-32 hardware. The tubular section of the film holder is perforated, near the closed end, with six  $\frac{3}{8}$ -inch holes evenly spaced at about  $\frac{1}{2}$ -in. from the end, to allow the breezes to pass through. Don't worry about being perfect in making holes, as any close attempt will do just fine.



Note that the power transistor is upside down, that is to facilitate mounting the leads on the top of the board.

Locate the tweeter near the back and in the center of the top of the cabinet and cut a hole to just clear the back extension of the speaker. Use the speaker as a template and drill the four mounting holes for 6-32 hardware, and mount it in place.

The perfboard holding the circuit components is mounted to the bottom of the cabinet with 6-32 hardware and supported with four  $\frac{1}{4}$ -in. plastic spacers. The 12-volt transformer is mounted in the corner with 6-32 hardware. A power cord connects to the transformer and S1 and passes through a rubber grommet on the back panel to the outside world.

### Making Her Sing

Don't place the #53 lamp in the socket until the following preliminary tests are completed. Look the circuit over for any wiring errors or poor solder joints, and if it looks good plug the witcher in and turn the power on.

Check the DC voltage at the plus side of C1, it should be somewhere between 15 and 20 volts. The voltage at the output

## PARTS LIST FOR THE WIND WITCHER

### SEMICONDUCTORS

D1—1N4734 5.6-volt zener diode D2,D3—1N914 silicon diode  
Q1,Q2—2N3904 NPN general purpose transistor  
Q3—2N3055 NPN power transistor  
U1—MC3401P quad-op-amp  
U2—7812 12-volt regulator

### CAPACITORS

C1—500- $\mu$ F, 25-WVDC electrolytic  
C2—220- $\mu$ F, 25-WVDC electrolytic  
C3—47- $\mu$ F, 25-WVDC electrolytic  
C4,C5—10- $\mu$ F, 25-WVDC electrolytic  
C6—47- $\mu$ F, 100-WVDC mylar  
C7—680-pF ceramic disc

### RESISTORS

(All fixed resistors are  $\frac{1}{4}$ -watt units except where noted.)

R1, R2—1,000  $\frac{1}{2}$ -watt resistor  
R3—R6—330-ohm  
R7, R11—470,000-ohm  
R8, R10—220,000-ohm  
R9, R13—100,000-ohm  
R12—15,000-ohm  
R14, R15—1-Megohm  
R16—10,000 potentiometer

### ADDITIONAL PARTS AND MATERIALS

BR1—1-A, 100-volt, full-wave, bridge rectifier  
I1—#53 bayonet lamp, (see text)  
SPKR1—2-in. Piezo tweeter (Radio Shack 40-1383)  
S1—SPST mini toggle switch  
T1—117 to 12.6-volt, 1.2-A transformer  
2- $\frac{7}{8}$  x 5- $\frac{5}{8}$  x 5- $\frac{1}{8}$ -in. instrument case, Radio Shack #270-250, power cord, perfboard, knob, 35-mm film case, etc.

of the regulator, U2, should be near 12-volts. The voltage at pin number 10 of U1 should be about 6-volts. If those voltages check out OK then proceed on to setting the constant current level for the sensor.

Set your VOM to DC on the 100-mA range. Connect the positive lead to the plus 12-volt supply and the negative lead to the collectors of Q2 and Q3. If the current reading is between 50 and 60 mA the circuit is ready for the #53 modified lamp to be placed in it's socket, but if the current value falls below or above the set limits, proceed to correct the current setting.

If the current is too high, remove one of the 330-ohm resistors, R3-R6, and recheck the current flow. Parallel a higher value resistor, say a 470-ohm and see if the new current value falls within the 50 to 60 mA range. If the current happens to be too low with the four 330-ohm resistors in place, try paralleling the foursome with a higher value resistor to obtain the desired current flow. Rummage through the junk box and pull out the resistor supply if necessary to hit on the right resistor combination.

With the #53 bulb in the socket, place the protective film case over it and set the witcher in an area where a slight breeze is blowing. Turn the gain pot, R16 to it's minimum resistance value and the Witcher should respond with a musical sound. Set the gain control to suit the amount of breeze or wind that's passing over the sensor. Enjoy. ■



# 5 × 5 AUDIO SWITCH BOX

Switch the connections between audio components without touching a single wire with this homebrew accessory.

By Sam Allen

**I**F YOU'VE EVER HAD TO SORT THROUGH A RAT'S NEST OF cables to get the right plug and jack combination to make a recording, or to play a device through your stereo amplifier, you'll appreciate the 5 × 5 Audio Switch Box. The Switch Box provides a convenient means by which to switch between 5 inputs and outputs in any combination, and features a built-in stereo headphone amplifier that allows you to monitor any of the outputs.

The Switch Box was designed to help in making musical demo tapes through a setup similar to the one shown in Fig. 1. However, it might just as easily be used in the home-stereo system setup (like that shown in Fig. 2), or in practically any system where needed.

Although the Switch Box's monitor amplifier was designed to be used with a mini stereo headset, it is capable of driving a standard headset or 8-ohm speakers. (But don't expect hi-fidelity audio; it's adequate for monitoring.)

The advantage of the built-in monitor is most apparent in the Fig. 1 setup. If you're dubbing from reel-to-reel to cassette, and there is an equalizer and reverb in the line, you can compare the raw output of the reel-to-reel with that of the equalizer or reverb simply by switching the monitor-select switch.

The schematic diagram in Fig. 3 shows one channel of the Switch Box; for stereo operation, two such circuits (tied to the same set of dual-gang 6-position switches). To make construction as easy as possible, the Switch Box is designed around commonly available components; all of them may be purchased at a Radio Shack or just about any well-stocked parts supplier. Although wiring the jacks and switches is time-consuming, it is not difficult, making the project one that anyone can tackle regardless of his or her level of skill.

## Construction

Begin construction by preparing the case. A metal case is important for shielding, so if you substitute another case,

## PARTS LIST FOR THE 5 × 5 AUDIO SWITCH BOX

### SEMICONDUCTORS

LED1—T-1 3/4 (RS #276-041) jumbo red light-emitting diode  
U1, U2—LM386 (RS #276-1731) 4-watt audio power amplifier, integrated circuit

### RESISTORS

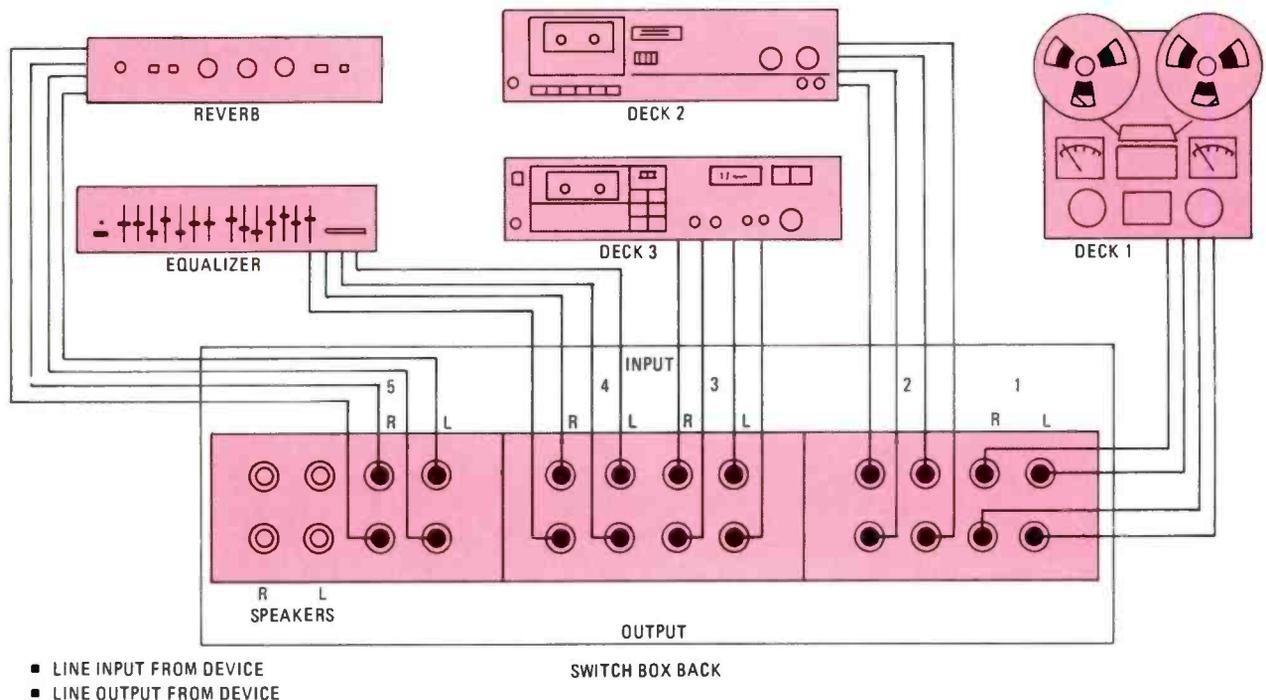
(All resistors are 1/2-watt, 5% units, unless otherwise noted.)  
R1—100,000-ohm audio-taper potentiometer (RS#271-1732)  
R2, R3—10,000-ohm  
R4, R5—10-ohm  
R6, R7—100,000-ohm  
R8—R17—2200-ohm

### CAPACITORS

C1, C2—220 $\mu$ F, 16-WVDC electrolytic  
C3, C4—0.047 $\mu$ F, 50-WVDC  
C5, C6—4.7 $\mu$ F, 50-WVDC non-polarized electrolytic  
C7—0.1 $\mu$ F, 50-WVDC ceramic disc

### ADDITIONAL PARTS AND MATERIALS

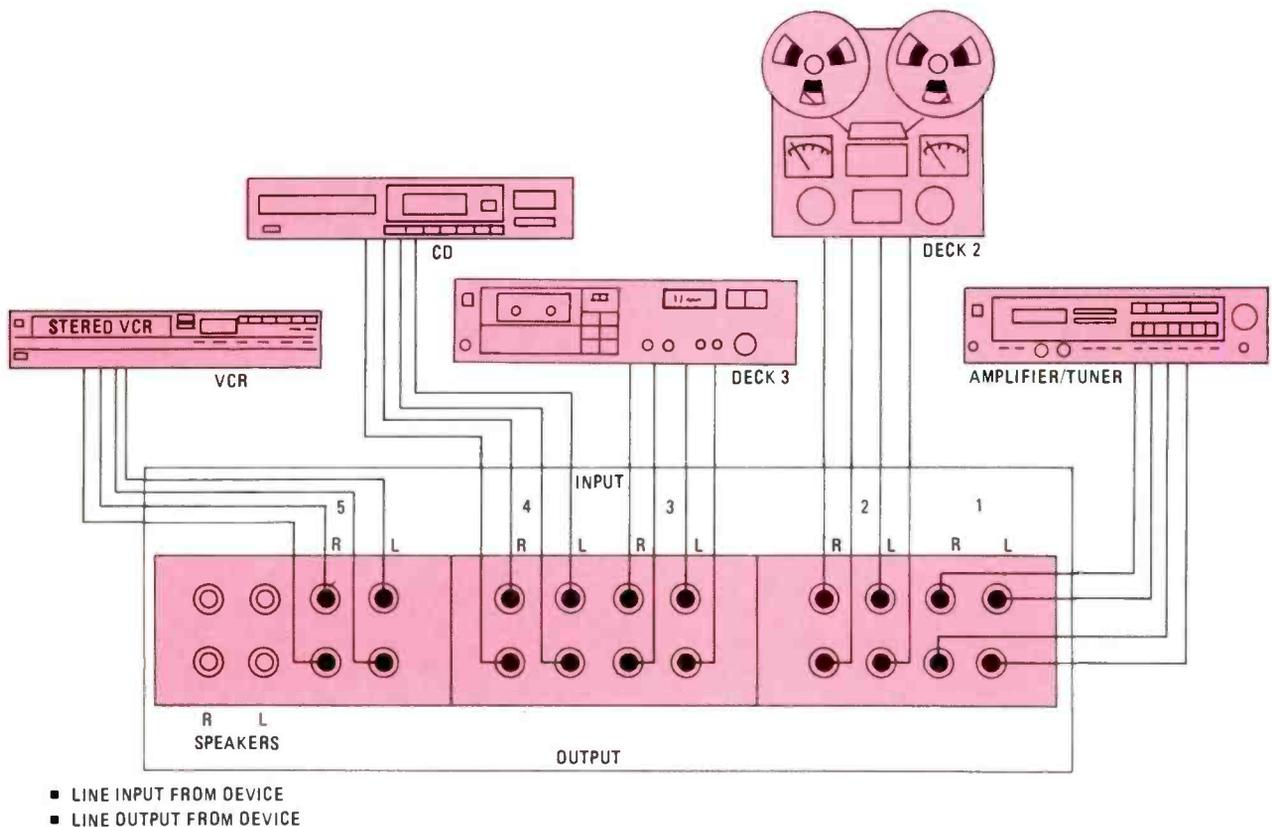
J1—J20—8-position, RCA phono-jack board (RS 274-370)  
J21—Miniature 3-conductor, closed-circuit jack (RS 274-250)  
S1—S6—2-pole, 6-position rotary switch (RS 275-1386)  
S7—Single-pole, single-throw (SPST) pushbutton on/off switch (RS 275-1565) Experimenters board (RS 276-170), PCB standoffs (RS 276-195) 8-pin IC sockets (RS 276-1995), 9-volt battery connector (RS 270-325), 9-volt battery holder (RS 270-326), knobs (RS 274-415), 3 1/16 × 8 1/4 × 6 1/8 enclosure (RS#270-274), dry-transfer labels (RS 270-201), two-conductor shielded cable (RS#278-1276), hook-up wire, solder, hardware, etc.



- LINE INPUT FROM DEVICE
- LINE OUTPUT FROM DEVICE

SWITCH BOX BACK

Fig. 1—This hook-up diagram illustrates how the Switch Box can be used in dubbing operations. The equalizer and reverb can be placed in line with any combination of tape decks.



- LINE INPUT FROM DEVICE
- LINE OUTPUT FROM DEVICE

OUTPUT

Fig. 2—The Switch Box can also be used to route signals from various stereophonic components to the amplifier or to other pieces of equipment in the system, allowing you to use all of the capabilities of your system without changing the cables.

make sure that it's large enough to accommodate the switches and jacks and that the entire enclosure is metal.

Figure 4 shows the front-panel layout used in the author's prototype of the Switch Box. (All dimensions are given in inches.) You can either lay out your circuit panel in a similar arrangement or try something more to your liking. Figure 5 shows how the input/output rear-panel jacks were laid out in

the prototype. Note that all inputs are positioned at the top, while all outputs are at the bottom. (Again, all dimensions are given in inches.) Drill holes (both fore and aft) for the panel-mounted components.

The case is then covered with a protective plastic film; with the film in place, the hole positions are center-punched to keep the bit reasonably stable during drilling. It's a good idea

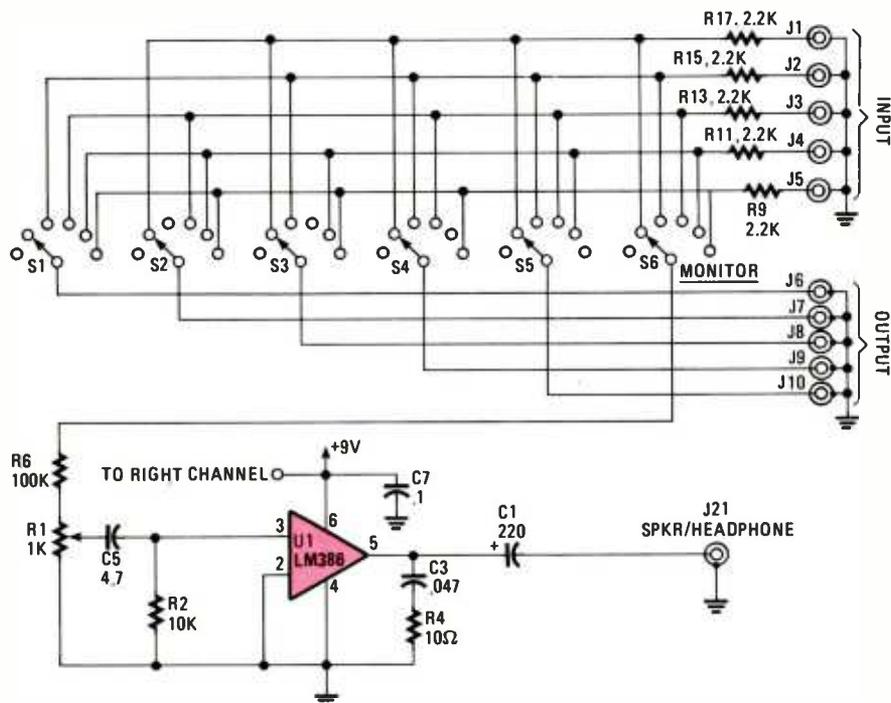
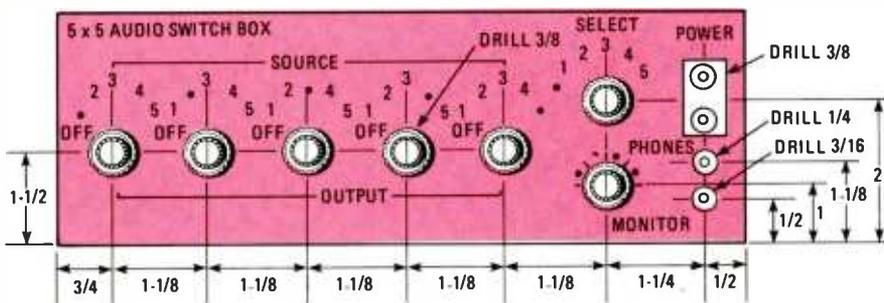
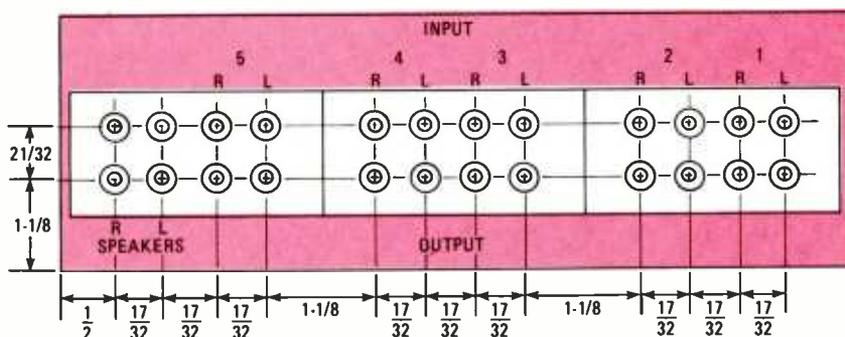


Fig. 3—To keep the schematic diagram simple, only the left channel is shown; if shown, the right channel would be the mirror image of the left.



NOTE: ALL DIMENSIONS IN INCHES

Fig. 4—Before you begin drilling holes for the front-panel mounted components, it is advisable that you first lay your pattern out on a sheet of paper. Then when satisfied with the arrangement, tape the pattern to the front panel, center-punch the panel, and drill to your heart's content.



NOTE: ALL DIMENSIONS IN INCHES  
ALL HOLES 3/8 INCH

Fig. 5—The rear-panel layout is made extremely simple through the use of 8-position RCA jacks. However, if you already have the single, double, or quad boards on hand, by all means use them.

to use some sort of solid backing for the panel while drilling. One way to provide a solid backing is to clamp a piece of 2 x 4 to your workbench, with

one end extending about 3 inches over the edge of the bench. After drilling, remove rough edges and the protective film from the case. And then rub-on lettering may be used to label the switch and jack locations.

may be used to label the switch and jack locations.

### The Panel-Mounted Components

Once the front- and rear-panel drilling is complete, mount three eight-position (six four-position or 12 two-position) phono-jack boards to the rear panel, using sheet-metal screws. It's OK for the ground terminal of the jacks to touch the metal case, but if the center terminal touches, remove the board and enlarge the hole with a file.

With the rear panel out of the way, turn your attention to the front-panel switches. The switch knobs should be mounted as close to the front panel as possible, meaning that the excess shaft length of each switch must be cut off. The least nerve-wracking way to accomplish that is to clamp the waste end of the shaft to your bench and, with a hacksaw, cut off the excess.

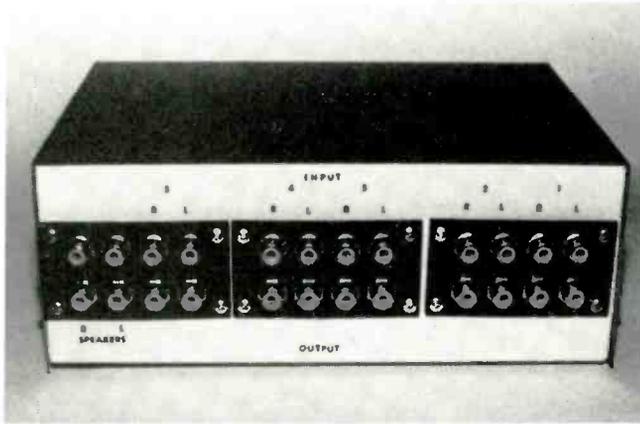
After the excess has been cut away, place a 1/16-inch washer over the threaded shaft, loosely mount the switches, and make sure that the knobs are close to the front panel.

With the case complete, you are ready to begin putting together the electronics.

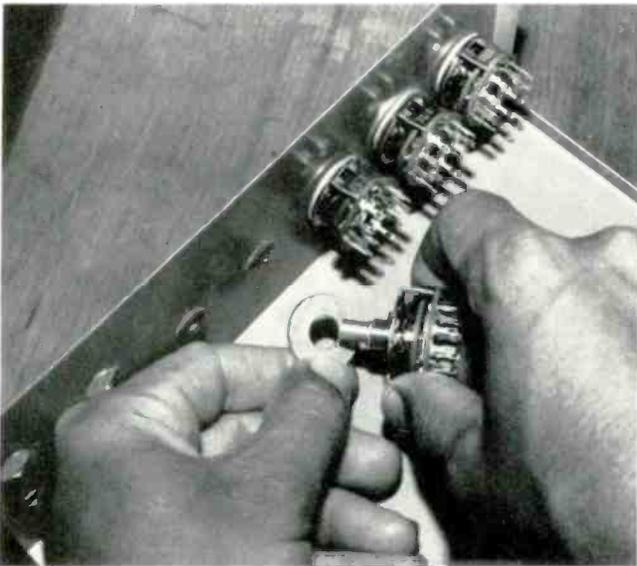
Begin with the switches. Each switch has 12 terminals around the outside and two in the center. Turn the switch counterclockwise until it stops to determine the first terminal of each, which will serve as the off position; therefore no connection is made to those terminals. Bend them slightly to mark their locations. Next turn the switch shaft one click in the clockwise direction, which will be input 1; one more click and you're at the input-2 position, and so on. Remember that the selectors are double-pole, six-position switches; one terminal (pole) is for the left channel and the other for the right.

For convenience, the author arranged the switches so that all of the left terminals were on top and the right terminals on the bottom. To make it (next to) impossible to connect the input and the output of the same device together, no connection is made to position 1 of S1; position 2 of S2, and so forth.

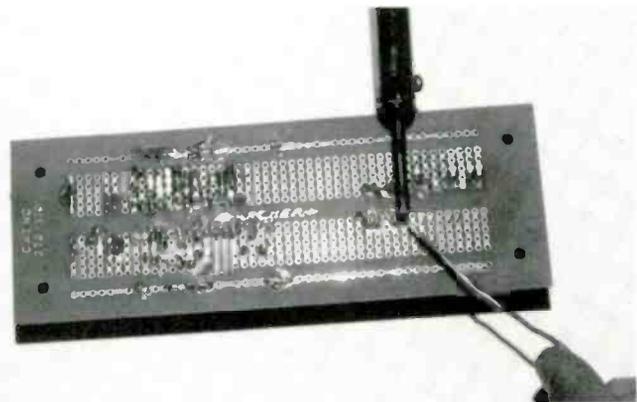
Next run jumpers from switch to switch to connect all of the left-channel position 1 terminals, and another to connect all of the right-channel position 1 terminals together. After which, connect all of the position 2 terminals together in the same manner, continuing until all of the terminals are properly connected.



This photo shows how the rear jacks are labeled.



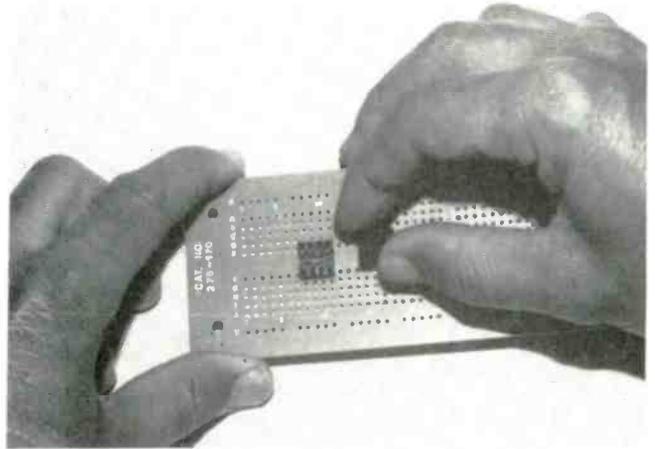
Test-fit the switches and other components in the case before proceeding with construction. Washers on the switch shafts will allow the knobs to be placed closer to the front.



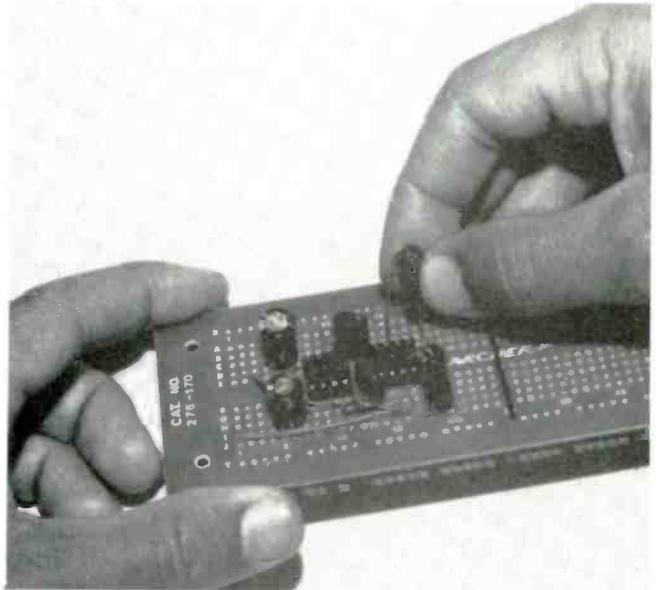
Insert the parts from the top of the board. Clip the leads to length and bend them over against the foil then solder them in place. When several parts are in close proximity, solder all of the leads at once to avoid closing off a hole with solder before the part is inserted.

Switch S3 lines up with the input terminals on the circuit board. Solder two-inch lengths of wire to all eight active terminals of S3. Also solder wires to the position 3 terminals of switch S4 since the number-three input is not connected to S3. They'll be connected to the circuit later.

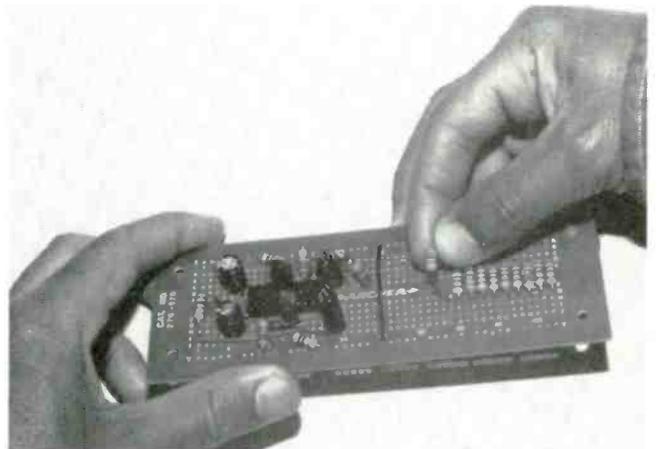
Next cut five pieces of shielded, two-conductor cable. The



Place the IC socket for U1 so that pin 1 is in hole E-17. Pin 1 on U2 should be in the hole corresponding to F-8.



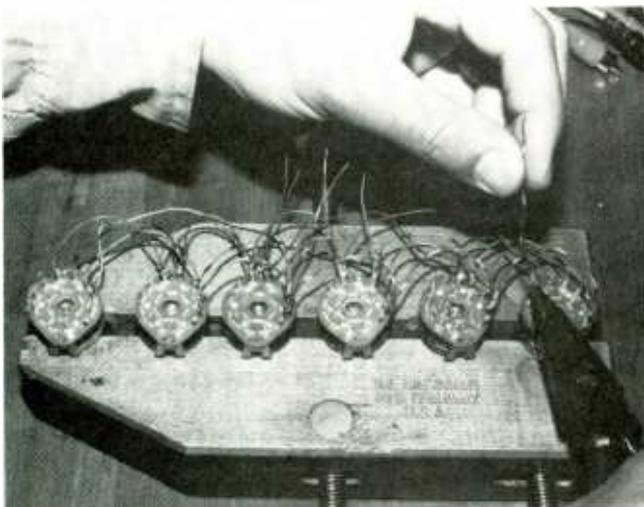
Next insert the capacitors in the locations indicated in the text: check their placement and orientation before soldering.



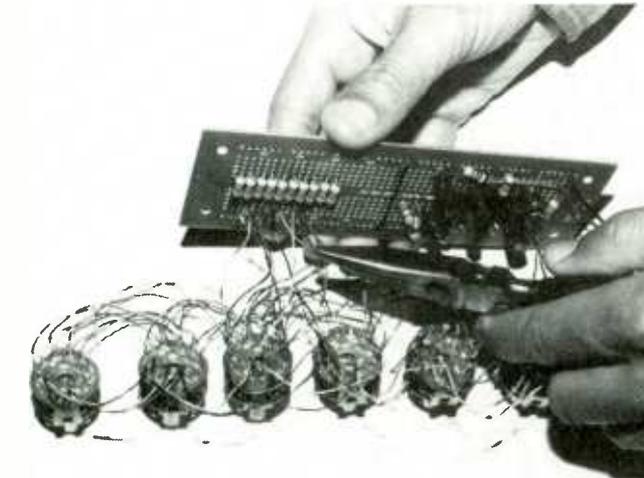
Insert the resistors into the holes listed in the directions.

cables should be long enough to reach from the switches on the front panel to the jacks on the back panel. Attach the two center conductors to the two center terminals on the switches; one terminal for the left channel and the other for the right.

Solder short pieces of insulated wire to the shield of each cable and insulate the connection with tape or heat-shrink-



Clamping the switches together like this makes it easy to connect all of the jumpers between the terminals. Space them about the same distance as they will be on the front panel so that the leads will be the correct length.



Before installing the switches and circuit board, solder the leads from the switches into the holes listed in the text.

ble tubing. Connect all of the shield wires together and then solder a short lead from them to the X ground bus on the circuit board.

Now connect the leads already soldered to switches S3 and S4 to the circuit board: left-channel, position I (L1) connects to the circuit board at position A-47 and right-channel position I (R1) to A-46; L2 to A-44 and R2 to A-43; L3 to A-41 and R3 to A-40; L4 to A-38 and R4 to A-37; L5 to A-35 and R5 to A-34. Solder two leads to the center terminals of the monitor-select switch and connect the left-channel lead to hole A-23 on the circuit board and the right to A-22.

Attach two-inch lengths of wire from volume control R1 to the circuit board. With the control placed so that the terminals are on the left side as viewed from the front, the top two terminals are the ground terminals; connect them together and use one lead to attach to hole X-17 on the circuit board. Connect the center terminal for the left channel to hole A-19 and the right channel to A-18.

The bottom terminal for the left channel attaches to hole A-21 and the right channel to A-20. Wire the headphone jack as shown in Fig. 6. Use a piece of shielded cable long enough to reach from the front panel to the rear-panel jacks for the speaker output. The leads that attach to the circuit board

should be about two inches long.

The ground lead connects to hole X-3, the left channel to A-3 and the right to A-5. Solder short, insulated wires to LED1 and insulate the connections with tubing. Attach the anode lead to the circuit board at A-1 and the cathode at X-1. Attach 3-inch leads for the power switch to the circuit board at H-2 and J-1.

The components can now be mounted in the case. Attach the PC standoffs to the case but leave the PC board unattached for now. Place the volume control and the switches in their holes and secure the nuts. Push the LED into its hole in the front panel; it should fit tightly to stay in place. If the LED is loose in its hole, use a little glue to secure it. Put the headphone jack in place on the front panel and secure it.

The power switch pushes in from the front of the panel and is secured with a nut on the back. After it is in place, connect it to the circuit board. Solder a three-inch long lead to the "Y" ground bus on the circuit board. Scratch the paint from a small area on the bottom of the case and solder the ground lead to the case at that point. That ensures a good ground connection to the case providing shielding from outside noise. Attach the battery holder to the case with a small machine screw and a nut. Place the nut on the bottom and cut the screw off flush with the nut.

Now connect the shielded cables from the circuit board and the switches to the jacks on the rear panel. The cable from switch number 1 connects to output jack 1 (left and right), switch number two to number two output and so forth.

The cables from the circuit board attach to the input jacks in as follows: left input jack J1 to position J-47 and right input jack to J-46; L2 to J-44 and R2 to J-43; L3 to J-41 and R3 to

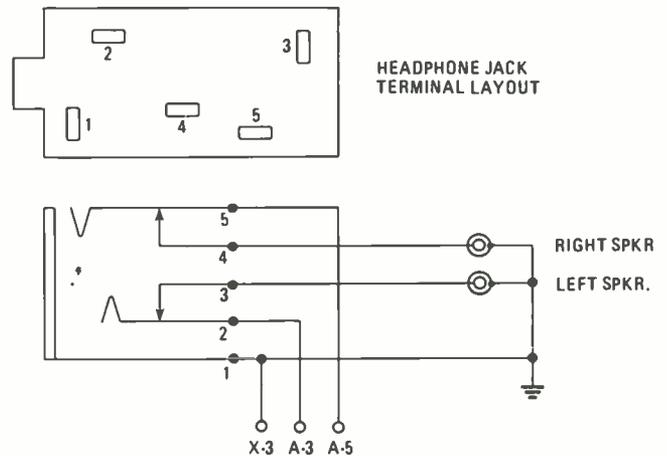


Fig. 6—Headphone-jack wiring diagrams. The upper drawing shows the terminals layout for the jack specified in the Parts List; if another type is used, terminals may differ.

J-40; L4 to J-38 and R4 to J-37; L5 to J-35 and R5 to J-34.

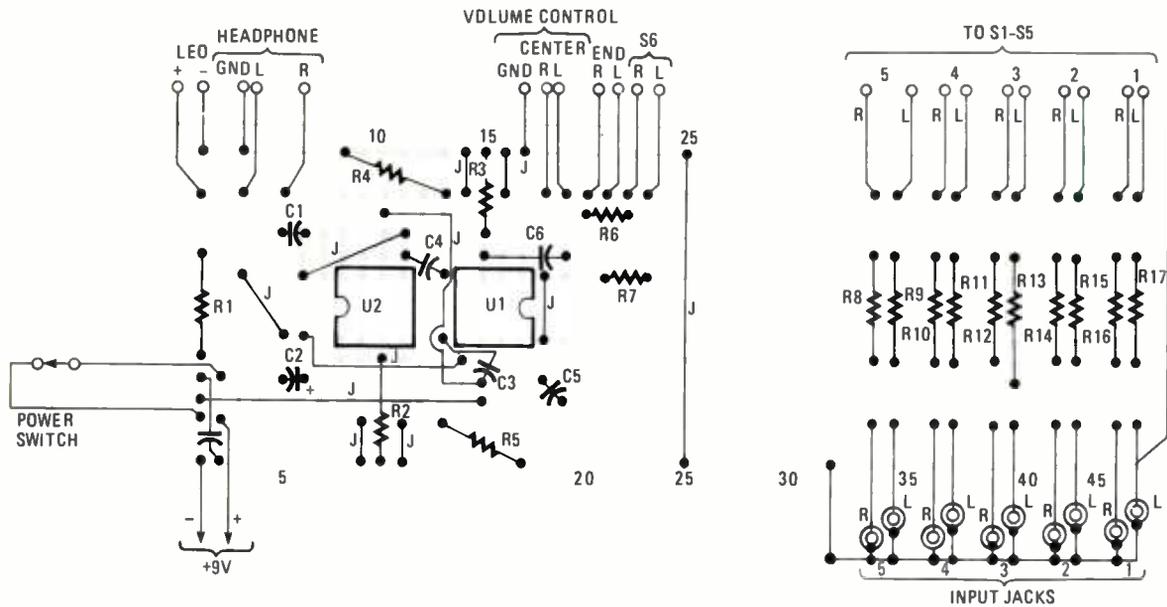
When attaching the cables to the jacks, twist the shield wires into two leads and attach them to the two ground terminals.

Connect the cable from the headphone jack to the two speaker terminals on the rear panel. The two jacks above the speaker jacks are unused.

Snap in a 9 volt battery and the unit is ready to test.

### Circuit Board Assembly

The author's prototype was built on a pre-etched board (available from Radio Shack) on which each hole is identified by a row letter and a position number. Fig. 6 shows the parts



**Fig. 7**—This diagram shows the position of the parts as viewed from the top of the board. Refer to the directions for circuit-board construction for the exact grid number for each lead.

layout of the circuit board as viewed from the top. The following instructions give the location of each part on the circuit board. When you insert the component, clip and bend the lead over to mechanically hold the part in place; then solder with a low-wattage iron. Where several parts are close together, you may want to wait until all of the leads are in place before soldering, so you won't have any trouble inserting adjacent components.

1. Mount the IC sockets on the board (see Fig. 7). The first socket is mounted so that pin 1 is in hole F-8. The second socket is turned around so that pin 1 is on the other half of the board in hole E-17.

2. Jumpers are used on the top surface of the board to connect some of the traces. Bare wire can be used for the short jumpers but insulated wire should be for longer runs or whenever one jumper crosses another. Keep the jumpers short and run them as directly as possible. Install jumpers between the following pairs of holes: J-25 to Y-25; J-9 to Y-9; J-11 to Y-11; A-14 to X-14; I-1 to I-15; H-15 to B-10; C-11 to E-6; G-14 to F-6; F-5 to E-3; F-18 to E-18; H-10 to J-19.

3. Mount the capacitors, referring to the Parts List for their values. Be sure to observe polarity where indicated. Install the capacitors in the following pairs of holes: C1 between C-6 and C-5; C5 between I-19 and H-18; C2 between + H-6 and H-5; C6 between D-15 and D-19; C3 between H-14 and F-13; C7 between H-1 and Y-2; C4 between D-11 and E-13.

4. Mount the resistors in the following pairs of holes: R1 between D-1 and G-1; R10 between D-37 and G-37; R2 between G-10 and Y-10; R11 between D-38 and G-38; R3 between C-15 and X-15; R12 between D-40 and G-40; R4 between A-13 and X-8; R13 between D-41 and G-41; R5 between J-13 and Y-17; R14 between D-43 and G-43; R6 between B-20 and B-22; R15 between D-44 and G-44; R7 between E-21 and E-23; R16 between D-46 and G-46; R8 between D-34 and G-34; R17 between D-47 and G-47; R9 between D-35 and G-35.

5. Connect the battery clip with the positive lead to J-2 and the negative lead to Y-1.

6. Cut five 4-inch lengths of two conductor shielded cable and attach them to the circuit board as follows: L1 to J-47, R1 to J-46, and GND shield XX to Y-47; L2 to J-44, R2 to J-43,

and GND shield XX to Y-44; L3 to J-41, R3 to J-40, and GND shield XX to Y-41; L4 to J-38, R4 to J-37, and GND shield XX to Y-38; L5 to J-35, R5 to J-34, and GND shield XX to Y-35.

7. When all soldering is complete, install the IC's in their sockets. Be sure to line up pin 1 correctly; the two IC's are oriented with pin 1 on opposite sides of the board.

### Operation

Various audio components are connected to the Audio Switch Box through shielded cables. The output of the device connects to the input of the Switch Box, whose output (in turn) connects to the input of another audio device. Switching can be accomplished with or without power turned on, because power is needed to operate the monitor only. Battery power is used to avoid any possibility of introducing hum into



**The completed project ready for testing.**

the circuit. For limited use, the battery lasts a long time. But if desired, a power supply could replace the battery. Just be sure that the power supply is well shielded and filtered.

As an initial check, turn all of the output switches to OFF and the monitor power ON. Turn on all of the devices connected to the box and set them for some type of output (play a tape, turn on the FM tuner, etc.). Now turn the monitor-select switch to each of the different settings. You should hear the output of the selected device in the headphones. Next try recording from one device to a tape deck. ■



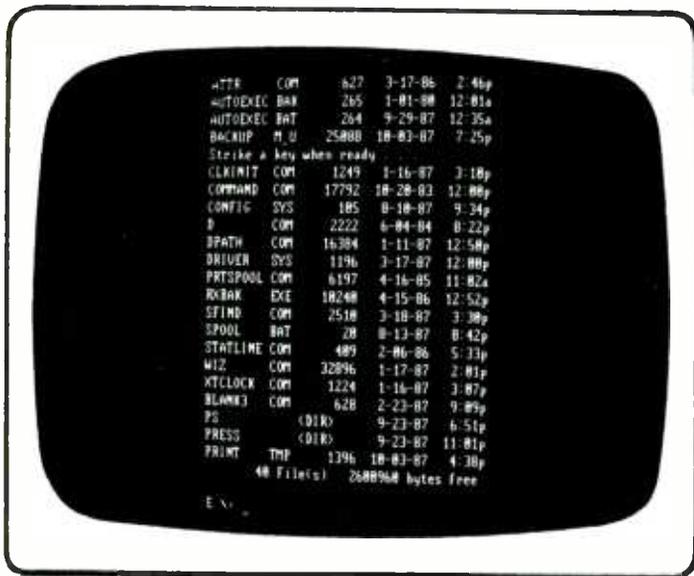


Fig. 1—This is how your directory listing will look when you enter DIR/P. Only part of the directly is available.

If you count down to the fifth line in Fig. 1, you'll see the cue from the previous screen display that says to strike a key to see more entries. You'll also note that the listing isn't sorted, and that the PRESS and PS subdirectories are intermixed with the regular files.

To make a directory somewhat easier to read, PC-MSDOS provides the DIR/W command illustrated in Fig. 2. DIR/W strips out the date, time and size information from each listing so the display can be compacted into five columns. Unfortunately, the listings still aren't sorted, and the subdirectories are still intermixed: They're the listings without extensions, such as COMCOR, SAFETY, IRWIN, etc.

Now look at Fig. 3, the same directory as displayed by the utility program D.COM (available via many BBSs). Firstly, the subdirectory clutter is gone—no subdirectory is listed. Next, and more important, the disk files are sorted alphabetically, which makes it much easier to locate a particular file. And the size of each file is shown; which is often a specifically desired bit of information.

### The Bigger, the Easier

Now you might say, "Big deal! So D.COM puts everything in column form." That was a simple illustration. Look at Fig. 4, a DIR/W of a subdirectory of one program with many overlay files. Compare the DIR/W listing with that of Fig. 5, a D.COM of the same subdirectory. Which would you rather work with?

Several variations of D.COM are available, such as DDIR.EXE, DDIR.COM, etc. Most are similar except they are limited to two, possibly three columns of data, with overflow listings held for another screen display. D.COM uses four columns and can display 80 files on one screen.

### Dumping It In

Another convenient utility for just about everyone is SFIND.COM, which came as a freebie in a *disk magazine* called *UPTIME*. In the game of hockey, one team will try to clear the puck by dumping it across the Blue Line; then everyone chases the puck. Getting the chase going is called "Dumping it in." Well, there's a "Dump it in" when it comes to locating files on a hard disk. For exam-



Fig. 2—Here's the same directory as in Fig. 1 but using the DIR/W command. Time, date, and size have been stripped.

ple, my hard disk contains several subdirectories that *might* contain text files. Once, months after it was written, I had to locate a letter written to the IRS. I had no idea which of many subdirectories it might be in. Since I use the extension .LET only for very important, or libelous letters, I got the chase going with SFIND.COM.

As shown in Fig. 6, I entered SFIND \*.LET, which meant find all files with the .LET extension in my hard disk. Within seconds it had found the only two files with the .LET extension: IRS.LET in the \LARRY subdirectory, and TELNASTY.LET in the \TEXT subdirectory.

Since I knew I was really looking for a letter to the Internal Revenue Service, as shown in Fig. 6 I could have used the "?" wildcard and entered SFIND ????\*.LET, which as you can see in Fig. 6 will quickly find the file in the \LARRY subdirectory.

Why did I use four wildcards (????) for a file with only three characters. Because there might have been more than one IRS file, perhaps IRS1, IRS2, IRS3, etc. The computer can usually find what you are looking for up to the limit specified, but not necessarily more than specified. If I had entered SFIND ???\*.LET it would not locate IRS1.LET (which has four characters before the dot). The general rule for wildcards is to specify more than you need, although some utility programs are very fussy and will only give a precise wildcard match: e.g., four wildcards will match only four characters.

### Don't Get Burned

Another outstanding freebie utility came with a disk supplied with the premier issue of *Computer Shopper's PC-Clone Magazine*. This one resolved something that's been a pain in the tractor-feed since I got my first printer back in '79. The utility, called BLANK3.COM, has two separate functions, which are shown on the screen when the program initializes (Fig. 7). Firstly (and this seems to have been its original purpose) it blanks the screen if a key has not been depressed for three minutes. The display returns the instant any key is touched.

Supposedly, the screen image will burn in if left on permanently. While I have seen it happen on an oscilloscope, only once have I seen a burn-in on a computer

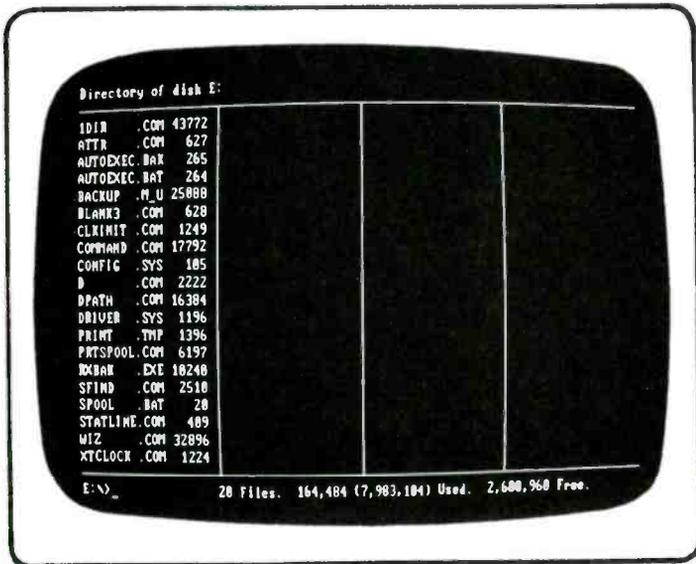


Fig. 3—The D.COM utility is what directory users want—a file listing (up to 80 per screen) void of date, time, etc.

monitor. Someone running a BBS had set the monitor's brightness and contrast controls to maximum. Since the screen display rarely changed, after several weeks of the same display 24 hours a day the image actually burned in.

### No Printer Blues

The second feature of BLANK3.COM is an automatic printer form-feed, and that's the one I consider a real winner. I would be very wealthy if I had a dime for every time I started a print with the paper set off alignment. Normally, that comes about when you make a screen print (SHIFT-PRTS) and simply tear the paper off when the printer stops. Or maybe it's from a word processor or database that stops the printer cold after the last character. Whatever, I either forget to realign the paper or to set the printer back on line. With BLANK3.COM those problems are eliminated.

At any time, from DOS, or from inside a program, the paper will automatically form-feed or complete a form-feed when I press ALT-F. It's a really outstanding convenience that cannot be fully appreciated until its used.

Normally, the best way to handle BLANK3.COM is to make it part of your AUTOEXEC, because it doesn't seem to interfere with any programs (so far). The program creates the screen display shown in Fig. 4 to let you know it's active.

### Save My Baby!

Perhaps the most dreaded command in personal computing is the accidental file or disk delete. Most of us at one time or other has inadvertently and stupidly issued a DEL \*.\* for the wrong disk or subdirectory. Contrary to common belief, neither the inadvertent DEL \*.\* or even a FORMAT of a hard disk is irrevocable, at least for the PC-compatibles. Some other computers have their files go belly-up when accidentally formatted and nothing can save them.

Both freeware (via BBS) and store-bought utilities are available that will recover a deleted file if it hasn't been written over. That is because the DEL command doesn't actually erase the data. Instead, it changes the first character of the directory listing and frees the file's space in

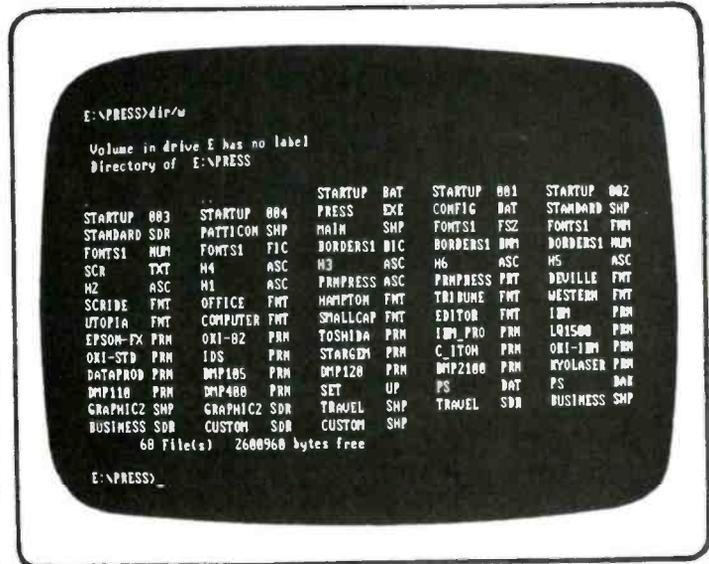


Fig. 4—Compare this display with the one in Fig. 5. Both are of the same subdirectory. Which one do you prefer?

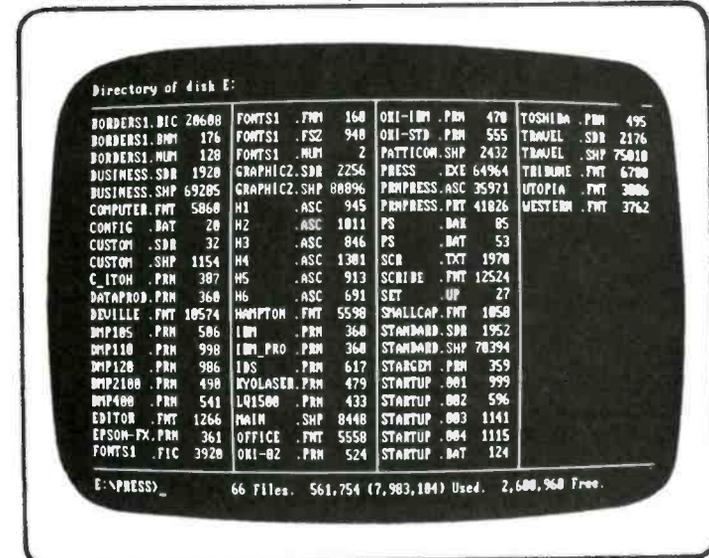


Fig. 5—If you picked this screen display over the one in Fig. 4, D.COM is the directory-listing utility for you!

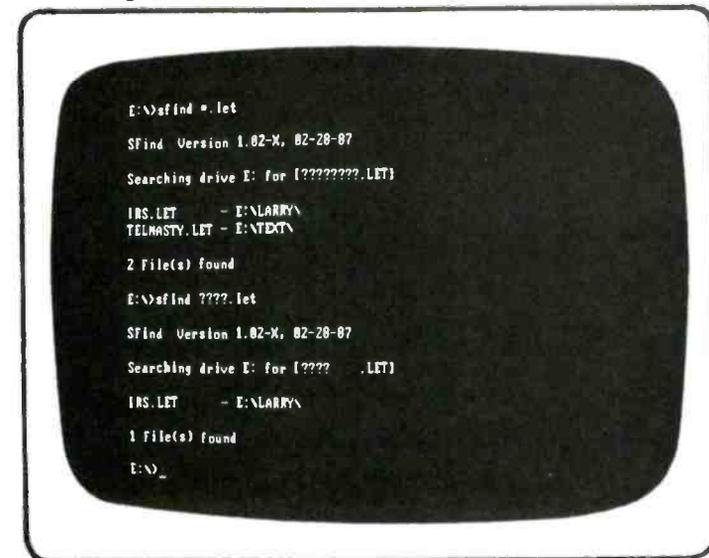


Fig. 6—The author looked through several subdirectories to uncover the letter he needed by typing SFIND ????.LET.

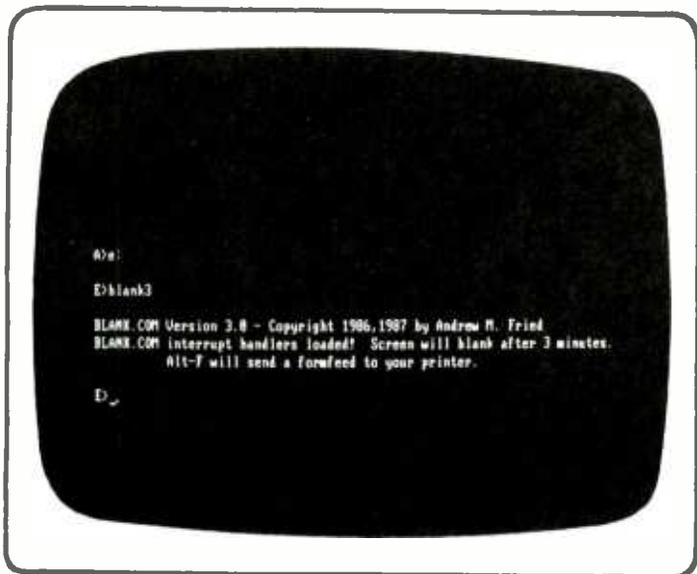


Fig. 7—The display tells the story. BLANK.COM darkens the screen in three minutes and can formfeed your printer.

the FAT (File Allocation Table). We usually simplify the explanation of the DEL process and simply say that the directory listing is eliminated, and if the computer can't find a filename in the directory it can't find the file.

### What is Restoration

As a general rule, you can figure out what the first character should be if you know all the other characters. An *undelete* utility will list the files and allow you to restore the correct first character, thereby *undeleting* the file. (Of course, the FAT is also restored.) However, it must be done before you write anything to the disk, because the space used by a deleted disk file is "free." A write can use the space, and even though you restore the directory's filename, there's no longer a matching file on the disk; you'll see bits and pieces of other files—whatever used the space. The utility will usually tell you if a file can be saved. For example, the highlight in Fig. 8 shows the file to be undeleted, but the display shows the file is probably erased, meaning its disk area has been used for some other file.

Undelete software generally works well on text files. I would not want to bet the farm that it will restore a program—a .COM or an .EXE file. More often than not, at least in my experience, .COM and .EXE files will not be properly restored.

### Restoration Plus

As a general rule, free undelete utilities do only that function. When they are part of a commercially-sold utility, such as MACE+, the undelete is only one of many utilities. For example, MACE+ can recover files from a hard disk that has been accidentally reformatted. The latest version of MACE even has a special FORMAT utility for computers that normally destroys data if accidentally formatted; the special FORMAT command is compatible with other formatting software, but doesn't destroy data.

Another outstanding MACE utility *unfragments* and repacks a hard disk, which can substantially speed up disk access.

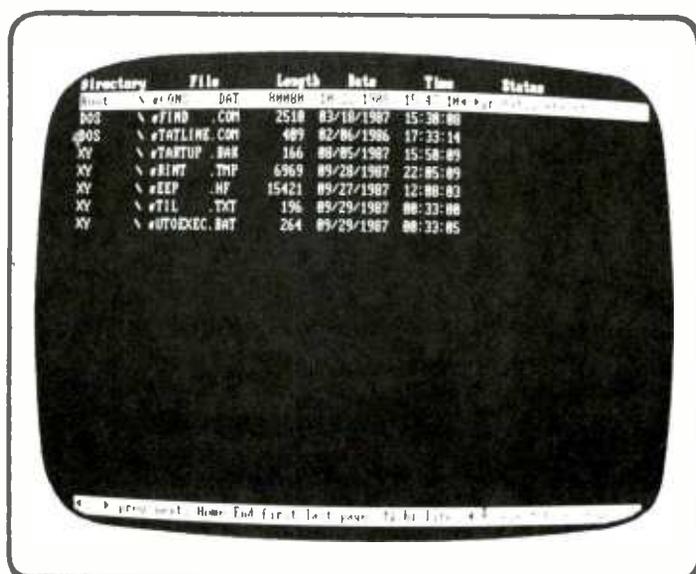


Fig. 8—Mace is a nice word when it restore files that are belly-up because you responded yes to an DEL \*.\* command.

### Solving Fragmentation

As you know, when you write to a disk the DOS finds fragments of unused disk space and spreads the data over the fragments. The more writing and deleting you do the greater the fragmentation. It takes time for a head to move from fragment to fragment when reading the data. *Unfragmenting* (repacking) re-writes fragmented data into segments that are read in order by DOS. (That's technical-hacker stuff we won't get into at this time.) The speed-up in accessing data can range as high as 50%, depending on the specific data and the degree of previous fragmentation.

As a general rule, the process of *unfragmenting* also repacks the entire disk so that all files are pushed as close as possible, with the empty segments together after the used segments. That process not only speeds up the reads, it keeps the most recent writes unfragmented. Figure 9 shows the screen display of disk utilization after MACE has unfragmented and repacked a disk. Notice that only a single cluster on the seventh line down is unused; it is from a file that was erased after the disk was repacked.

### Locking Out a Cluster

A side benefit to unfragmenting and packing is that defective and "weak" disk clusters that might have developed are locked out, much in the way a conventional format locks out defective sectors.

As shown in Fig. 10, which is a MACE display from my WordStar 4-equipped computer, unfragmenting once saved me from losing Wordstar's spelling checker. Access to the spelling checker was getting more difficult and read errors were becoming more frequent. So I did a repack, hoping the utility could read the weak data, because it will try 10 times before it quits. Sure enough, on the fifth try it read the data, repacked the sectors, and then locked out the defective cluster forever.

Figure 10 shows how the lock-out recently appeared when I ran a periodic MACE test on the hard disk. On the second line down, near the right, one cluster has a faint X mark, meaning it is locked out. It can never be used. Mace saved the cluster's data and moved it to a good cluster during the repack. You can also see the fragmen-

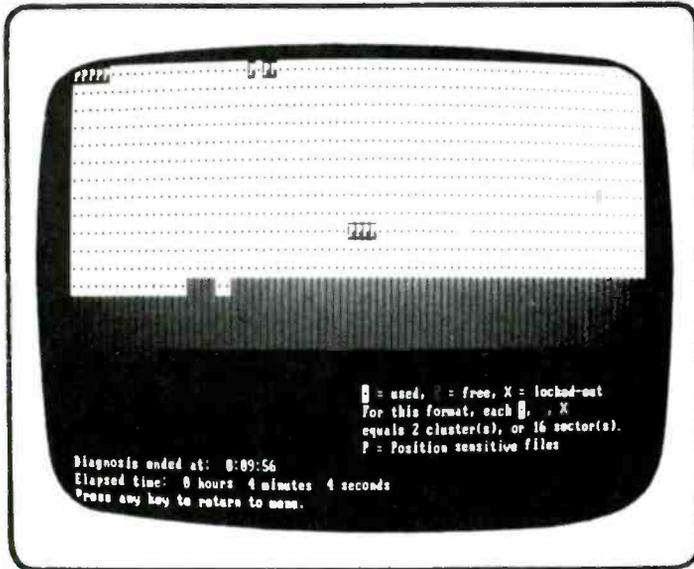


Fig. 9—Mace can fragment and repack a disk for better memory utilization and give a graphic of what was done.

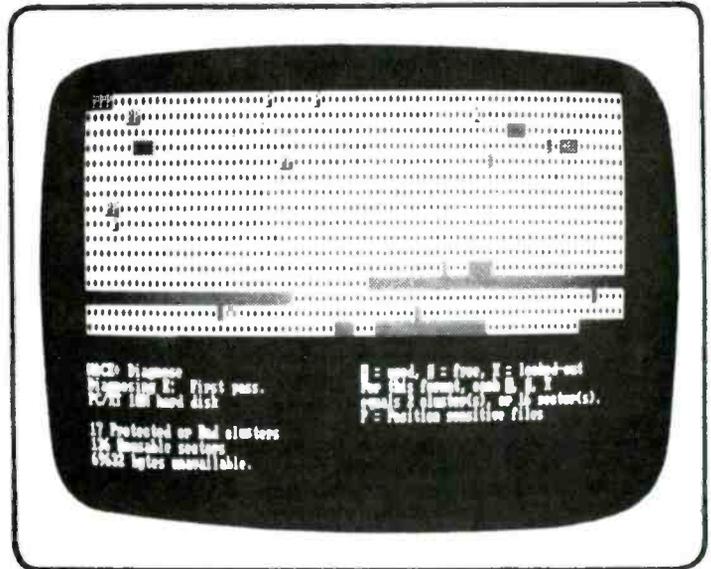


Fig. 10—Defective and "weak" disk clusters are locked out by Mace the way FORMAT.COM locks out defective sectors.

tation (dark clusters) caused by erasing text files. If it gets much worse I'll unfragment the data so it more closely resembles the display shown in Fig. 9.

### Hide the Files

Getting back to freebie software again, a classic favorite when others will be handling your software is ATTR.COM, available from many bulletin boards. ATTR.COM (attrib) is similar to the PC-MSDOS ATTRIB command, only it's more useful. As shown in Fig. 11, ATTR.COM can display whether a file is archive, system, hidden, or read-only. It also allows you to change any function to its opposite. Further down in Fig. 11 you see the attributes for the files in my computer's root directory. Note the famous IBMIO.COM and IBMDOS.COM files which are usually not shown during a DIR. ATTR.COM note only shows you all the files, but their attributes. Note that IBMIO.COM and IBMDOS.COM are also system files, hidden—meaning they won't be listed by a DIR command, and they are read-only.

Notice that I have used ATTR.COM to set CLKINIT.COM and XTCLOCK.COM to R-O (read-only). These are the programs used to set my computer's automatic date and time stamp, and it seemed that substituting software for a different clock module—which drove my autoexec'ed boot-up crazy—was the highlight practical joke of some people who had access to my computer. By setting the files to read-only, try as they might, they could neither delete nor substitute other software for my computer's clock.

Also, I have some text files which are no one's business, but my own. By making them hidden files they don't appear on any listing, yet I since I know they're there I can access them through my word processor.

### More From BBS

Another favorite utility from a BBS is VTREE.COM which is very useful when moving between subdirectories. I'll just give you an illustration of what it can do when a disk has so many subdirectories you can't keep track of what went where.

If you have ever used the DOS command TREE to lo-

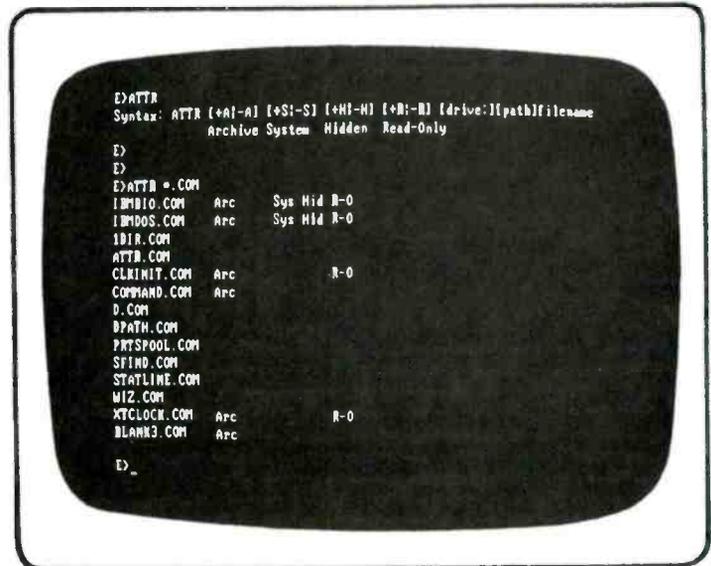


Fig. 11—ATTR.COM is more useful than MSDOS ATTRIB. It can say when a file is archive, system, hidden, or read-only.

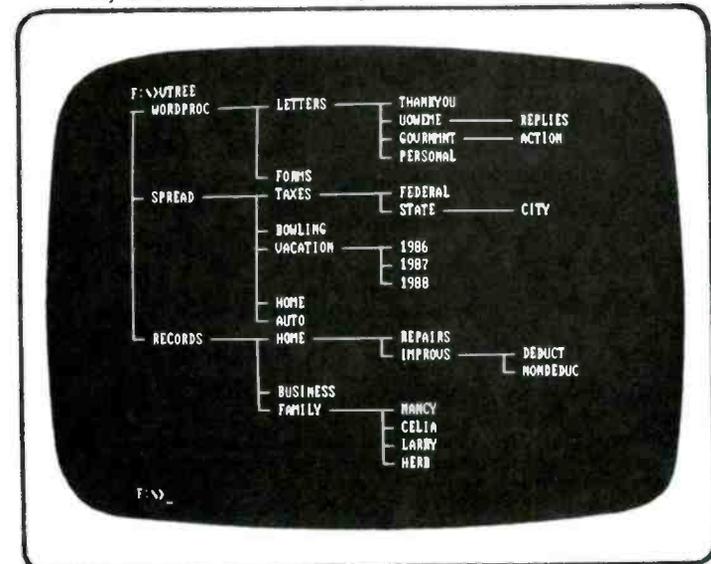


Fig. 12—Look at the display when you type VTREE and you'll know what subdirectories you have and where they are.

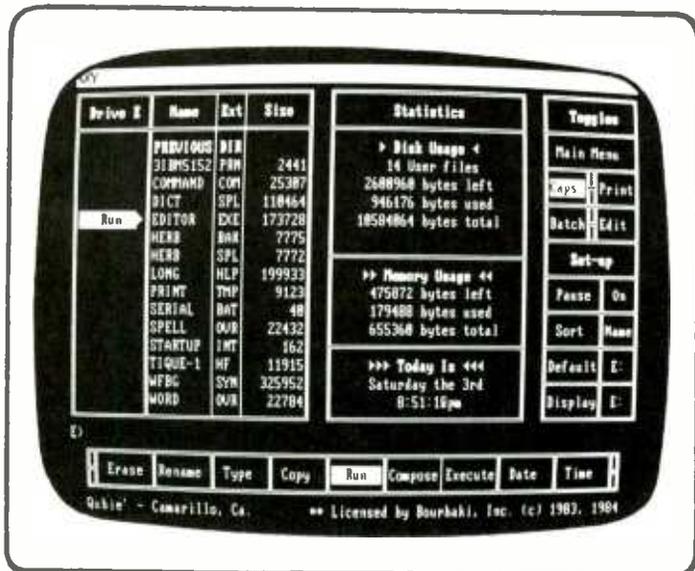


Fig. 13—1DIR lets you select the XY subdirectory from one of the formatted on your hard disk. Now press ENTER.

cate a subdirectory you have learned that the eye must be quicker than the hand, because the listing flows right out the top of the screen. On the other hand, VTREE.COM produces a screen display such as the one in Fig. 12, which shows precisely how the various subdirectories are interconnected and interrelated. If VTREE can't find the subdirectory you're looking for, you probably have made a gross error in creating your subdirectories.

### And the Kitchen Sink

BBS utilities usually provide only a few functions. Store-bought utilities usually throw in the kitchen sink in order to justify their expense. One of the oldies, but still goodies, is something called 1DIR, meaning "wonder." (Isn't that clever?) 1DIR is a file management utility that allows the user to handle files in batches: You can tag and erase a string of files, copy them, etc. As shown in Fig. 13, 1DIR also throws in gobs of data. First, it sorts both the subdirectories and the files; then it provides as much data as your mind can take without exploding. You get the date and time, memory usage, and the disk usage for the particular subdirectory at which you have only pointed. The toggle and set-up data are self-explanatory.

In Fig. 13 we have elected to view the XY (Xywrite) subdirectory. When we press the ENTER key the XY subdirectory is selected and the screen shifts to a display. Fig. 14, that shows the XY subdirectory files, and the highlight is positioned to run the editor program. Notice from Fig. 14 that the disk usage has changed. It shows 14 user files, the total number of files in the XY subdirectory.

As shown by the boxed functions running across the bottom of the screen, you can preset the computer to do almost anything to the file that's pointed at.

### An Extra Line of Data

If you have one of the original PCs, you have probably cursed the sadist who designed the keyboard. Not for it's layout, but because there's no light, or indicator of any kind, to tell you when the CAPS LOCK is on, whether the NUM LOCK key has set up the numeric pad for cursor control, or whether the SCROLL LOCK is set.

The solution to IBM's omissions is software called STAT-

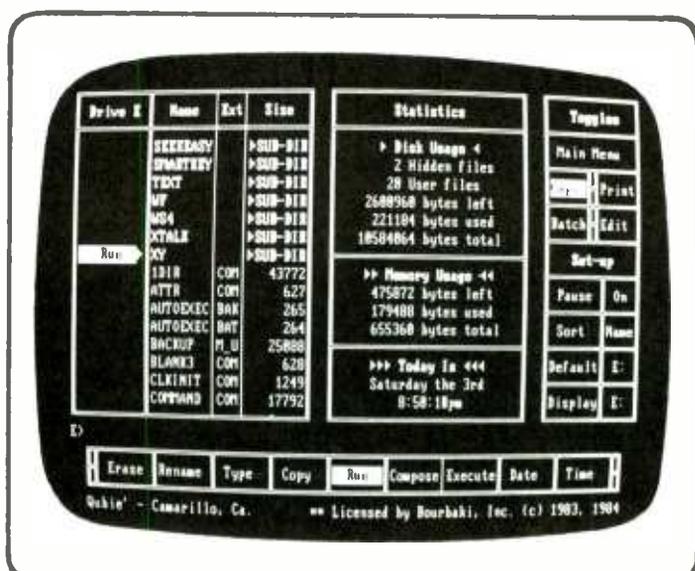


Fig. 14—Press enter key (Fig. 13) and the XY subdirectory is displayed. The highlight is positioned to run XyWrite.

LINE.COM, usually available from a BBS. STATLINE creates a 25th line with indicators for the condition of the three "guess me" keys.

Figure 15 shows a typical STATLINE display as it appears when running a program. The "up arrow" symbol means the CAPS LOCK is set; the tic-tac-toe symbol means the NUM LOCK is set so the numeric keypad functions as a cursor control; the up-down arrow means the SCROLL LOCK is set.

The program isn't entirely perfect. Some word processors, such as Xywrite, provide their own screen display for the "guess me" keys so the STATLINE display is redundant, or it simply freezes on the screen.

Other software, or certain parts of the software, will, as shown in Fig. 16, display as much of the first line as it can after the three STATLINE symbols. That is particularly true for a DIR. But it's a minor inconvenience you adjust to very quickly. In most instances, the STATLINE display is very useful, and avoids keyboarding a string of 4's and 8's when all you want to do is move the cursor to the left or right.

Take note that spillover of the first line to the statline applies only to TTL monochrome display, not to a CGA display. When the CGA monitor adapter is driving a composite mono, composite color, or RGB color display, the statline contains only the three "guess me" symbols—not part of the first line.

### How They Got Bigger

Regardless how complex or intricate it might be, anyone can write a program for personal computers. At least that's the way it's told after someone else has made the breakthrough. Until *VisiCalc* there was no spreadsheet for personal computers. After *VisiCalc*, everyone was an expert at writing spreadsheet software. One wonders if there would ever have been a *SuperCalc* or *Lotus 1-2-3* if there were no *VisiCalc*.

Similarly, we might still be plodding along with the older *WordStar* instead of the modern *Xywrite* had there been no *Electric Pencil* to show how word processors really should work.

As for database software for personal computers, early versions were so complex only the programmers who

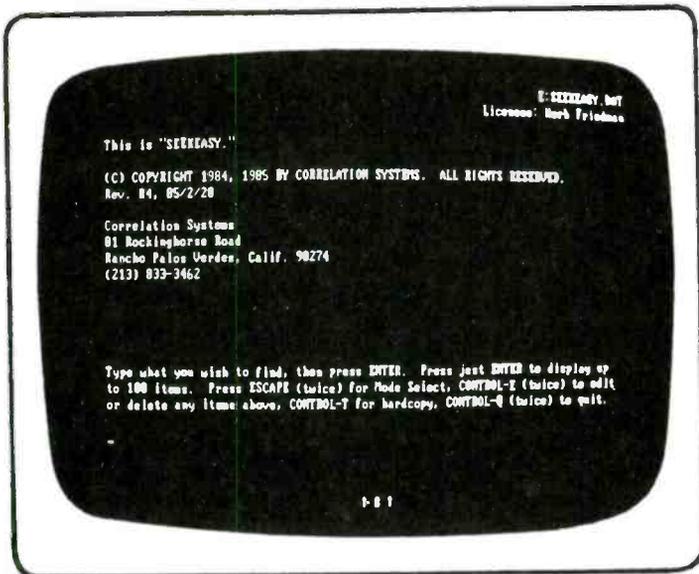


Fig. 15—The up-arrow means that CAPS LOCK is set; #, for the num lock; and the up-down arrow is for scroll lock.

wrote them had any idea what was going on until dBase II came along (which was really an intricate programming language that was brilliantly promoted and advertised). Of course *dBase III+* came along and made us all database experts.

Regardless of the kind of software, no one knew what to do until someone else had developed the key to how it could be done. Then everyone became an instant "expert," uttered their "Aha's," and claimed there was nothing to writing a good spreadsheet, word processor, database, communications package, or whatever.

Utilities also needed pathfinders for the "experts" that were to follow. Until Peter Norton showed how easy it was to restore deleted files, one had to be a 12th-degree black-belt in computer-hacking to understand how to use the "public domain" undelete software. Similarly with such programs as *SFIND.COM*, which was covered earlier. Before *SFIND*, one had to be at least a 10th-degree black-belt hacker to locate files. And to find specific text, even IBM's own *SFIND* filter (which came with PC-DOS) was incomprehensible to the average user.

But once the breakthrough for a particular kind of software was developed, it became possible—and relatively cheap—to provide both simplified and complex versions of utility-software packages.

### Heavyweights

Previously, we covered several free or low-cost, easy-to-obtain utilities. This time out we'll look at some real heavyweight utility software: the kind of stuff you should get into only after you really understand how to use your personal computer. It's not the kind of software recommended for real beginners and newcomers to personal computing, because it can literally reduce you to tears if you don't know the ins-and-outs of how your computer uses paths, directories, subdirectories, and the general way in which disks interchange information and filenames.

### CP/M Again?

We'll lead off with a utility for those of you might have started out in personal computing with a CP/M computer and have so much "good stuff" on CP/M disks that you

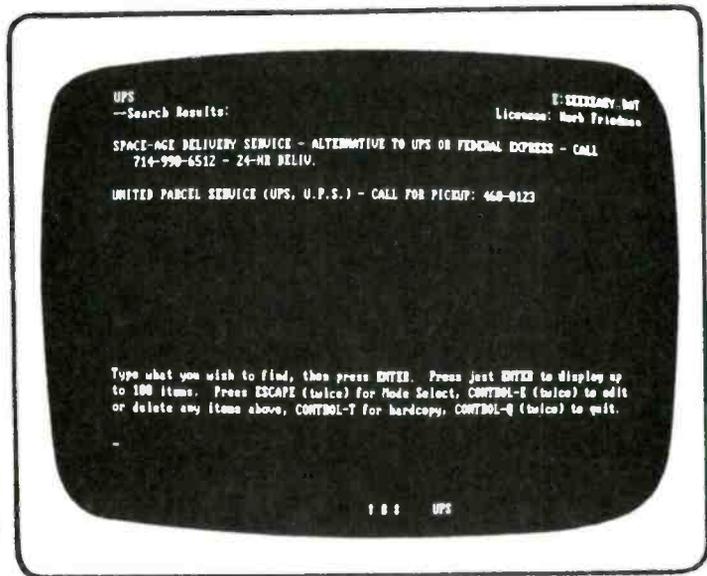


Fig. 16. The first line of a SEEKEASY display is to the right of the STATLINE symbols. See UPS at top and bottom.

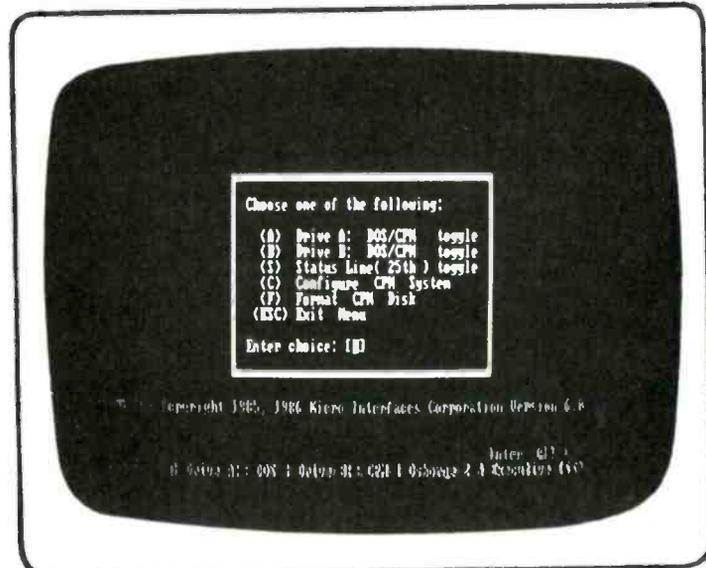


Fig. 17—RUNCPM has been initialized here. The user toggles either drive A: or B:, between the DOS and CP/M formats.

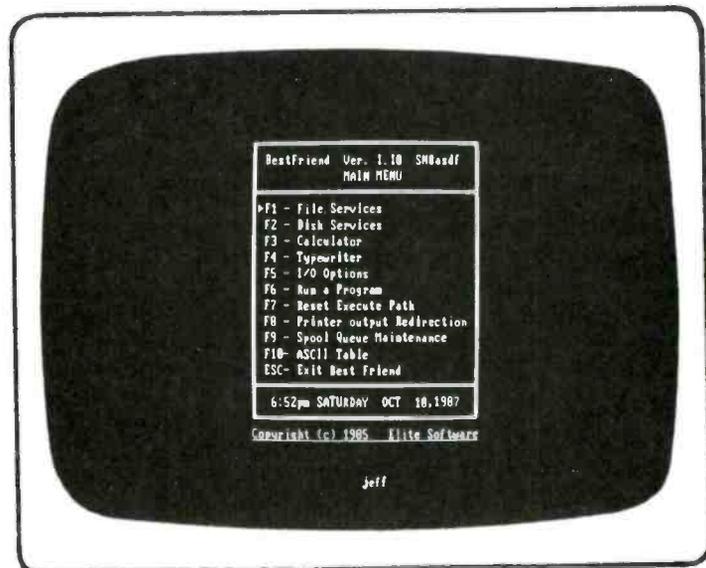


Fig. 18—Using Best Friend you can set the options for printer, COM1:, and COM2:, and slave the printer.

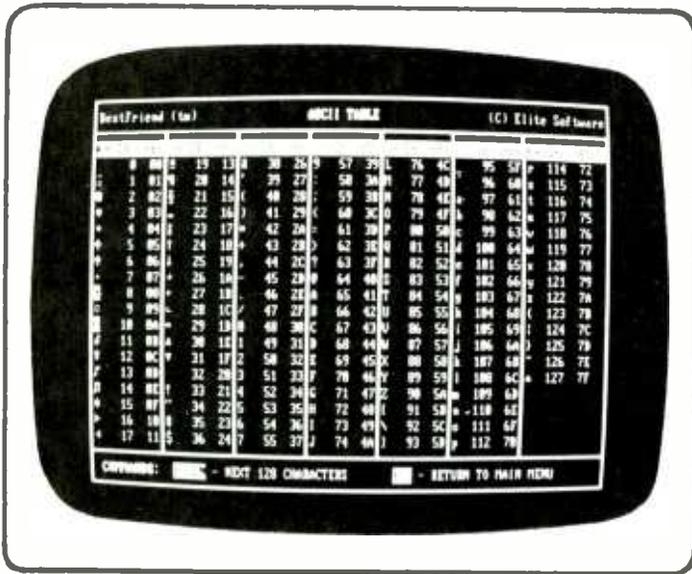


Fig. 19—Best Friend offers an ASCII table mode. The most common characters are shown in the first screen image above.

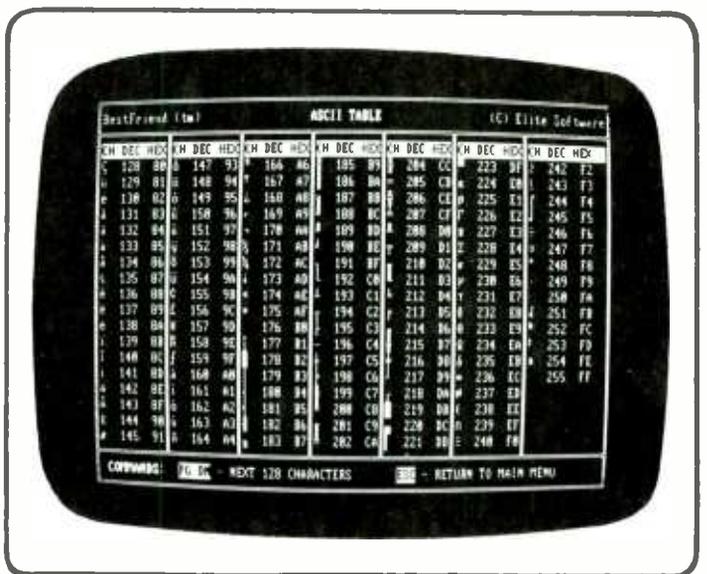


Fig. 20—ASCII codes used for the cute faces, the male and female symbols, etc., can be found in this display.

can't get rid of the old CP/M workhorse. Or maybe you're attending a school that built their computer labs seven years ago and still haven't gotten around to upgrading to the mainstream computer for virtually all business use: the IBM-compatible.

For those in the CP/M bind, the utility of choice should be *RUNCPM*. To explain: There are several utilities that allow CP/M files to be copied to PC-MSDOS disks. Unfortunately, the only value in doing so is to "save" text or data files to be run under PC-MSDOS versions of the CP/M software; you cannot run a CP/M program on an IBM-compatible. Well, that's not entirely true. There are utilities that allow IBM-type computers, which have 8088 CPUs, to emulate CP/M running on an 8080 or Z80 CPU. Problem is, the emulators are so slow they are often more difficult to use than simply doing nothing.

On the other hand, *RUNCPM* is intended for use with what is known as a V20 CPU. In very basic terms, a V20 is a special version of the 8088 that also contains the 8080 instruction set (op code). For those IBM-compatible computers that have been upgraded with the V20 CPU, the *RUNCPM* software permits the computer to actually run an 8080-based CP/M program in true CP/M—not emulated. You can also run both PC-DOS and CP/M disks at the same time. For example, if your home computer is an IBM clone but you're still using an Osborne down at the shop, you could do your shop database in a CP/M version of *dBase II*, and then take the disks home and run them directly in your IBM clone under the exact same CP/M version of *dBase II* that you use at the shop!

### Using CPM Stuff

Figure 17, the main menu of *RUNCPM*, should give you a good idea of the kind of magic you can expect from the utility. First, you initialize *RUNCPM* to the particular kind of CP/M disk you will be using. In Fig. 17, as shown by the bottom line on the screen, you'll note that we have initialized *RUNCPM* for the disk format used by Osborne's Model 2 and Executive computers. Also note that the menu allows the user to toggle either drive A: or B: between the DOS and CP/M formats. As shown on the bottom line of the screen display, we have selected

drive A: for DOS, and drive B: for the CP/M format.

Now we can run any way we want. We can actually run a DOS version of a program, and read and write to a DOS disk in A:, or read and write in a CP/M format on B:. Better still, we can actually run a CP/M program on B: and save its files in CP/M format on B: or in a DOS format on A:. Or, we can run either a DOS or CP/M program and intermix the data reads and writes.

We can also simultaneously toggle both drives so the computer can be instantly switched back and forth between the DOS and CP/M modes.

As you can see from Fig. 17, you can even format a disk for CP/M, configure a specific CP/M system, and turn on the 25th status line: the line that shows which drive is toggled for what system.

### Stepping Back

One word of caution, however. Although it is claimed that the V20 will run all DOS software, in actual fact some of the lesser-known software used undocumented features of the 8088, which were eliminated in the V20. After all, if the features weren't supposed to be used there was no reason to keep them. Unfortunately, some programmers gamble that undocumented features will always be available, a gamble they often lose. It is quite possible that if you substitute a V20 for an 8088 CPU some of your software—most likely a utility—won't run.

We have not found a single instance where major software won't run on a V20, because they always use only the documented CPU features. (Using undocumented CPU features is often successful, but it is a sign of poor programming.)

### Your Best Friend

*Best Friend* is a kitchen sink utility in that it contains almost everything having to do with file manipulation, and even throws in a "scientific calculator" having an on-screen "paper tape."

Figure 18 shows *Best Friend's* main menu. There's probably stuff there you have never seen before, such as I/O options, which allows the user to set all the printer options and the COM1: and COM2: configurations at one

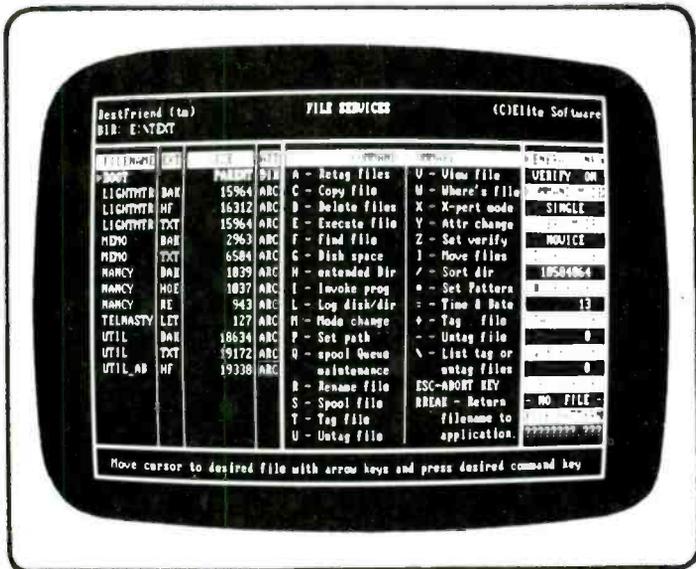


Fig. 21—The Command Summary column on the screen lists the functions available for file maneuvering by Best Friend.

time. Then there's a *typewriter mode* that makes your printer function almost the same as one of the new memory typewriters; and there's even an *ASCII table mode*, which is shown in Figs. 19 and 20.

If you need to know the ASCII codes that create the regular ASCII characters, the cute faces, the international male and female symbols, musical notes, and even a small Monopoly house, you'll find their ASCII code in the first table (Fig. 19). If you need the ASCII codes for foreign characters, Greek and math symbols, even IBM graphics so you can use them in a word-processed document, you'll find them in the second ASCII table (Fig. 20).

But *Best Friend's* real power is in disk-file manipulation, as shown in Fig. 21. The functions shown in the COMMAND SUMMARY column gives you a good idea of the extensive file manipulation that's available. There's even a *Find File*, which is similar to, but not as flexible as our old friend SFIND.COM.

### Figure It Out

Most unusual, and impressive, is *Best Friend's* calculator, which, as shown in Fig. 22, comes up in the lower right corner of a blank screen. The screen display closely resembles a small scientific calculator (note the scientific functions on the F1–F10 keys). As shown in Fig. 23, a "paper tape," flows out the top, much as it would from a conventional calculator having a built-in paper-tape printer. In the illustration, the "tape" shows both multiplication (at the top—indicated by the \* symbol) and addition. The scientific functions operate only within the calculator's window, although answers are printed on the "tape."

### Disk Wiz

Another heavyweight, though a low-cost, utility program, is *Disk Wiz*, which is basically a memory-resident, kitchen-sink, file-transfer utility with the usual extras such as a typewriter mode, an ASCII chart, even a background color control. But my favorite part is direct output of printer-control commands while running any program—that's the biggie.

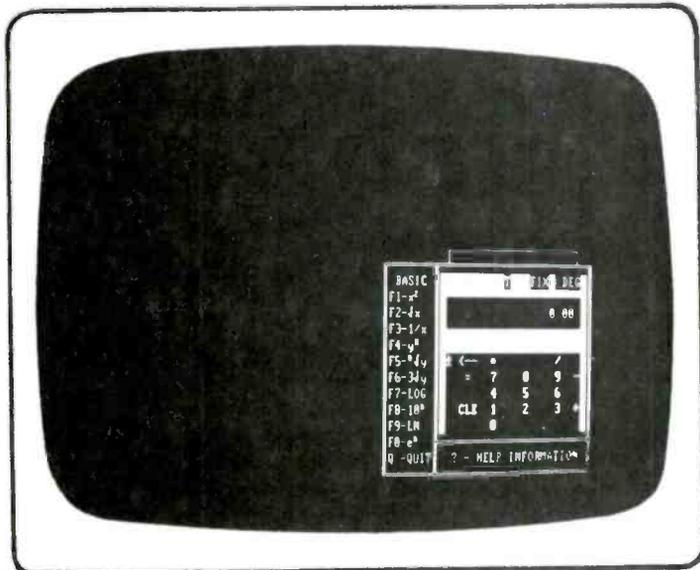


Fig. 22—Best Friend's calculator pops-up in the lower right corner. The F1–F10 keys trigger scientific functions.

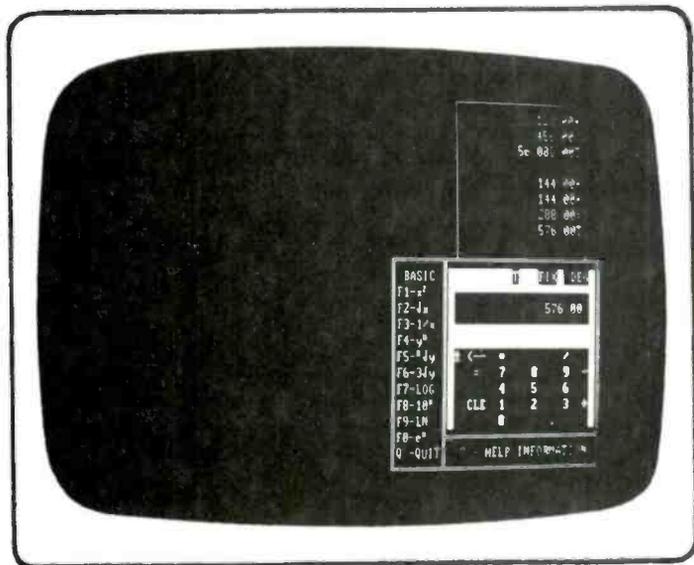


Fig. 23—Graphic paper-tape of Best Friend's calculator comes out of the top like a conventional desk-top job.

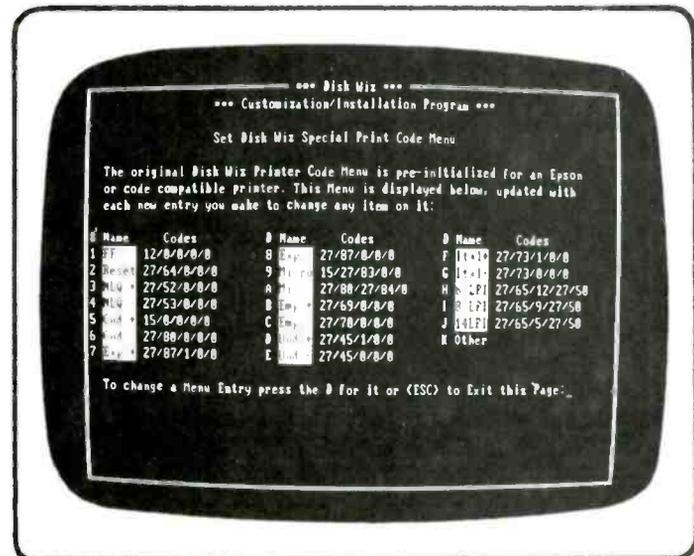


Fig. 24—Disk Wiz programs 19 printer-control codes. A 20th is a wide card that the user can compose when needed.

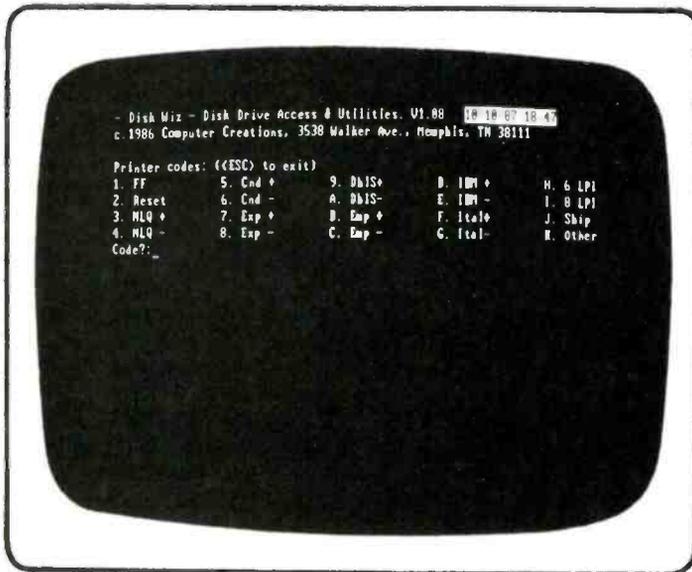


Fig. 25—Once the codes are entered into Disk Wiz, the screen will display only the functions, not the codes.

As shown in Fig. 24, *Disk Wiz* allows 19 printer-control codes to be user-programmed. A 20th position is a wild card that the user can compose when needed. As you can see, the program comes configured for the most commonly used Epson printer codes, but the user can set them for any function for any printer, and any function can accept up to five control codes.

Once the codes are entered via a configuration program, the printer-control operating screen will appear as shown in Fig. 25. Notice that only the functions, not their actual codes are displayed. Also notice that the functions in Fig. 25 are not the same as the functions shown in Fig. 24. I have changed several Epson codes to IBM printer codes. For example, the Epson codes D and E shown in Fig. 24 have been changed in Fig. 25 to turn on my printer's IBM graphics character emulation. Likewise, the Epson J code, which provides 14 lines per inch, has been changed so my IBM printer will do a *Skip* (perforation skip) when listing BASIC programs.

### How to Do It

To send a code to a the printer you simply enter the appropriate number or letter in response to the screen cue "Code." You can enter several codes, because the screen cue appears after each code is selected. When the ENTER or RETURN key is pressed all the codes are immediately sent to the printer, even if you're running a program.

For example, let's assume your word processor makes no provision for easily entering an italics or microtype printer code; no problem! At the point in the text that you want to switch to italics you embed the STOP PRINT command in the text, use *Disk Wiz* to send the italics printer code, resume printing (which will be in italics), have the printer stop when you want to return to standard printing, and use *Disk Wiz* to send a RESET printer control code. Or, you could send a microtype code, even combine several codes, such as bold/italics/NLQ (Near Letter Quality).

### Find Anything

Finally, we come to an unusually powerful shareware database utility called *Seekeasy*. To refresh your memory, shareware is provided free of charge on bulletin boards

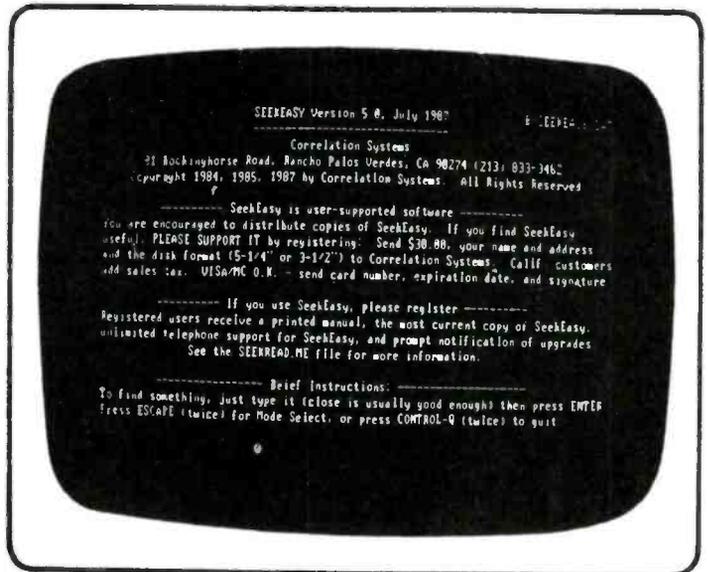


Fig. 26—For a fee Seekeasy offers registration, printed manual, recent version, telephone support, and upgrades.

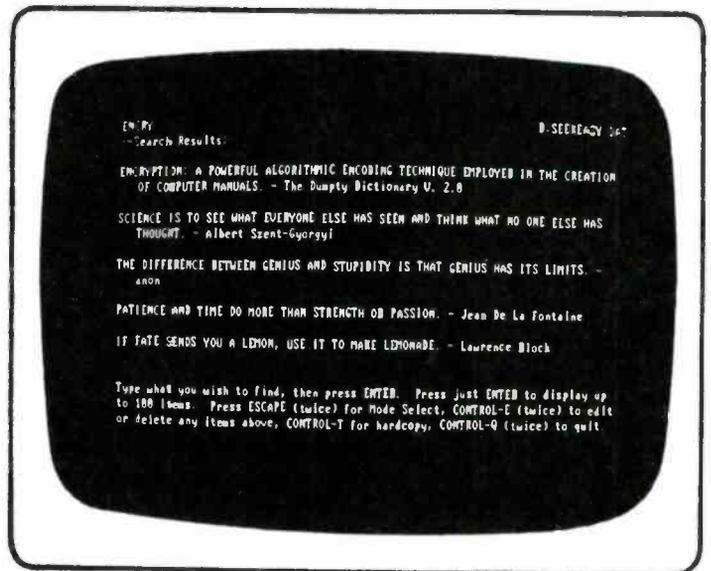


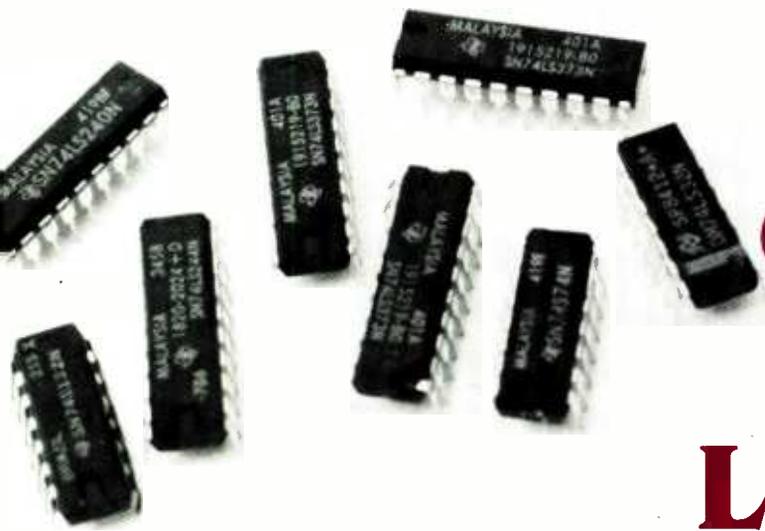
Fig. 27—By inputting the letters "ENCRY," Seekeasy sought what the user was looking for. Seekeasy provided the five quotes.

or by direct copy from users. As shown in Fig. 26 (*Seekeasy's* opening display) the user is informed that for a modest fee he can register to obtain a printed manual, get the most-recent version of the program, telephone support, and notification of upgrades.

*Seekeasy* creates a database that is really limited only by the capacity of the disk system. Each entry consists of two lines of randomly entered information. To locate any data the user simply keyboards whatever he or she can remember. In just a few seconds—and I have never taken more than 10 seconds regardless of the type or size of my disk system or database—*Seekeasy* will dig out all the data that has any resemblance to the entered search characters.

For example, I have a database of quotations I occasionally like to use in letters, speeches, and even articles. Recently, I needed something on *encryption*, which I knew was in the database, but I had no idea how it was filed. So as shown in Fig. 27, I simply keyboarded the letters

(Continued on page 92)



# CHOOSING the *RIGHT* LOGIC CHIP

**The chips are stacked against you if you don't understand the difference in the capabilities of various logic IC groups!**

Often, when putting together some contraption from a magazine article, or an electronics-hobby project book, it's difficult to determine if you're using the right component: For instance, the circuit might call for an inverter at a particular point. Simple....any 'ol inverter will do, right? Wrong! Haven't you ever wondered why there are so many different inverters available? Well it's because different inverters have various capabilities; for example, one might be a high-speed type, while another might be endowed with low-power capabilities.

Those cryptic code letters on integrated circuits are important; and if they are ignored, you could have some very unpleasant surprises. For instance, take this scenario: You've finally finished designing your *whatsit* and now you're ready to build it. The next step is to select the chips that you are going to use. You pick up your chip catalog and there are a half a dozen versions for every chip you need.

Do you pick the one that costs the least, or the one that has the highest speed? Or maybe you should use CMOS. Selecting the correct chip type for your particular application is a decision that can only be made logically if you know the advantages and limitations of the various types.

## Different Strokes

The two largest TTL families—and often the easiest to obtain—are the 5400 and 7400 types. There are over two hundred and fifty different chips in each of those families. The main difference in the two families are their specified operating-temperature range. For the 5400 type, the operating-temperature range is specified as 0 degrees to 70 degrees centigrade. The specified temperature range for the 7400 type is -55 degrees to 125 degrees centigrade. Both types are usually well within the temperature limits of any equipment the experimenter might build, so the choice between the two families may not be an important factor.

Now that we have distinguished between the two main families, we see that they are subdivided into more groups, which are classified by speed and power ratings. With TTL, increasing the speed results in an increased current require-

ment. Speed is traded off for less power consumption and the various trade-offs that resulted were regular TTL, high-speed TTL, and low-power TTL.

Then along came the Schottky devices which added Schottky TTL, low-power Schottky TTL, and advanced low-power Schottky TTL to the groups. Schottky devices are faster than regular TTL, and require far less power. Speed is one of the specifications used to subdivide chips.

## Operating Speed

The speed of a gate is defined as the propagation time. Simply stated, it is the time that it takes for the output to change after the input has changed. That time is designated in nanoseconds. (A nanosecond is defined as one billionth of a second.)

Admittedly, a nanosecond is a very short period, but it is still the factor that limits the upper operating frequency of the particular chip. The power capability of the chip determines how many other gate inputs can be tied to one gate output without drawing excessive current. If too many gates are tied to one output, the output will drop below a usable value.

It also determines the final power-supply current required for the particular circuit, which could be an important factor in your design criteria. The term used for describing how many inputs can be tied to the output of a single gate is called the *fan-out*. Low-power TTL chips are not capable of driving more than one high-power chip reliably, and are limited to driving only two regular TTL logic inputs. It can be seen that the designer can receive some nasty surprises when logic-chip types are mixed.

The CMOS family usually does not present any problems with fan-outs as long as they are fanned out to other CMOS inputs. The rule of thumb is no more than 50 CMOS inputs tied to one CMOS output. Since CMOS logic operates quite well at the same voltage as TTL logic, and since some logic functions are only available on one type or the other, it is inevitable that the logic types will eventually be mixed in the same circuit.

Problems can arise when mixing the two logic types if the

fan-out limits are not observed. The fan-out capabilities of various chip types are given in Table 1. The table allows you to determine how many inputs of one chip type you can drive with the output from another type of chip.

The frequency range of the CMOS is quite adequate for many applications, and power requirements make it ideal where minimum battery current drain is required. There are two different series of CMOS logic chips (designated by an "A" or "B" after the part number), and a recently developed high-speed type.

The A and B types are identical in operation, but do have a subtle difference. The "A" following the part number indicates that that particular chip is not buffered. They can cause some abominable problems (which we won't go into at this time). Needless to say, the "B" type is a better choice and it is hoped that one day, all of the CMOS chips will be of the "B" type.

The "B" type has a buffered output, improving its risetime, while making the output drive between the various chips identical. The third type is constructed using silicon on sapphire, which improves the propagation time. They are

often capable of frequencies of better than 50-MHz. A little more care must be taken in using CMOS "A"-series chips over TTL, but it is not beyond the capabilities of the beginner.

If you live in an area where the air is extremely dry, static charges can be developed that will destroy the chip by just picking it up. Your particular geographical area may require you to use grounded wrist-straps and floor pads when working with the "A" series chip. That problem has largely been eliminated by buffering in the "B" series.

Now that we have briefly covered some of the good and bad features about the different types, learning how to read the various designations seem to be the next order of business.

### Reading the Markings

When we are looking at TTL chips, the first two numbers (54 or 74) designates the chip series. The letter or letters following the series number indicate the sub-family. The letter H stands for hi-speed. The letter L indicates low-power while S means that the chip is a regular Schottky device. The letters LS stand for low-power Schottky, while ALS means advanced low-power Schottky. There are others, but those types cover most circuit requirements.

The numbers following the letters indicate the type function of the chip. At the last count, those numbers started at 00 and ran as high as 670 with a lot of numbers missing between them. If the numbers follow the series number without any letters, it designates a regular or standard TTL chip. Any letters following the function numbers pertain to the package type and/or military specifications. Those designations are not that important for the beginner, since the plastic encapsulations (that we've grown used to) always cost less than the ceramic version of the same chip.

Choosing the correct chip for your own particular application is just a matter of determining your frequency and power requirements. Table 2 compares the speeds and power ratings of the various integrated-circuit chip types. That chart can help to determine which chip to use in your design. It's obvious that a high-speed TTL chip works well in a low-speed circuit, but a slower chip may not perform in a circuit that calls for high-frequency response.

You wouldn't want to use high-speed TTL logic with its high-current requirements to design a low-frequency circuit that will operate for months on a small battery. You will also want to avoid fanning too many gates from a low-power output. Those are only a few of the pitfalls that can be avoided—and you're sure to run into others. Knowing the various chip variations can help you pick the right chip and, we hope, avoid the design problems before they happen. ■

TABLE 1—FAN-OUT TTL CHIPS COMPARISONS

Output From:	Regular TTL Inputs	Low-Power TTL Inputs	High-Speed TTL Inputs	Schottky TTL Inputs	Low-Power Schottky Inputs	CMOS Inputs
Regular TTL	10	40	6	6	20	50
Low-Power TTL	2	10	1	1	5	50
High-Speed TTL	12	40	10	10	40	50
Schottky TTL	12	40	10	10	40	50
Low-Power Schottky TTL	5	20	4	4	10	50
CMOS	* 1/2	* 1/2	* 1/2	1	1	50
High-Speed CMOS	2	10	1	1	5	50

\*Two gates can be paralleled to drive 1 input.

TABLE 2—TYPICAL VALUES FOR TTL CHIPS COMPARISONS

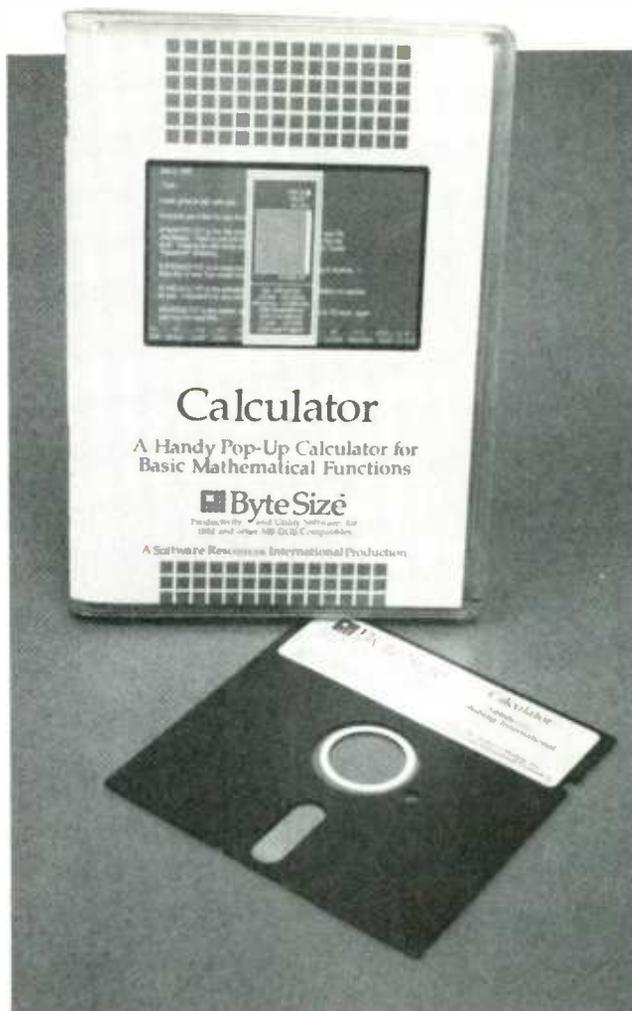
Type	Series Number	Propagation Time (Nanoseconds)	Output Current (mA)	Gate Input Current	Freq. Range (MHz)	Operating Voltage (VDC)
Regular TTL	5400 7400	10	16	1.6 $\mu$ A	35	5
LowPower TTL	54L00 74L00	33	3.6	.18 $\mu$ A	3	5
High-Speed TTL	54H00 74H00	6	20	2 $\mu$ A	50	5
Regular Schottky	54S00 74S00	3	20	2 $\mu$ A	120	5
Low-Power Schottky	54LS00 74LS00	10	8	.4 $\mu$ A	45	5
Advanced Low-Power Schottky	54ALS00 74ALS00	5	4	20 $\mu$ A	30	5
CMOS	CD4000 MC14000	60	.8	5 pA	5	5
		25	2	15 pA	15	15
High-Speed CMOS	74HC4000	8	8	1 $\mu$ A	30-50	2-6



# SOFTWARE STUDIOS BYTESIZE CALCULATOR

**A handy, memory-resident, pop-up, calculator program for basic mathematical applications on IBM and MS-DOS machines**

CIRCLE 75 ON FREE INFORMATION CARD



□ONE DAY I WANTED TO CHECK MATH the accounting department used to waste my salary. In particular, I wanted to sum the deductions and subtract them from the total gross income. Simple? I thought so as I picked up a pocket calculator from an engineer's desk. I couldn't sum two plus two to ring up four. My engineer friend said that the calculator was a programmable type set to operate on Laplace transforms for four-dimensional vector analysis. I ended up in the accounting department using a vintage 1965 adding machine with tape readout. That was more my speed.

When calculators were first introduced, they were basically adding-machine types with almost no frills. Today, a pocket-calculator operator has to keep the manual handy because of the many add-on features. The features came about during the past two decades, because of the state-of-the-art improvements and marketing techniques demanded more and more features as the price fell through the floor.

Thus the scene was set for calculator software for personal computers. A host of calculator programs popped-up in the last ten years that could count the spots on a newt as it *Laplaced my transform*. Sometimes, the simple things are what we need and you can't find them.

My thanks to Software Studios in Cal-

ifornia for introducing the ByteSize Calculator. The program provides an on-screen calculator that is a full-function, printing calculator with memory display and no high-order math settings. Its features include: add, subtract, multiply, and divide; add to, or subtract from, displayed memory; square root; make a printed tape of calculations; and display results in everyday decimals or hex, binary, or octal notation.

The software is designed to be an alternative to expensive, difficult to learn, and often difficult to use, programs. ByteSize Calculator can run as a stand-alone program or it may be accessed as memory-resident and thus, *pop-up* when needed, even when another application is being run.

## Getting Started

All you require is a machine that is an IBM PC, XT, AT, or MS-DOS compatible computer that uses either IBM DOS or MS-DOS. It'll work with a one 5-1/4-in. disk-drive system, or two disk drives, or one disk drive with a multi-megabyte hard-disk drive. Copy ByteSize Calculator onto a diskette and store the original diskette in a safe, storage bin at room temperature. It's a good idea to write-protect the original.

After a diskette containing ByteSize

Calculator is inserted into a drive or the program has been copied to a hard disk, type CALC (CALC B for monochrome screens) at the DOS prompt (A:, etc.) ByteSize Calculator is now on the screen. Press any key to get past the title plate and you're ready to run ByteSize Calculator.

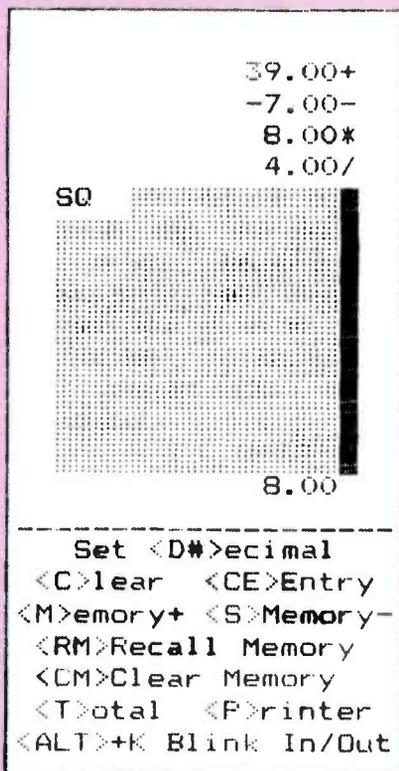
## Memory Resident

Loading ByteSize Calculator as a memory-resident program requires 49K of RAM—a very small price to pay. Other programs can be loaded in memory and run while the software lies dormant in memory, but it is executable at any time even from within another program.

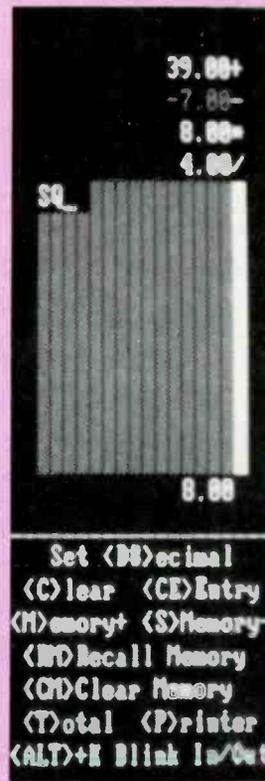
To load ByteSize Calculator into RAM, type CALC R (with a monochrome screen type CALC B R) and press ENTER. To bring Calculator to the screen type ALT-F-K. When the title screen appears, press any key—you're up and running!

## Using the Calculator

If you know anything about calculators, you can start experimenting with ByteSize Calculator once the program is on the screen. The operands are +, -, \*, /, M, S, and SQ which stand for *add, minus, multiply, divide, add to memory, subtract from memory, and square root*. It does not matter where the operand is placed. For example, typing \*8 and ENTER or 8\* and



Here's what you see on the monitor's screen (left) after adding 39 and subtracting 7, multiplying by 8, dividing 4, and taking the square root. Imagine what you see is a paper tape spooling from an office-type, desk-top calculator. The listings at the top indicate the numbers keyboarded and the operand in effect to the right. The total appears near the bottom. At the very bottom of the tape are prompts that you need to operate ByteSize Calculator. In fact, once the program is on the screen, you can toss away the owner's manual. The first prompt shown is <D#> which sets the number of decimal places. You can select any value from 0 to 9; the default is 2 assuming that most additions will be for dollar values. Should you want a printout of your calculations, the P key toggles the printer in and out. Where the decimal setting indication was previously, there now appears either THE PRINTER IS ON or THE PRINTER IS OFF toggle information. At right is a DOS printout using the SHIFT and PRN keys. For more information on ByteSize Calculator circle No. 75 on the Free Information Card.



ENTER will have the same effect—the previous total will be multiplied by 8. If no operand is used, the previous operand is used. If there is no previous operand (when first starting or after a total), addition is assumed.

To add the total on the screen to the Calculator's memory, press the M key and then the ENTER key. To subtract, use the S and ENTER keys. To recall the number in memory, type RM and ENTER. To clear memory, type CM and ENTER.

To repeat an entry, press ENTER. To clear the calculations, press C and ENTER. To clear the current entry, press C and E and then ENTER. To take the square root of the total, type SQ and then ENTER.

One unusual feature is the opportunity to display the total in notation other than decimal. To read out in hexadecimal, octal or binary, press H, D, or B, respectively. If you have no need to use that feature, ignore it. Some software programmers will find that they will be living with it.

### Print Out

You can have your printer provide a hard readout for your calculations up-to-the-minute each time you press the ENTER key. To toggle the printer on and off, press the P and ENTER keys. That option prints each entry as the ENTER key is pressed. In order to get a print-out total, press T and ENTER. You can also press the SHIFT and PRN keys at the same time. The unused portions of the screen display will print out zeros.

To get out of ByteSize Calculator press

the ESC key when operated as a stand-alone program. If Calculator is memory-resident, press the ALT and K keys simultaneously to exit the program. Pressing the ESC key will purge the resident-memory program from RAM. In some programs you will not be able to use the ESC key to rid the resident memory or Calculator directly. A message will come up which reads, "CANNOT EXIT NOW." Apparently, that is a blocking device that prevents loss of resident memory to other stored programs or the introduction of a disastrous glitch. You must return to the DOS prompt to remove ByteSize Calculator from RAM.

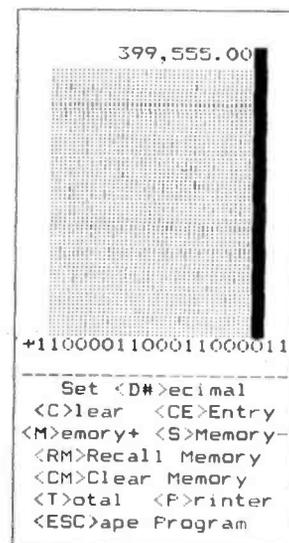
### Putting It to Work

The last few paragraphs are all you need to know to successfully operate ByteSize Calculator—you can throw away the user manual in CALC.DOC, because you now know it all. If you set up your path statements correctly, pressing the ALT and K keys will toggle ByteSize Calculator in and out. If you don't know how to set up a sub-directory and path statements, refer to the user's manual. Follow the directions and then cast the manual aside.

After the first time into the program, the title screen will not reappear and the program goes direct to the image of the calculator's tape. Part of the tape image contains a prompt-key directory, hereby a clever operator can surmise the operating procedure without further reference to the user manual.

ByteSize Calculator is available from computer and software outlets for \$19.95

(suggested retail price). Mail orders should be sent to Software Studios, 8516 Sugarbush, Suite 104, Annandale, VA 22003. Include \$5.00 for shipping costs. Software Studios can be reached by telephone: 703/978-23239. For more information via Hands-on Electronics, circle No. 75 on the Free Information Card. ■



One of the features of ByteSize Calculator is the ability to obtain binary, hex, and octal numbers from decimal numbers. The screen print-out shows the decimal number 399,555 converted to an eleven-place binary number. Check the results using pencil and paper. You'll get to appreciate this time-saving feature.

□ EVERY RADIO AND RADAR TECHNICIAN WANTS TO OWN A Second Class FCC General Radiotelephone Operator License; a First Class license would be all right, too. Just mention the very title to a tech (with or without class distinction) and watch his eyes roll, and then listen as he talks about his potential for increased earnings if he had it. Oh yes, even today with technical school diplomas, associate degrees from junior colleges, and even engineering degrees from the big institutions, all electronic wizards dream of holding an FCC license. Apparently the prestige, the mystique, and the pride still ring true for those who pass the test to receive the coveted FCC General Radiotelephone Operator License (GROL).

Every tech, at one time or another, has the experience of going to some social event or gathering, meeting other electronic enthusiasts, and pretty soon the conversation comes around to the question, "Gee, do you have your FCC license?" Wouldn't it be great to say, "Sure I have it." Then the guy smiles broadly, because everyone recognizes the FCC *ticket* as the very top; moreover, when you get your license you're automatically accepted as someone who know his stuff.

### Climbing the Ladder

In today's increasingly competitive job market every feather in your cap is to your own benefit. The FCC license carries with it government certification saying you are recognized as legally and technically competent to install, maintain and repair marine, land mobile, aviation and public radio stations. It's this legal authorization and government stamp of approval that sets the FCC license apart from all other technical certificates.

There are many obstacles to overcome on your way to passing the FCC test. As someone who just passed the GROL, I'm going to tell you my secrets (that is, hard work and dedication) so you too can pass the examination. Everything you need to know to get started on that road to success, I've put down on the following pages. All the little frustrating mistakes that discourage so many techs and prevent them from reaching their goal, you can now breeze right through. The study materials you will need, the FCC rules and regulations, the different types of test questions you will encounter, and finally taking and passing the examination. I will walk you through it all so that you'll know what to expect in the examination room and can be better prepared to pass the FCC examination.

### GROL Requirements

The General Radiotelephone Operator License is required for persons responsible for internal repairs, maintenance, and adjustment of FCC-licensed radiotelephone transmitters in the Aviation, Maritime, and International Fixed Public-Radio Services. It is also required for the operation of Maritime Land Radio transmitters operating with more than 1500-watts peak-envelope power, and Maritime Mobile Ship and Aeronautical transmitters with more than 1000-watts of peak-envelope power. The GROL is normally valid for the lifetime of the operator.

To be eligible for this license, you must: 1 be a legal resident of (eligible for employment in) the United States; 2 be able to receive and transmit spoken messages in English; and 3 pass a written examination covering basic radio law, operating procedures, and basic electronics.

For example, let's say you want to repair and maintain two-way communications equipment in the aviation industry. You

# GETTING YOUR FCC LICENSE

## Here's everything you need to pass the FCC examination and get your FCC General Radiotelephone Operator License

By Jon Gordon

need the GROL license to certify that the equipment you test and install does indeed meet the FCC standards for emission type, power output, carrier frequency tolerance, etc. Without the GROL license you are not qualified to make such a determination. (That's an interesting point—you are not qualified even though you may be very knowledgeable and proficient.)

### Getting Started

Changes in technology and FCC rules have made previous examinations for the Commission's General Radiotelephone Operator License obsolete. As a result, the commission has revised all future GROL examinations to include certain marine radio subjects and omit outdated questions.

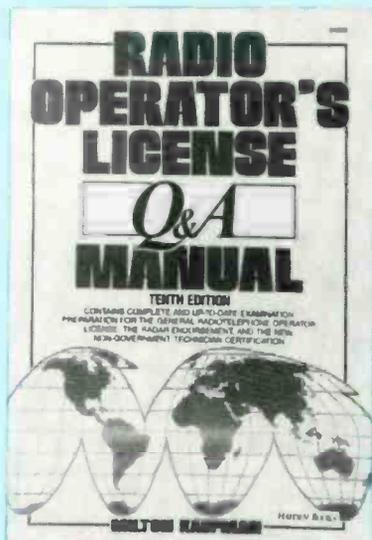
Preparation for the GROL examination should include review of materials contained in commercially available study guides. The FCC does not certify schools or review study manuals. Consequently, the FCC will not recommend a particular school or publication. The review material should include information that covers both the GROL and the Marine Radio Operator Permit. Anyone who uses preparation materials provided by any FCC Field Office should study both Bulletins FO-32 and FO-33. The commercial license examination policy is outlined in Bulletin FO-4, and the FCC examination schedule is also available upon request.

### Study Manuals

Adequate preparation for any examination is the key to passing. There are several commercially available study guides, and since the study guide will be your main focal point to success, it's important to select the one that's right for you. Walk into any large book store or library and at least one or maybe two different study guides will be on display. If you have the opportunity to compare them you'll find they're organized differently and the scope and depth of technical information contained in them will vary widely. I visited a shopping mall and checked out two book stores. Between those stores and the public library I selected Milton Kaufman's: *Radio Operator's License Q & A Manual, Tenth Edition*.

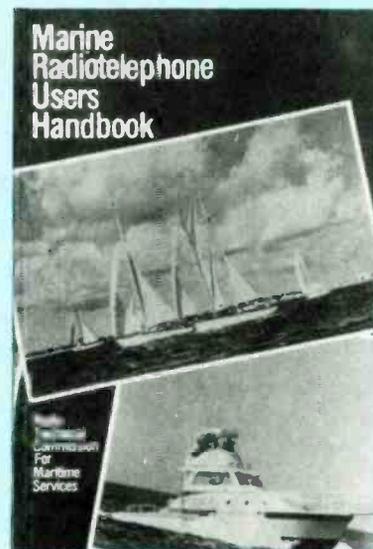
My reasons for selecting Kaufman's manual were many fold. First, there seems to be much more in-depth technical information than in the other books I have seen on the same topic, and the author included a lot of schematic diagrams for illustrating his technical points.

For most of the FCC topic questions he had a straightforward answer and then elaborated further with a technical



◀ This is the study guide I used to pass the GROL. There are several other guides available, you be the judge as to what's best for you. You can get this one from Hayden Books, 4300 West 62nd Street, Indianapolis, IN 46258, Book No. 040666, Tel. 800/428-3602. \$16.95.

FCC recommended the Marine Radiotelephone is available from Radio Technical Commission for Maritime Service, P.O. Box 19087, Washington, DC 20036, \$7.95. ▶



discussion. I found the learning approach to be the easiest for me to understand and follow. I also found the technical discussion to be helpful as background information, so that I could better understand other reference sources that I have.

The FCC rules and regulations for the GROL examination may contain as many as 15 to 20 R & R questions alone. Kaufman takes the confusion out of the new FCC license structure with a book preface of the most commonly asked questions, and of course he supplies the answers. The Q & A manual has a number of other useful items like a list of FCC Field Offices and their addresses, a guide to troubleshooting and analyzing FCC exam-type circuits, and a complete FCC sample examination. Lastly, the 531 page manual is in its tenth edition, and I figured any book in its tenth edition must be doing something right. I will further review Milton Kaufman's Q & A Manual as the article continues.

### Radiotelephone Handbook

The FCC recommends that you obtain the *Marine Radiotelephone Users Handbook*. The text explains and describes in detail the proper radiotelephone operating procedures and also contains a complete list of the VHF Marine Channels, U.S. Coast Guard Stations, and Public Coast Stations. This is a great little book and gives you all the marine VHF Channel frequencies and their uses; it's loaded with radio operating procedures like how to make a distress call, how to place a ship to shore telephone call, and procedures for calling ship to ship, etc. Anyone who owns a pleasure boat should have this handbook.

### Getting Information

When you call the FCC Field Office, ask for the General Class Exam Application Form 756 and Exam Schedule, also ask for Bulletins FO-32, FO-33, FO-4 and any public notices concerning the GROL. There is no fee for any of the FCC bulletins or forms, and there is no GROL application fee.

Form 756 can also be used to apply for a renewal when necessary, replacement of a lost or mutilated license, and for a verification card, when necessary.

Typical examination dates vary slightly from year to year. Contact the FCC Field Office nearest you for an official schedule.

### The Bulletins

FCC Bulletin FO-33, January 1987, has all the information you will need in order to answer questions encompassing elements 1 and 2. According to the FCC, elements 1 and 2 require knowledge of the following: Marine Radiotelephone Operator Permit; basic marine radio law and basic marine radio operating practice. Provisions of laws, treaties and regulations with which every radio operator in the maritime radio services should be familiar. Radio operating procedures

TABLE 1—FCC FIELD OFFICES AND PHONE NUMBERS

Office	Number
ALASKA, Anchorage	907/243-2153
ARIZONA, Douglas	602/364-8414
CALIFORNIA, San Diego	619/293-5478
CALIFORNIA, Livermore	415/447-3614
CALIFORNIA, Long Beach	213/426-4451
CALIFORNIA, San Francisco	415/556-7701
COLORADO, Denver	303/236-8026
FLORIDA, Ft. Lauderdale	305/473-9845
FLORIDA, Miami	305/350-5542
GEORGIA, Atlanta	404/347-3084
GEORGIA, Powder Springs	404/943-5420
HAWAII, Walpahu	808/677-3318
ILLINOIS, Chicago	312/353-0195
LOUISIANA, New Orleans	504/589-2095
MAINE, Belfast	207/338-4088
MARYLAND, Baltimore	301/962-2728
MARYLAND, Columbia	301/725-3474
MASSACHUSETTS, Boston	617/223-6609
MICHIGAN, Allegan	616/673-2063
MICHIGAN, Farmington Hills	313/226-6078
MINNESOTA, St. Paul	612/725-7810
MISSOURI, Kansas	816/926-5111
NEBRASKA, Grand Island	308/382-4296
NEW YORK, Buffalo	716/846-4511
NEW YORK, New York	212/620-3437
OREGON, Portland	503/221-4114
PENNSYLVANIA, Philadelphia	215/752-1323
PUERTO RICO, San Juan	809/753-4567
TEXAS, Dallas	214/767-5690
TEXAS, Houston	713-229-2748
TEXAS, Kingsville	512/592-2531
VIRGINIA, Norfolk	804/441-6472
WASHINGTON, Ferndale	206/354-4892
WASHINGTON, Seattle	206/764-3324

and practices generally followed or required in communicating by radiotelephone in the maritime radio services.

FCC Bulletin FO-32, April 1983, is slightly outdated but it's all the FCC has to offer. It's just a list of study questions without answers, and they're identical to the study questions with answers in Kaufman's Q & A Manual. According to the FCC, element 3 requires knowledge of the following: General Radiotelephone, all of elements 1 and 2 stated above plus technical matters including fundamentals of electronics technology, and maintenance techniques as necessary for repair and maintenance of radio transmitters and receivers.

### More Stuff

If your electronic tech skills are a bit rusty or you're really starting from scratch and would like additional study material, then try Command Productions, FCC License Training, Dept. 90, P.O. Box 2223, San Francisco, CA 94126. \$169.95 They advertise in **Radio Electronics** magazine all the time. I sent them a request for more information on their product and I received a well organized brochure which described their FCC study approach. It included teaching audio tapes, sample FCC test questions, and a large study manual with a separate pamphlet for calculating FCC-type math problems. The brochure looks good. If you can afford it and you are well motivated, then it might be worth your while.

Lastly, in Table I we include a list of FCC Field Offices and their phone numbers to help you get started. If you don't live near one that's listed, then you've got a problem. Some people end up with a long plane ride and expensive hotel accommodations.

### Test Questions

All FCC questions are the multiple-choice type, none require a written, essay, or verbal response. You might think that multiple-choice questions are usually the easiest to answer; but you can be sure that the FCC is not going to make your life easy while your sweating-out their test questions. Every question has 5 possible answers labeled a, b, c, d, and e. The questions themselves are usually straightforward, but the answers are typically thought-provoking and downright tricky. The correct answer is never so obvious that it appears to jump right out of the page, tap you on the shoulder and say, "Here I am." I was surprised because I was depending on at least five or so give-me questions to help me through the test, but there really were no easy questions. It seemed that every question had answers with curve balls thrown in, and believe me they were hard to hit. Take for example test question Q1, a seemingly easy question:

What do you measure DC current with?

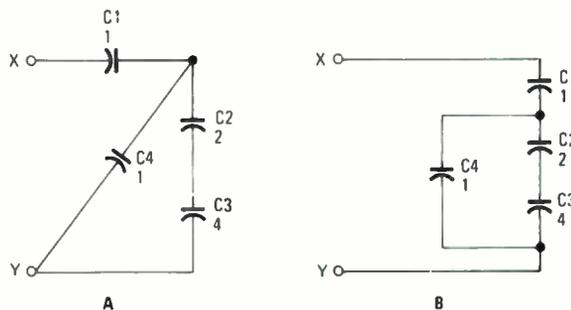
- VOM
- DMM
- VTVM
- Current Probe
- Ampere Meter

Obviously you know that a VOM can measure DC current, and so can a VTVM; those are usually multi-meters which can measure voltage, current, ohms, etc. so answers a, b, and c seem possible. Answer d current probe usually needs to be connected to some kind of meter which they don't mention. I've used a current probe to measure really heavy currents in a thick wire by sensing the strength of the self induced magnetic field generated around the wire. Answer e is the best

answer since the question only asks about DC current, and an ampere meter measures only DC current.

As you can see you have to watch out for trick questions which have more than one right answer; you are then required to select the best answer or the most correct answer. Another trick question is where all the answers seem wrong and you have to select the one that appears most nearly correct. Those can drive you crazy. Your best defense against trick questions is a thorough knowledge of the facts.

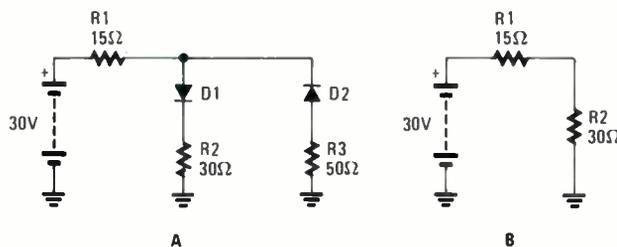
Many of the test questions require a mathematical answer, at least you can then calculate a precise number. But watch out, they'll trick you in the way the question is worded or the way the schematic is drawn. Very often I'll redraw the given schematic into a form which is more familiar to me. Take for example test question, Q2 following; I'd redraw Fig. 1A into schematic Fig. 1B which looks easier to solve. That sometime takes a considerable amount of time, but if you get the right answer then it's well worth the effort. Since there's no examination time limit, you can take as long as you like to complete the test.



Q2: What is the total capacitance between points X and Y?

- 1.43  $\mu\text{F}$
- 0.70  $\mu\text{F}$
- 2.1  $\mu\text{F}$
- 8.0  $\mu\text{F}$
- 6.0  $\mu\text{F}$

The correct answer to Q2 is b, 0.7  $\mu\text{F}$ . Capacitor C4 is drawn on a slant to confuse you. Towards the end of the test after three hours have passed and you're getting tired, you want to finish up and break for lunch. That's when they'll throw a schematic like that in question Q2 at you, and because you're tired you'll rush through it and get it wrong. Don't fall into that trap. If you find yourself rushing through the questions, stop for a few seconds and take a deep breath and stretch your arms out, that may help you get a second wind, so to speak.

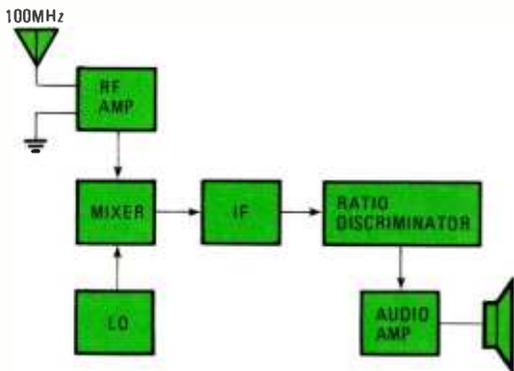


Q3: Find the approximate voltage drop across R1.

- 15 volts
- 20 volts
- 10 volts

- d. 5 volts
- e. None of the above

The correct answer to Q3 is c, 10 volts. It's plain to see in the test question they're trying to test your knowledge about diodes and voltage divider circuits. Diode, D2, is reverse biased and can be considered an open circuit; while diode, D1, is forward biased and, since the question asks for an approximate voltage, we'll consider it a short circuit. Normally the forward voltage drop across a silicon diode is about 0.7 volts. The given schematic in Fig. 2A can be redrafted into the schematic in Fig. 1B which is a simple voltage divider circuit. One you could probably solve with your eyes closed.



Q4: A standard FM broadcast receiver is tuned to 100MHz, the local oscillator frequency is above the incoming signal, what is the image frequency?

- a. 121.4 MHz
- b. 110.7 MHz
- c. 100 MHz
- d. 10.7 MHz
- e. 20.4 MHz

A superheterodyne receiver is subject to image interference. FM broadcast receivers have an IF (intermediate frequency) of 10.7 MHz. Although this information is not given, you're expected to know that to answer the question. There are two frequencies that will give the same IF difference frequency for a given local oscillator frequency, these are, one lower and one higher than the local oscillator. The LO (local oscillator) is given as above the incoming frequency which means the LO equals 110.7 MHz. The image frequency in this case equals:

$$2 \times IF + \text{Incoming frequency} = 121.4 \text{ MHz.}$$

You can check that by subtracting the image frequency from the LO:

$$121.4 \text{ MHz} - 110.7 \text{ MHz} = 10.7 \text{ MHz}$$

and the IF frequency is the same.

In Kaufman's Q & A manual he provides a typical FCC practice examination which is structured to cover all the vital topics of each element. The test questions are geared to the text so if you're confused, you can turn back and review the material, then try the test question again. The practice exam questions are excellent and I wish there were more of them. Very often I would think I knew a topic until I was quizzed, then I'd realize I needed more review.

### Extra Q&A's

While using the manual as a study guide you'll find that after the required FCC Q&A's is a section where additional Q&A's and new material has been added. As Kaufman puts it, the added material has been included to acquaint students with the current state of the electronics art. It is felt that the added material contains subject matter that may be required of students who have obtained a GROL and are seeking employment.

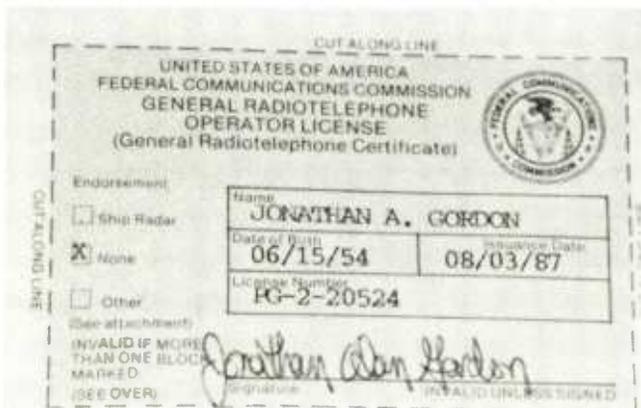
Additionally, the added material contains valuable information for future reference. He goes on to say that the new "added" questions do not appear in any current FCC document. However, the general topics for the questions do appear in an FCC topical outline (not yet officially in force).

I personally found that the added material was vital in passing the exam. The FCC has not officially said, for example, that you need to know op-amps, but, you better know them because they were on my test and were also in Kaufman's added Q&A's. Another such exam question I had was on varactors. A varactor is a diode that acts as a variable capacitor. It is normally reversed biased creating a capacitance that varies with applied voltage and is used as a tuning element in, for example, TV sets using varactor tuning. The FCC does not require you to know varactors according to their outdated exam study guide Bulletin FO-32, however, Kaufman in his added Q&A sections addressed varactors and many other types of present-day diodes. In fact I can honestly say that Kaufman's added Q&A's were as equally important as the FCC-required questions and answers to pass the exam.

### Tubes Too

The FCC has certainly updated their examinations, and Kaufman has kept up. How about another example? I worked really hard on electronic tube theory, like triodes, pentodes, and cold cathode voltage regulators, etc., but almost all my questions were on transistors. The ironic part is the one tube question I did get was not from the required FCC topic questions, but, you guessed it, from Kaufman's additional Q&A section. How many of you know what aquadag is? Well, if you study Kaufman's manual you'll know and then you too can pass the examination. Aquadag coating is on the forward portion of the CRT glass envelope and is electrically connected to the accelerating anode potential. The aquadag assists in the electron beam acceleration; and additionally, when secondary electrons bounce off the screen due to electron-beam bombardment, they are picked up by the aquadag and returned to the power supply.

(Continued on page 90)



Here's my pride and joy all nice and new before cutting. It may look like a small piece of paper, but it can help your career in a big way. It may be worth your while.

# Scientific Notation and Unit Conversions

By Louis E. Frenzel, Jr.

**Tired of writing out zeros? Getting confused with milli, micro, kilo, meg, etc.? This month we'll clear it all up with powers.**

□ MOST OF THE ELECTRONICS MATH YOU WILL DO IS IN solving standard formulas with values related to your application. You will plug in the values, do the math, and arrive at the data you require. The numerical values of the parameters used in the formulas will be expressed in the appropriate basic units such as volts, amperes, ohms, farads, henries, hertz, etc. Because of the very wide range of electronic values, you

will constantly be working with very large and very small numbers.

Further, you will be converting the values from one unit to another. That process is relatively easy when you use a math technique known as scientific notation. In this article, we introduce you to scientific notation and show you how to use it in converting between units.

## Scientific Notation

In electronics, we work with very large and very small numbers and everything in between. For example, most satellites transmit and receive on frequencies in the C band, 4 to 6 GHz (gigahertz). A frequency of 6 GHz means 6,000,000,000 Hz or six billion hertz per second. Using such a number in a formula is a problem. It takes time to write all those zeros, and it is very easy to make a mistake.

Another example are capacitor values. Capacitor values are expressed in farads (F). A farad is a huge value, so most capacitors have values only a fraction of that. A typical value might be 100 pF (picofarads) or .000000001 F. Such decimal fractions are also a problem to work with for the same reasons mentioned above. On top of that, keeping track of the decimal point after a math operation is a nuisance.

Another problem with such large and small numbers is that most ordinary calculators won't handle them. A typical calculator has an 8-digit display. So, how do you enter or display a number with 9, 10 or more digits?

The solution to those problems is to use scientific notation. Scientific notation is just a special way of writing large and small numbers. Any number is divided into two parts:

1. A number between 1 and 10 multiplied by
2. A power of ten.

Our frequency of 6 GHz or 6,000,000,000 would be expressed as:

$$6 \times 10^9$$

Our capacitance of .000000001 F would be expressed as:

$$1 \times 10^{-10}$$

Once numbers are expressed in scientific notation form,

they are much easier to deal with. Operations such as addition, subtraction, multiplication, and division are faster because you are working with small values. The operations with the powers of ten are separate from the other values.

## Working with Exponents

A power of ten is the number ten with an exponent. The exponent, as you know, is the number at the upper right. All it really tells you is how many times to multiply ten by itself. For example,  $10^2$  means to multiply two tens together, or

$$10^2 = 10 \times 10 = 100.$$

The value of  $10^5$  is simply

$$10 \times 10 \times 10 \times 10 \times 10 = 100,000.$$

Table 1 shows all the values up to  $10^{10}$ . Note the two special cases  $10^0$  and  $10^1$ . Any number with an exponent of zero is simply 1. A number with an exponent of 1 is just the number. So,  $10^1$  is simply 10.

TABLE 1—POWERS OF 10

$10^0 = 1$
$10^1 = 10$
$10^2 = 100$
$10^3 = 1000$
$10^4 = 10000$
$10^5 = 100000$
$10^6 = 1000000$
$10^7 = 10000000$
$10^8 = 100000000$
$10^9 = 1000000000$
$10^{10} = 10000000000$

The exponent also tells you where to put the decimal point. In the expression  $10^2$ , the 2 says to write two zeros after a 1 or 100. The expression  $10^5$  says to write a 1 followed by 5 zeros. Easy, huh?

### Negative Exponents

There are also negative exponents such as  $10^{-2}$ . When you see a negative exponent, it means that the number is a fraction, or less than one. Remember,  $10^0$  is 1, so when the exponent goes negative, the value drops below one.

The expression  $10^{-1}$  is the same as  $1/10^1$  or  $1/10$ . Of course, you can get the decimal value by dividing the numerator by the denominator or 1 divided by 10, which is .1.

**TABLE 2—NEGATIVE POWERS OF 10**

$10^{-1} = 1/10 = .1$
$10^{-2} = 1/100 = .01$
$10^{-3} = 1/1000 = .001$
$10^{-4} = 1/10000 = .0001$
$10^{-5} = 1/100000 = .00001$
$10^{-6} = 1/1000000 = .000001$
$10^{-7} = 1/10000000 = .0000001$
$10^{-8} = 1/100000000 = .00000001$
$10^{-9} = 1/1000000000 = .000000001$
$10^{-10} = 1/10000000000 = .0000000001$
$10^{-11} = 1/100000000000 = .00000000001$
$10^{-12} = 1/1000000000000 = .000000000001$

To remove the minus sign on the exponent, just divide 1 by the expression without the minus sign. Thus  $10^{-2}$  is the same as  $1/10^2$  or  $1/100$ . Converting to decimal form you get .01. Table 2 gives all the equivalent values through  $10^{-12}$ .

There is one handy procedure you should learn. We can call it the reciprocal trick. The reciprocal of a number is just the number divided into 1. The reciprocal of the number N is  $1/N$ . The reciprocal of 2 is:

$$1/2 = .5$$

The reciprocal of the reciprocal of the number N is just N, or

$$1/(1/N) = N$$

Using those relationships, you can simplify the handling of powers of ten. Here's how.

The reciprocal of a power of ten is just the power of ten with the exponent sign changed. Here are some examples:

$$\begin{aligned} 1/10^3 &= 10^{-3} \\ 1/10^{-5} &= 10^5 \\ 1/4 \times 10^8 &= .25 \times 10^{-8} \\ 1/8 \times 10^{-6} &= .125 \times 10^6 \end{aligned}$$

Reciprocals are found in many electronic formulas. You can get rid of them with this trick.

### Practice Problems 1–3

Just to be sure you've got the idea, work the practice problems below. Do NOT look at Tables 1 and 2.

1. Convert the following expressions to their normal form:

- $10^{-3} =$
- $10^9 =$

2. Convert the following to decimal fractions:

- $10^{-6} =$
- $10^{-12} =$

3. Find the reciprocals of the following.

- $10^{-2} =$
- $10^6 =$
- $1/(5 \times 10^{-3}) =$
- $1/(4 \times 10^7) =$

### Converting Standard to Scientific

A number in standard form looks like this:

7,520,000

If no decimal point is shown, it is assumed to be directly to the right of the right-most digit.

7,520,000.000

We can add zeros after the decimal point without affecting the value. Now we want to put that number into scientific notation. Here's what you do:

1. Convert the number to some value between 1 and 10 by moving the decimal point left, so that it is just to the right of the left-most or most significant digit.

7.520000

The number 7.52 is between 1 and 10. Note that you had to move the decimal point over six places.

2. Multiply the number by the appropriate power of 10. The exponent is a number equal to the number of places you moved the decimal point or:

$7.52 \times 10^6$

If you moved the decimal point to the left, the exponent is positive.

This procedure also works with decimal fractions. Take the value:

.000036

First, move the decimal point right to create a number between 1 and 10, or

00003.6

Then multiply by the correct power of 10. Again, the number of places you moved the decimal point gives you the exponent value.

$3.6 \times 10^{-5}$

In this case, since you moved the decimal point to the right, the exponent is negative.

### Practice Problems 4 and 5

OK, before we go on, try this yourself. Convert the following numbers to scientific notation:

- 910,000,000
- .0000000825

### Converting Back

Often you will need to go the other way, or change your scientific notation values back into standard form. It is pretty easy to do. Here's how.

1. Look at the exponent and move the decimal point the number of places indicated.

a) Move it left if the exponent is minus.

b) Move it right if the exponent is positive.

2. Add zeros to the right or left as needed to fill the digit places.

For example:

$$5.027 \times 10^4 \text{ is} \\ 5.0270. \text{ or } 50,270$$

Add any extra zeros on to the right if you need to. Here we added one.

Another example:

$$1.9 \times 10^{-5} \text{ is} \\ .00001.9 \text{ or } .000019$$

Add as many zeros as needed.

Another way to look at the procedure is just multiply the two parts of the expression. First, replace the power of 10 part with its value from Tables 1 or 2, then multiply. Thus:

$$5.027 \times 10^4 = \\ 5.027 \times 10000 = 50270$$

or

$$1.9 \times 10^{-5} = \\ 1.9 \times .00001 = .000019$$

---

### Practice Problems 6 and 7

Here's a couple more for you to try. Convert from scientific notation to standard form.

6.  $9.5 \times 10^3$

7.  $3.303 \times 10^{-9}$

---

### Changing the Format

The standard way to present scientific notation numbers is to write the value as a number between 1 and 10 multiplied by a power of 10. But there are times when you will want to change that. For example, you may want to show the number in thousands or as a fraction. Or you may want the exponent to be a specific value. The resulting numbers will still be in scientific notation, but not in standard format. Here are several examples to show how it is done.

Assume you have the number

$$4.7 \times 10^3$$

You want the numerical value to be between 10 and 100 multiplied by the appropriate power of 10. To do this, multiply 4.7 by 10 to get 47. Since you multiplied the number by 10, you have to divide the power of 10 part by 10 or

$$10^3/10 = 10^2$$

The new expression is

$$47 \times 10^2$$

Another way to look at that is that you moved the decimal point on the number one place to the right. As a result, you have to reduce the exponent by one. In either case, the value didn't change, just its form.

Here's another example. You have the number

$$2.9 \times 10^{-4}$$

You want the power of 10 to be  $10^{-6}$ . That is equivalent to

multiplying by  $10^{-2}$  ( $10^{-4} \times 10^{-2} = 10^{-6}$ ). Now you have to divide the numerical value by  $10^{-2}$  to keep the total value the same.

$$2.9/10^{-2} = 2.9/.01 = 290$$

The new expression is

$$290 \times 10^{-6}$$

Or, you could say, if you increase the numerical value of a negative exponent by 2, you have to move the decimal point on the number 2 places to the right.

The whole idea of this process is to change the decimal points location without changing the actual value represented by the expression.

---

### Practice Problems 8 and 9

Try these for practice:

8.  $8.3 \times 10^5$

Express the numerical part as a value between 100 and 1000.

9.  $1.5 \times 10^{-5}$

Express the exponent as  $10^{-3}$

---

### Doing Math

Now let's see how we can perform all the basic math operations using numbers in scientific notation form. As it turns out, most operations will be either multiplication or division. Here's what you do:

1. Simply multiply or divide the numerical values as you normally would.

2. Then add or subtract the exponents to get the new correct power of 10.

a) Add exponents if multiplying.

b) Subtract exponents if dividing.

3. Convert the new number back to scientific notation.

Here's an example of multiplication.

$$(6.4 \times 10^3)(3.1 \times 10^2) \\ 6.4 \times 3.1 = 19.84 \\ 10^3 \times 10^2 = 10^5$$

The product is:

$$19.84 \times 10^5$$

Note that the numerical value is larger than ten so we convert it to scientific notation.

$$1.984 \times 10^1 \times 10^5$$

To get to a single power of 10 again, just add exponents since you are multiplying.

$$1.984 \times 10^6$$

Here's how division works.

$$(3.2 \times 10^6)/(8.0 \times 10^2)$$

First, divide the numerical values or

$$3.2/8.0 = .4$$

Then subtract exponents.

$$10^6/10^2 = 10^{6-2} = 10^4$$

The new value is:

$$.4 \times 10^4$$

To put it in correct scientific-notation form, move the decimal point to create a number between 1 and 10:

$$4.0 \times 10^{-1} \times 10^4$$

Now add exponents:

$$4.0 \times 10^{4-1} = 4.0 \times 10^3$$

Adding a positive and a negative number is the same as taking their difference and using the sign of the larger.

Here's a more complex problem with both multiplication and division as well as some negative exponents:

$$(4.5 \times 10^{-3})(6.8 \times 10^5)/(7.2 \times 10^{-4})$$

First, do the multiplication in the denominator.

$$4.5 \times 6.8 = 30.6$$

Add the exponents:

$$10^{-3} \times 10^5 = 10^{5-3} = 10^2$$

The product is:

$$30.6 \times 10^2 = 3.06 \times 10^1 \times 10^2 = 3.06 \times 10^3$$

Now the problem is:

$$(3.06 \times 10^3)/(7.2 \times 10^{-4})$$

Dividing the numerical values first gives:

$$3.06/7.2 = .425 \text{ or } 4.25 \times 10^{-1}$$

Then subtract the exponents:

$$10^3 \times 10^{-4} = 10^{3-4} = 10^{3+4} = 10^7$$

The new value is:

$$4.25 \times 10^{-1} \times 10^7 = 4.25 \times 10^6$$

### Practice Problems 10 and 11

The only way to master this is to get some hands-on experience. Try these problems:

10.  $(1.2 \times -3)(4.5 \times 10^{-6})/(7.8 \times 10^{-9})$

11.  $(3.5 \times 10^7)/(9 \times 10^1)(2.4 \times 10^6)$

### Squares and Square Roots

Squares and square roots are also common operations. Squaring a number is just multiplying it by itself. Therefore, you can use the multiplication procedure described above. A short-cut is to just multiply the numerical value by itself, then double the exponent value. For example:

$$\begin{aligned}(8.8 \times 10^{-4})^2 &= 8.8 \times 8.8 \times 10^{-8} = \\ 77.44 \times 10^{-8} &= 7.744 \times 10^1 \times 10^{-8} = \\ &7.744 \times 10^{-7}\end{aligned}$$

To take the square root of a number in scientific notation form, the exponent has to be an even number. If it is, just take the square root of the numerical value, then halve the exponent value.

$$\sqrt{9 \times 10^6} = 3 \times 10^3$$

Or,

$$\sqrt{4 \times 10^{-8}} = 2 \times 10^{-4}$$

If the exponent is not even, then simply move the decimal point one place to the right (or left) on the numerical value and adjust the exponent accordingly.

$$\begin{aligned}\sqrt{3.6 \times 10^{-5}} &= \sqrt{.36 \times 10^1 \times 10^{-5}} = \\ \sqrt{.36 \times 10^{-4}} &= .6 \times 10^{-2} = 6.0 \times 10^{-3}\end{aligned}$$

Or, you could have moved the decimal point the other way. It doesn't matter as the result is the same:

$$\begin{aligned}\sqrt{3.6 \times 10^{-5}} &= \sqrt{36 \times 10^{-1} \times 10^{-5}} = \\ \sqrt{36 \times 10^{-6}} &= 6.0 \times 10^{-3}\end{aligned}$$

### Practice Problems 12 and 13

Try these yourself to ensure you understand the concept.

12.  $(2.2 \times 10^{-4})^2$

13.  $\sqrt{5.8 \times 10^7}$

### Addition and Subtraction

It's not likely that you'll need to add or subtract numbers in scientific notation form. But here's how to do it.

Remember, when adding or subtracting decimal fractions you had to line up the decimal points first? To add 12.36 and .0178 you did this:

$$\begin{array}{r} 12.36 \\ + .0178 \\ \hline 12.3778 \end{array}$$

You did the same thing to subtract. For example, 105.9 less 2.348 is:

$$\begin{array}{r} 105.900 \\ - 2.348 \\ \hline 103.552 \end{array}$$

To add and subtract numbers in scientific notation, you have to do the same thing. You do that by adjusting the numerical value of one number until the exponents on the powers of 10 are equal. The problem below illustrates that:

$$(4.9 \times 10^3) + (7.5 \times 10^4)$$

Let's make both powers of 10 have exponents of 3.

$$(4.9 \times 10^3) + (75. \times 10^3)$$

Now, all you do is add the numerical values and attach the same power of 10.

$$79.9 \times 10^3$$

Readjust to scientific notation:

$$7.99 \times 10^4$$

Here's a subtraction problem.

$$(3.1 \times 10^{-5}) - (8.2 \times 10^{-7})$$

Let's use  $10^{-7}$ .

$$\begin{aligned}3.1 \times 10^{-5} &= 310 \times 10^{-7} \\ (310 \times 10^{-7}) - (8.2 \times 10^{-7}) &= \\ 301.8 \times 10^{-7} &\end{aligned}$$

## Practice Problems 14 and 15

Do these for some experience:

14.  $(2.7 \times 10^5) + (5.6 \times 10^4)$

15.  $(3.1 \times 10^{-2}) - (8.7 \times 10^{-3})$

## Units and Powers

Each electrical characteristic is expressed or measured in special units. For example, current is measured in amperes. You are probably familiar with most electrical units, but the most common ones are summarized in Table 3.

TABLE 3—COMMON ELECTRICAL UNITS

Electrical Characteristic	Unit	Abbreviation
Voltage	Volts	V
Current	Amperes	A
Resistance	Ohms	$\Omega$
Impedance	Ohms	$\Omega$
Power	Watts	W
Capacitance	Farads	F
Inductance	Henries	H

As you learned earlier, very large and very small values are common. So, scientific notation is commonly used to express these values. However, it is common practice to use certain multiples or submultiples of those units. For example, the terms milli, micro, nano, and pico are used to represent very small values while kilo, mega, and giga are used to represent very large values. Here's what each of these terms mean:

milli = one thousandth =  $1/1000 = .001 = 10^{-3}$

micro = one millionth =  $1/1,000,000 = .000001 = 10^{-6}$

nano = one billionth =  $1/1,000,000,000 = .000000001 = 10^{-9}$

pico = one trillionth =  $1/1,000,000,000,000 = .000000000001 = 10^{-12}$

Those are called sub units since they are smaller than a unit.

kilo = one thousand =  $1000 = 10^3$

mega = one million =  $1,000,000 = 10^6$

giga = one billion =  $1,000,000,000 = 10^9$

Those are called super units since they are larger than a basic unit. Numbers expressed using sub or super units are said to be in engineering notation.

Here are some typical examples:

- A millivolt is one thousandth of a volt (abbreviation mV).
- A microampere is one millionth of an ampere (abbreviation  $\mu$ A).
- A picofarad is one trillionth of a farad (abbreviation pF).
- A kilowatt is one thousand watts (abbreviation kW).
- A megohm is one million ohms (abbreviation M).
- A gigahertz is one billion hertz or cycles per second (abbreviation GHz).

The above prefixes can be attached to any unit to express a very large or very small value.

## Unit Conversions

Let's look at some examples of how units are converted.

If the voltage applied to a circuit is 5 volts and the resistance is 400 ohms, the current according to Ohm's law is:

$$I = V/R = 5/400 = .0125 \text{ A} = 1.25 \times 10^{-2} \text{ A}$$

You can use the current value in that form, but normally if the value is less than one ampere, then we use milli or micro amperes instead. Let's use milliamperes here. Since milli is one thousandth, then our power of 10 should be  $10^{-3}$ . As a result, we have to readjust the decimal point on the numerical value.

$$1.25 \times 10^{-2} = 12.5 \times 10^{-3}$$

Now, we can drop the  $10^{-3}$  and simply say that the current is 12.5 milliamperes or 12.5 mA. You get the idea?

What if you go the opposite way and want to calculate the resistance given the values of voltage and current. Let's use the values above.  $V = 5$  volts and  $I = 12.5$  mA. What is the resistance?

$$R = V/I = 5/12.5 = .4 \text{ ohms}$$

Ooops! The value is supposed to be 400 ohms. What happened? The answer is that all values used in electronic formulas must be in basic units, not in sub- (smaller) units or super- (larger) units. We used 12.5 mA in the formula. That has to be expressed in amperes (A) to get the right value. To do this we use scientific (or engineering) notation:

$$12.5 \text{ mA} = 12.5 \times 10^{-3} \text{ A}$$

$$R = 5/(12.5 \times 10^{-3}) = 400 \text{ ohms}$$

Keep this important fact in mind: **Use only basic electrical units in formulas, not sub or super units!**

## More Examples

Now, let's take some more examples. You are given a value of 268 mV. To get scientific notation, all you do is replace the mV with  $10^{-3}$ .

$$268 \times 10^{-3}$$

Then convert to a number between 1 and 10, or:

$$2.68 \times 10^{-1} \text{ volt}$$

Let's take another example. The voltage (V) across a load is 12 volts. The load current (I) is 40 microamperes. What is the load power (P)?

$$P = V \times I$$

$$P = 12 \times (40 \times 10^{-6})$$

Note what we did in writing out the current. We have to use amperes in the formula, not microamperes. Since the subunit is microamperes, we multiplied the value by  $10^{-6}$  since micro means one millionth. That gives the units in amperes. The resulting power is:

$$480 \times 10^{-6} \text{ watts}$$

We can drop the  $10^{-6}$  and just say 480 microwatts (mW).

What about resistor values? Large values such as 47,000 and 2,200,000 ohms are common. In that case, we can use the kilo or mega prefixes. A kilo prefix means  $10^3$  so we divide the value by 1000 to get kilo units.

$$47,000/1,000 = 47 \text{ kilohms or } 47\text{K ohms}$$

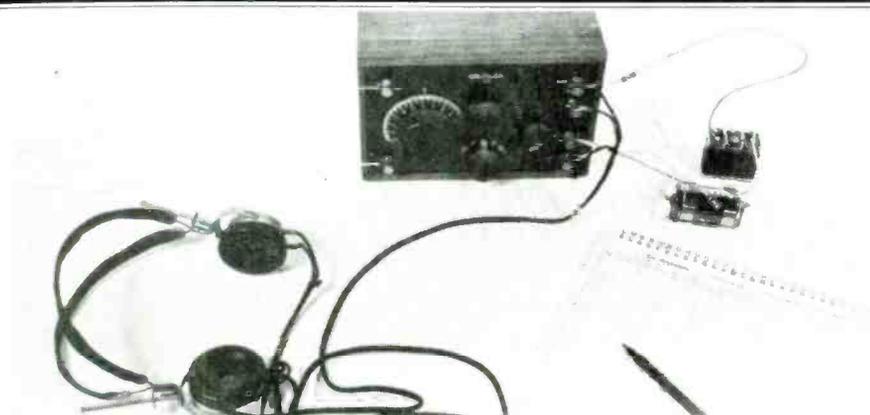
To express 2,200,000 in megohms, we divide by  $10^6$  or 1,000,000.

$$2,200,000/1,000,000 = 2.2 \text{ megohm or } 2.2 \text{ M}$$

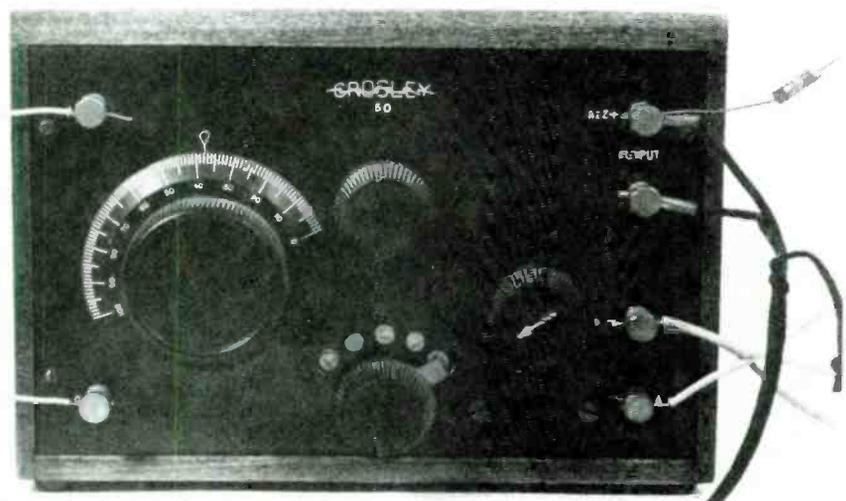
Or, you can go the opposite direction. A value of 3.6K

(Continued on page 92)





Ready for the listening test! Batteries, headset, antenna and ground are connected and a logbook is handy to note stations heard.



The Crosley 50's tuning dial is at left, and the filament rheostat at the right. The regeneration-control knob is located directly above the tap switch. The plate-voltage dropping resistor can be seen in the upper right hand corner.

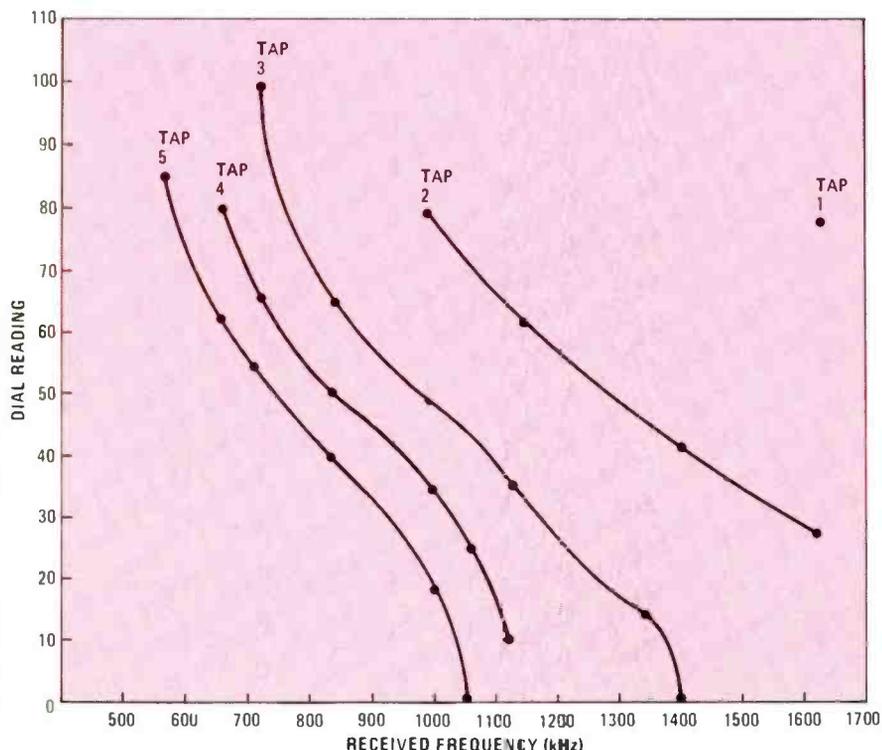


Fig. 2—This graph shows relationship between dial readings and received frequencies for various tap switch positions.

## Evaluating Performance

The first set feature I explored was the operation of the regeneration control. This is a knob that varies the distance between the tuning and tickler coils. Pulling it out brings the coils closer together, increasing plate-to-grid feedback; pushing it in does the opposite.

I expected to notice a pronounced increase in sensitivity with the coils adjusted so that the set was just on the point of oscillation. Stations came in readily, and signal strength remained constant, regardless of the position of the coils. Perhaps the stations that I was listening to were too strong for a sensitivity effect to be apparent. With the coils almost touching, sound would become garbled and "watery" sounding. That, I assume, indicated the onset of oscillation.

By the way, if you should be experimenting with a regenerative receiver hooked up to an outside antenna, don't leave the set in an oscillating mode for more than a few seconds. When it oscillates, your receiver becomes a miniature transmitter that can radiate a signal for miles—possibly interfering with various radio services.

My next project was to run some frequency-calibration curves on the set. I wanted to determine what frequencies the numbers on the tuning dial corresponded to for each of the five tap positions. To do that, I tuned in as many stations as I could in each tap position—verifying the frequency of each station by tuning it in on a modern receiver with a good dial scale.

The graph shown in Fig. 2 summarizes my results. Tap 1 (on which I was only able to pick up one station), Tap 4, and Tap 3 might just as well have been left off the set. Taps 2 and 5 do an excellent job of covering the entire broadcast band. I've listened to many vintage radios through vintage earphones—but most of the sets were multiple-tube setups with a reasonable amount of output power. At the normal volume levels used when there's power to spare, the earphone sound tends to be harsh and tinny.

But when there's just a couple of milliwatts of power going to the phones, things sound quite different. The little metal diaphragms are barely vibrating and your ears are alert to catch every sound. Under those conditions, the reproduction has no trace of tininess and sounds are pure and clear. In fact, you'd be amazed at how well you can hear at that minimal-volume level. Try it some time and let me hear about your experiences!

Well once again we've run out of space for the month. But before signing off, a little reminder: We welcome tips, questions, and comments related to the antique-radio hobby. Write to Marc Ellis, C/O Hands-on Electronics, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■



By Charles D. Rakes

# CIRCUIT CIRCUS

Produce the most basic building-block circuits from inexpensive op-amps

THIS MONTH'S CIRCUS STARTS OUT BY showing how easy it is to turn a low-cost IC into a number of basic building-block circuits, that can stand alone, or be used as an important functioning block in a future project. In fact I find it worth while to keep a similar set of building blocks on the bench ready to use in testing a new project idea. Such an approach won't solve all of your project needs (to think so would be absurd), but when any of the blocks can be used, it can certainly speed up the process of designing, building, and checking new circuits.

The recipe: Take a popular, low-cost IC (in this his case the LM324 quad op-amp), add a few support components, shake gingerly, and presto!—you've got four basic building-block circuits to play with. Actually, unless you live on the yellow brick road, the more predictable route to take is to duplicate the following circuits.

## Voltage Follower

Figure 1 shows an AC Voltage-Follower built around just one of the op-amps contained in a single LM324. The high input impedance of the Voltage-Follower circuit makes it an ideal electronic matching device to connect between high and low impedance circuits.

The circuit's voltage gain is one, and the frequency response is nearly flat from 10 Hz to 40 kHz. Above 40 kHz, the gains

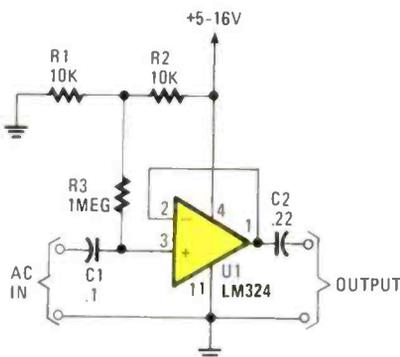


Fig. 1—The Voltage Follower, circuit built around an LM324 quad op-amp integrated circuit, has a high input impedance, a voltage gain of one, and a frequency response that is nearly flat from 10 Hz to 40 kHz—above which gains decreases rapidly as the frequency increases.

decrease rapidly as the frequency increases. Resistors, R1 and R2 cut the supply voltage in half to provide a bias voltage to the positive input of the op-amp (U1) through R3. That automatically sets the output voltage to one-half that of the power source, to allow an even up-and-down output swing.

By removing the R and C components from the circuit, a DC Voltage Follower is produced (as shown in Fig. 2) that makes an excellent buffer stage to operate between a high-output impedance DC circuit, and a driver or output stage.

One of the most useful building-block circuits that an op-amp can provide is the fixed gain AC amplifier. By selecting the value of two resistors its gain and input impedance can be set to any value.

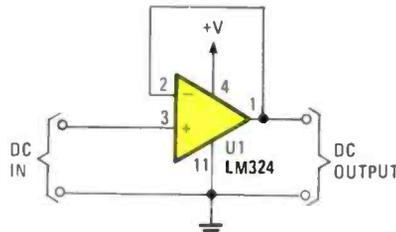


Fig. 2—By removing the R and C components from the Fig. 1 circuit, you are left with a DC Voltage Follower, which makes an excellent buffer stage to operated between a high output impedance DC circuit, and a driver or output stage.

## PARTS LIST FOR THE VOLTAGE FOLLOWER

- C1—.1-μF, 100-WVDC mylar capacitor
- C2—.22-μF, 100-WVDC mylar capacitor
- R1, R2—10,000-ohm, ¼-watt resistor
- R3—1-Megohm, ¼-watt resistor
- U1—LM324 op-amp integrated circuit
- IC socket, perfboard, etc.

## Inverting Amplifier

The block circuit (of Fig. 1) can be built as an inverting or noninverting amplifier stage with the gain preset to almost any value from 1 to over 100. The Inverting Amplifier circuit is shown in Fig. 3. The input impedance is set by the value of R1.

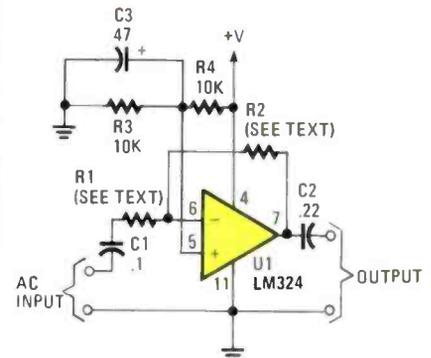


Fig. 3—The gain of the Inverting Amplifier—with its input impedance set by the value of R1 and gain set by the combination of R1 and R2—can be preset to almost any value from 1 to over 100.

and the circuit's voltage gain is set by the combination of R1 and R2 by using the following simple formula:

$$R2/R1 = \text{gain.}$$

For example; If the input impedance needs to match the output of a 1000-ohm dynamic microphone and a voltage gain of 100 is required, then R1 would be 1000-ohms and R2 would be 100,000 ohms. With a fixed input impedance of 1000-ohms, the gain can be set to 10 by simply changing R2 to 10,000 ohms; to 50,000 ohms for a gain of 50; and to 200,000 ohms for a circuit gain of 200.

## PARTS LIST FOR THE INVERTING AMPLIFIER

- C1—.1-μF, 100-WVDC mylar capacitor
- C2—.22-μF, 100-WVDC mylar capacitor
- C3—47-μF, 25-WVDC electrolytic capacitor
- R1, R2—See text
- R3, R4—10,000-ohm, ¼-watt resistor
- U1—LM324 op-amp integrated circuit
- IC socket, perfboard, etc.

The maximum obtainable gain that a single op-amp stage can offer is determined and limited by several internal design factors—including the amp's open-loop gain figure and the amplifier's inter-

nal frequency-compensation network. Just remember, that as the gain goes up the frequency response goes down. And when used in a general-purpose audio amplifier, a maximum gain-per-stage of 100 would be a good value to shoot for with the LM324.

### Buffer Amplifier

A noninverting Buffer-Amplifier circuit is shown in Fig. 4. The main difference between the previous circuit and this one is that the output remains in phase with the input signal. A number of active filters (such as the *XMI Electronic Crossover* featured in the November 1987 issue of HOE), oscillators, and other special function circuits require that in-phase signal relationship.

The method used in selecting the gain

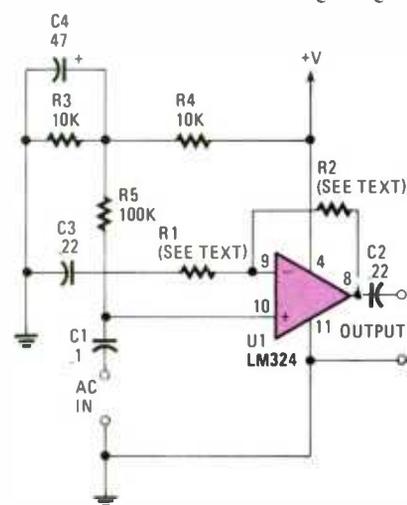


Fig. 4—The Buffer Amplifier differs from the Inverting Amplifier in that the Buffers output waveform is a carbon-copy of the input signal.

### PARTS LIST FOR THE BUFFER AMPLIFIER

- C1—.1-μF, 100-WVDC mylar capacitor
- C2, C3—.22-μF, 100-WVDC mylar capacitor
- C4—47-μF, 25-WVDC electrolytic capacitor
- R1, R2—See text
- R3, R4—10,000-ohm, ¼-watt resistor
- U1—LM324 op-amp integrated circuit
- IC socket perboard, etc.

resistor values for the noninverting configuration is different than the one used for the inverting type, and it goes like this:

$$R1 + R2/R1 = \text{gain.}$$

With the same resistor values, as used in the Inverting Amplifier, the gain is:

$$1000 + 100,000/1000 = 101,$$

which is very close to the gain of the

inverting configuration. So if the circuit is general-purpose in nature, you can use the simpler inverting formula for both.

### Squarewave Generator

The Squarewave Generator, shown in Fig. 5, is another handy-dandy building block that can be a real helpmate in the design and evaluation of new circuits. The oscillator can be tuned, with the component values given from about 1.5 kHz to over 4 kHz. And with new values for C1 and R6, it can cover the frequency range of 1 Hz to over 10 kHz.

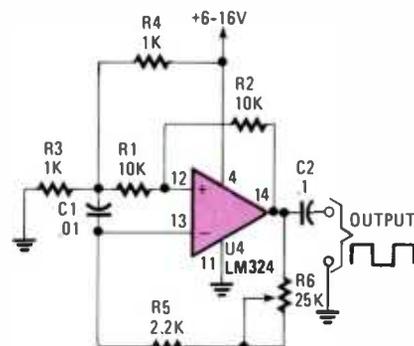


Fig. 5—The Squarewave Generator's output frequency can be varied from about 1.5 kHz to over 4 kHz (with the component values given).

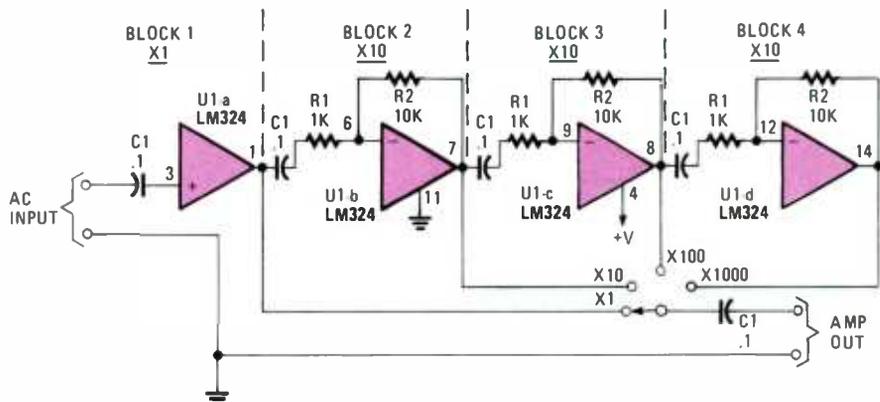


Fig. 6—The Instrumentation Amplifier—built from the previous building blocks—is ideally suited for mating with an oscilloscope or an AC voltmeter for checking low-level audio signals.

The simplest way to vary the frequency range of the Squarewave Generator, is to change the value of C1.

### Instrumentation Amplifier

What would this little gathering of useful circuits be if we left out the Instrumentation Amplifier—which, coincidentally, can be made by stringing four of the above building blocks together (Fig. 6).

The Instrumentation Amplifier is ideally suited for mating with an oscilloscope or an AC voltmeter for checking low-level audio signals. If a 1-millivolt wiggle on your scope looks like a mini snake, then build this amplifier and boost the snake's size to that of a Loch Ness monster, which

### PARTS LIST FOR THE SQUAREWAVE GENERATOR

- C1—.01-μF, 100-WVDC mylar capacitor
- C2—.1-μF, 100-WVDC mylar capacitor
- R1, R2—10,000-ohm, ¼-watt resistor
- R3, R4—1000-ohm, ¼-watt resistor
- R5—2200-ohm, ¼-watt resistor
- R6—25,000-ohm potentiometer
- U1—LM324 op-amp integrated circuit
- IC socket, perboard knob, etc.

### PARTS LIST FOR THE INSTRUMENTATION AMPLIFIER

- C1—.1-μF, 100-WVDC mylar capacitor
- R1—1000-ohm, ¼-watt resistor
- R2—10,000Ω, ¼-watt resistor
- S1—Single-pole 4-position switch
- U1—LM324 op-amp integrated circuit
- IC socket, perboard, wire, terminals, etc.

in this case is to a 1-volt level.

With S1 in position 1, the circuit gain is only 1, but with the voltage follower cir-

cuit the loading effect on the monitored circuit is at a minimum. In position 2 the gain is times 10.

Start with block amp #1 and build it to match the circuit shown in Fig. 1, using the component values given. The remaining three block amplifiers are identical and are constructed to match the circuit in Fig. 3, using the component values given for Fig. 3, with the exception of the values of R1 and R2 which are taken from the parts list for Fig. 6. Connect the four amps together.

Remember that the largest building started out one block at a time, so give the building block design approach a go and see what you come up with. ■



# CARR ON HAM RADIO

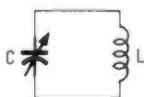
## Why is my receiver dial all scrunched up....while yours is not?

□ HAVE YOU EVER NOTICED THAT SOME radio-receiver dials are linear, while others are not? Some receiver dials are equally spaced for equal frequency differences, while others have the calibration points spread out at one end and all *scrunched up* at the other. Let's find out why that happens.

Most radio receivers are tuned by an inductor—capacitor (LC) tank circuit such as Fig. 1. The resonant frequency is determined by the values of inductance and capacitance in the circuit, according to the formula in the figure. We can tune the radio by varying either L or C. Most table-model radios (including most shorewave receivers) use a variable capacitor as the main tuning control, while both AM and FM auto radios usually use a variable inductor.

The main problem causing the "scrunching effect" is seen by evaluating the equation for resonance (see Fig. 1) to see what happens when either inductance (L) or capacitance (C) are varied. Note that a squareroot symbol appears in the equation. That fact alone tells us that the frequency change is not linear with respect to L or C change.

In fact, if you are up on your math, you might recognize that the curve will be a "parabola." The *max/min frequency ratio* is the square of the *max/min capacitance ratio*:



I. RESONANCE: 
$$F = \frac{1}{2\pi\sqrt{LC}}$$

II. RATIO: 
$$\frac{C_{MAX}}{C_{MIN}} = \left(\frac{F_{MAX}}{F_{MIN}}\right)^2$$

III. 
$$C_{MIN} = \frac{C_{MAX}}{\left(\frac{F_{MAX}}{F_{MIN}}\right)^2}$$

Fig. 1—Most radio receivers are tuned by an LC tank circuit, with the resonant frequency determined by the values of inductance and capacitance. Most table-model radios (including most shorewave receivers) use variable capacitors as the main tuning control, while AM and FM auto radios use a variable inductor.

$$C_{max}/C_{min} = [F_{max}/F_{min}]^2$$

For example, the AM broadcast band on most radios runs from 550 to 1610 kHz. The frequency ratio for AM is therefore 1610/550, or 2.93:1. The standard capacitor used in those AM sets (and most general-coverage SW sets, as well) has a maximum capacitance of 365-pF, so the minimum value is found (as shown in equation III in Fig 1) by re-arranging the equation. Working the arithmetic would show a required minimum capacitance of 42.5-pF

In addition to the inherent non-linearity of the tuning process, we also have to deal with *tracking error*. Modern radios are built on the *superheterodyne* principle (see Fig. 2) in which the desired signal (RF) is mixed ("heterodyned") with a local oscillator, LO, signal. The output of the mixer contains the following frequencies: RF; LO; LO + RF; and LO—RF.

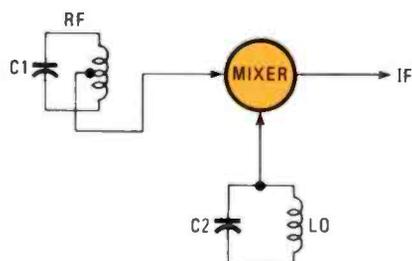


Fig. 2—In addition to the inherent non-linearity of the tuning process, there is also tracking error to deal with. Modern radios are built on the superheterodyne principle in which the desired signal (RF) is mixed ("heterodyned") with a local oscillator (LO) signal.

A tuned circuit picks off either the sum or difference of RF and LO, and calls it the intermediate frequency (IF). It is the IF that receives most of the radio's amplification and bandpass filtering.

The superhet (as it is called) is spectacularly successful, but there is a problem or two. Let's consider a standard AM band receiver with the usual 455-kHz IF section. The RF section tunes from 550 to 1610-kHz, so the LO must tune (RF + IF) frequencies from 1005 kHz to 2065 kHz. Remember our earlier discussion? Then

note that 1610/550 and 2065/1005 are not the same number! That is, 2.93 does not equal 2.06, which means that a radio with a single-knob tuner will not track between the RF-tuned circuit and the LO-tuned circuit.

### Coming Together

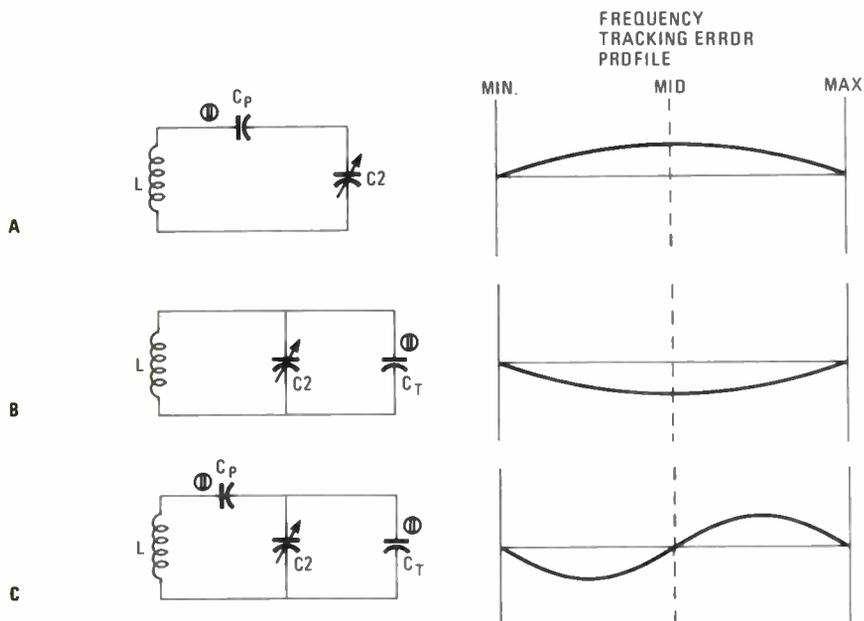
Fortunately, there is an answer to the problem. Figure 3 shows three variations of the LO-tuned circuit designed to improve tracking with the RF circuit. In Fig. 3A, we see the use of a small variable capacitor ( $C_p$ ) in series with the main tuning capacitor ( $C_2$ ). That small capacitor is called a *padding*. We can also connect a small capacitance in parallel with  $C_2$ , in which case the small cap is called a *trimmer* ( $C_t$  in Fig. 3B). In either case, the tracking-error profiles are about the same, but of opposite sense. The best kind of tracking (Fig. 3C) combines  $C_p$  and  $C_t$  in the same circuit.

Some modern sets have a slightly different dial-linearity problem if they use variable-capacitance diodes (varactors) instead of mechanical capacitors. Figure 4A shows the simplest varactor-tuned LC circuit. The capacitance that is needed to resonate the inductor is the junction capacitance of diode D1 (i.e.,  $C_j$ ). The junction capacitor is varied by a DC tuning-voltage,  $C_v$ . Capacitor C1 is used to block the DC tuning-voltage in order to keep it from being shorted to ground through the inductor. If C1 is very much larger than the diode capacitance, then C1 does not affect the resonant frequency very much.

In varactor-tuned receivers, the main dial is hooked to a potentiometer that (in turn) is connected to a regulated DC voltage. Unfortunately, the C vs. V curve is very non-linear. That problem is partially overcome by connecting two varactor diodes back-to-back as shown in Fig. 4B.

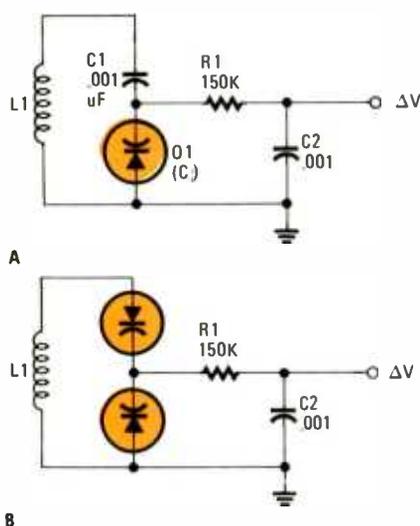
### Straightening the Dial

If you look at your AM car radio, you might notice that the dial tuning is nearly linear. In other words, the distance on the dial for equal frequency differences are the same across the dial. How do they do it? Other radio receivers also have linear tuning. Let's see what tricks are used in those sets.

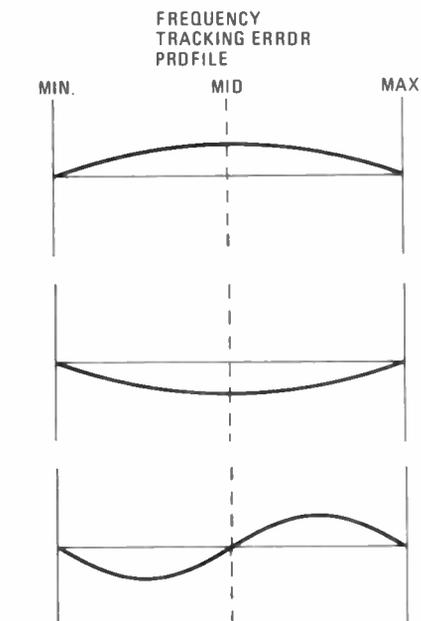


**Fig. 3—**Here are three variations of the LO-tuned circuit designed to improve tracking with the RF circuit: "A" uses a small variable capacitor ( $C_P$ ) in series with the main tuning capacitor ( $C_2$ ); in "B," a small trimmer capacitance ( $C_T$ ) is connected in parallel with  $C_2$ . The LO-tuned circuit in "C" offers the tracking-error profile by combining  $C_P$  and  $C_T$  in the same circuit.

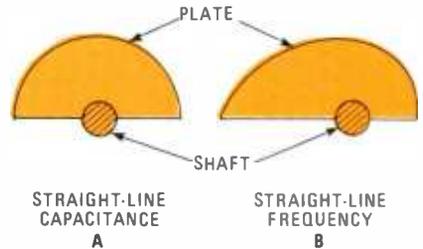
Most radios use a one-to-three section variable capacitor (Fig. 5) to tune the resonant circuits. Each variable capacitor consists of a set of fixed stator plates insulated from—but parallel and meshed together with—the movable rotor plates. The total capacitance is determined by the area of the plates facing each other. As the shaft rotates, the rotor plates become more or less meshed with the stator plates, and capacitance changes. The shape of the rotor plates sets the linearity.



**Fig. 4—**Some modern sets use variable-capacitance diodes (varactors) instead of mechanical capacitors. A simple varactor-tuned LC circuit is shown in "A." The non-linearity of varactor-tuned circuits is partially overcome by connecting two varactor diodes back-to-back as shown in "B."



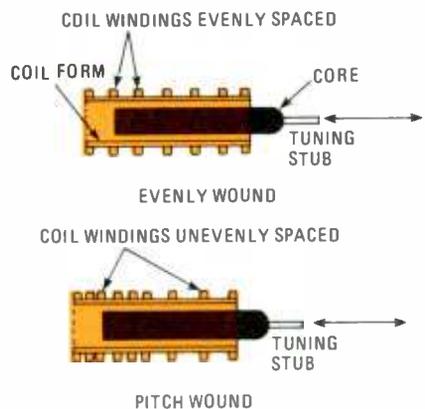
**Fig. 5—**Most radios use a one-to three-section variable capacitor to tune the resonant circuits. Each variable capacitor consists of a set of fixed stator plates insulated from—but parallel and meshed together with—the movable rotor plates.



**Fig. 6—**The shape of the rotor plates of the tuning capacitor determines the linearity. By far the most common form is the straight-line capacitance type shown in "A;" with a more expensive, and less common, form of variable capacitor—the straight-line frequency type—see "B."

rite core of the inductor (Fig. 7) is moved in and out of the coil form to change the inductance. If the coil windings are evenly spaced (as in Fig. 7A), then we have the same problem as before—except that it is straight-line inductance. But if the coil is pitch wound (see Fig. 7B), on the other hand, we can linearize the dial scale relatively easily.

In the pitch-wound coil equal changes of core position cause different changes of inductance. In a resonant circuit, however, that inductance non-linearity turns into straight-line frequency.



**Fig. 7—**Car-radio tuning circuits vary the inductance rather than the capacitance. If the coil windings are evenly spaced (as in "A"), we have the same problem as before—except that it is straight-line inductance. But if the coil is pitch wound ("B"), we can linearize the dial scale.

### Bandspreading

Once upon a time, all general-coverage shortwave receivers of any quality (and most of low quality) had two tuning dials: *main tuning* and *bandspread*. The main tuning dial was scrunched up on one end and spread out on the other. The bandspread dial, on the other hand, was relatively linear. Actually, if you measured with a fine rule or micrometer, you would find that both dials were non-linear, but the bandspread dial was much better than

(Continued on page 98)



# FRIEDMAN ON COMPUTERS

## It takes no space to tick away the time

□ ONE DAY I REALIZED THAT MY IBM/PC had had it. Its five slots could no longer accommodate my assortment of "must have" adapters. Since one slot was needed for the disk controller, another for a Paradise monitor adapter that provided compatible IBM-type monochrome and graphics monitor adapters in a single slot, and a third slot was used for the hard-disk controller, under the best of circumstances, I would be juggling cards to accommodate 512K of memory, two serial ports, a parallel printer port, a joystick port, an Apple/IBM converter, and anything else that came down the pike.

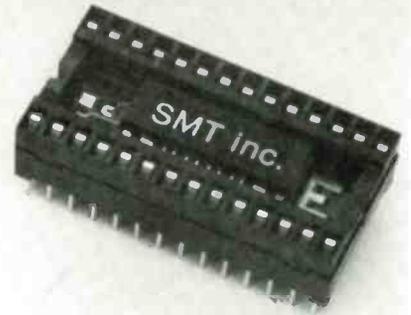
It seemed I was always playing musical slots with my PC, but I knew the game was up when I actually wore out a slot. Adding an expansion unit was out of the question because it costs almost as much as an XT-clone computer, and several adapters that I use won't work in an expansion box.

So it was time to move up to an 8-slot XT-clone, which actually gave me more

than three extra slots; and because the XT had 640K of RAM on the motherboard, I wouldn't have to use up a slot for memory expansion.

My rapture with the XT-clone lasted exactly one day. The dual Paradise monitor, the floppy and hard disk controllers, the parallel and serial adapters left over from my first PC, an internal modem, and my mouse adapter used up seven of the eight slots. A clock/calendar adapter used up the final slot, leaving no room for anything else.

Something had to go because I needed at least one slot for an IBM/Apple-Macintosh converter, and it looked like the clock was the most likely candidate for banishment. But I like a full-time clock/calendar that keeps track of the time and date: I truly detest entering the time and date when booting up, particularly because my AUTOEXEC.BAT file does so much I can walk away and prepare a sandwich before the computer is ready for use. The last thing I wanted to do was interrupt the



The SMT clock/calendar is actually assembled inside a 28-pin ROM socket that plugs directly into an empty ROM socket on an XT-clone motherboard. If necessary, another ROM can be mounted piggyback on the clock module.

AUTOEXEC to enter the time and date.

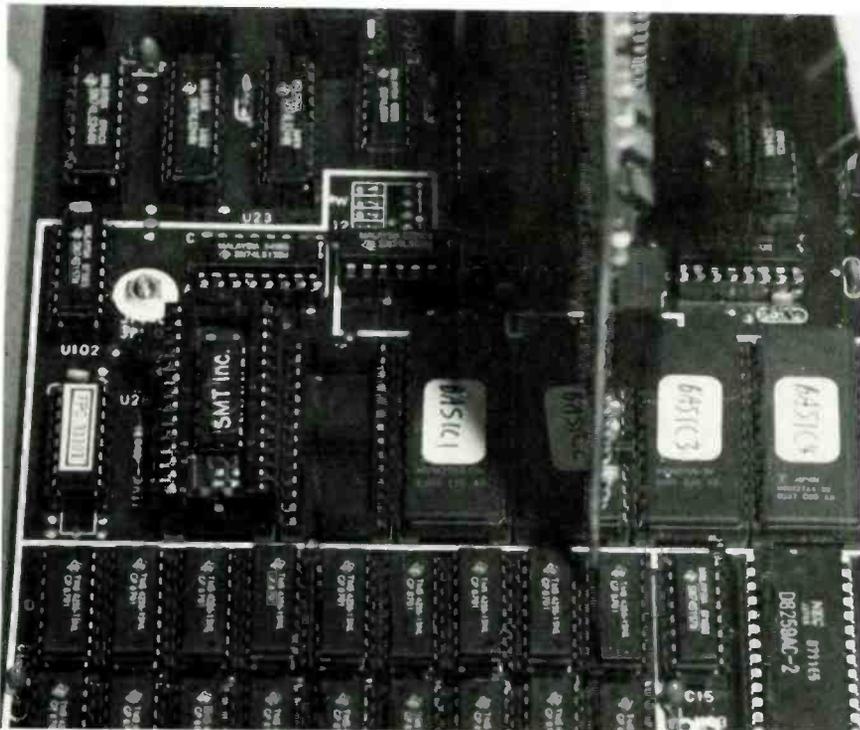
### The Zero-Slot Option

Fortunately, I discovered the *No-Slot Clock* from SMT (Systems Manufacturing Technology); one of those cute, worthwhile ideas that never seems to get the attention it truly deserves. Basically, instead of using a slot-mounted card to provide the clock/calendar hardware, SMT (as shown in Fig. 1) built a real-time clock/calendar into a CMOS IC, then installed the IC along with two miniature lithium power-backup batteries in a 28-pin ROM socket that fits both IBM/XT/AT and Apple compatibles.

I simply don't have time nor the space to discuss all the computer models, so we'll simply cover the XT—the most popular computer of all, and the one that I use. (Keep in mind that the SMT clock works with the 8088, V20, 8086, 80186, and V30 microprocessors.)

If you look at an XT's motherboard, you'll find several empty 28-pin ROM sockets. You can plug the SMT No-Slot Clock into any empty socket. And if for some reason you don't have an empty socket, simply remove one ROM, install the SMT clock, and then re-install the ROM piggyback on the SMT clock. If there is some reason why you can't piggyback a ROM, you can install the clock/calendar module on certain daughter-

(Continued on page 95)



Here's how the clock module looks when installed in the last empty ROM socket on an XT motherboard. Note the empty ROM socket just right of the module.

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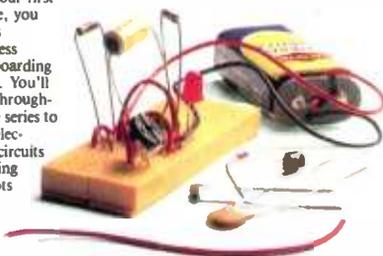
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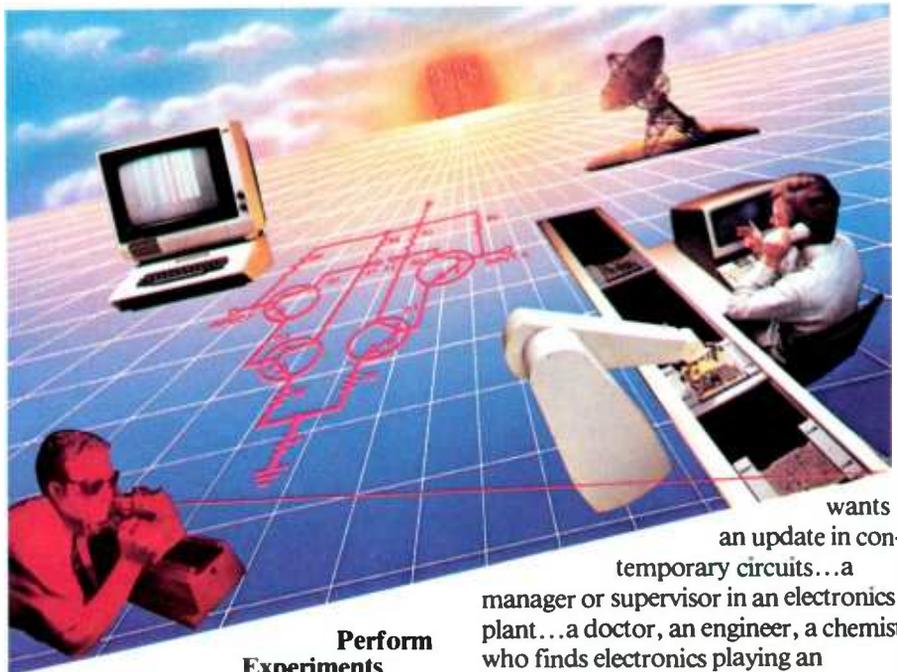
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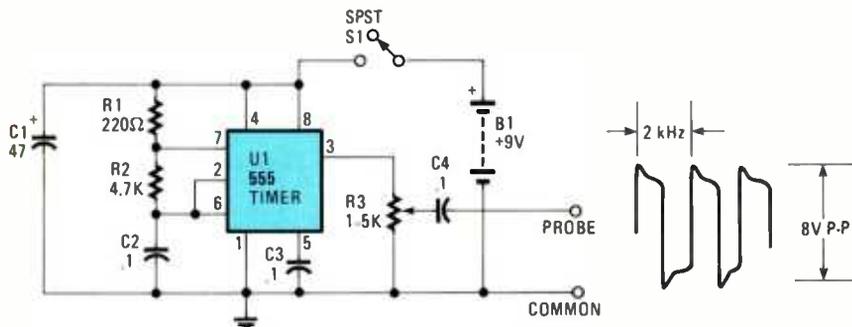
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**Fig. 3—The Signal Injector can put out signals from about 2 kHz up to the RF range, with levels running from a few millivolts to about eight volts.**

from the antenna right to the speaker terminals.

The Injector consists of a single 555 oscillator/timer (U1) connected as an astable multivibrator. It puts out a squarewave with a fundamental frequency of about 2 kHz with harmonics that are modulated at 2 kHz, and the harmonics go well into the broadcast band. Power is provided by a 9-volt transistor-radio battery.

Nothing special is required in the design or assembly; just use good wiring and soldering practices. A length of wire (about 10-inches long) with an alligator clip on one end is used for the common lead. A modified VOM test probe cut to a length of two inches including the probe is used as the signal-carrying lead, which was cemented to the plastic box.

It was shortly after Jim built the unit that he had the opportunity to put it to an unusual application. In a new house under construction, the sheetrock crew inadvertently covered an outlet box. He then connected the injector at the circuit breaker and with a small, portable AM broadcast receiver, was able to get his first cut in the sheetrock within four inches of the hidden outlet box!

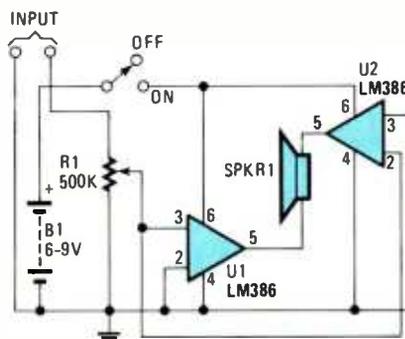
Super, Jim. And guess what YOU have coming in the mail!

### Cheapie Amp

Myron Hilton of Union, ME came across with a quick-and-dirty amplifier with more applications than you could shake a stick at—just in case you're into stick-shaking. Among other things, Myron recommends it for small radios, tape recorders, record players, or its use as a PA amplifier. (See Fig. 4.)

Another interesting aspect of the circuit is that nothing seems critical in building the circuit; almost any components that you may have lying around the shop should do the trick. And if you want long-lasting power, use a six-volt lantern battery; or if lightweight portability is desired, use a nine-volt transistor-radio battery. According to Myron, the only really critical point is the loudspeaker, which ought to have at least a five-watt capacity.

Myron, that little wing-ding must really kick out. *Betcha* that if you use too



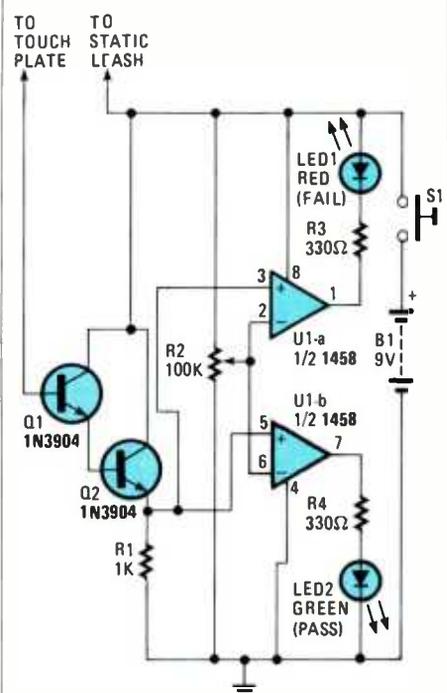
**Fig. 4—This simple amplifier circuit can be used with small radios, tape recorders, record players, or as a PA amplifier. For long-lasting power, use a six-volt lantern battery; or if lightweight portability is desired, use a nine-volt transistor-radio battery.**

small a speaker, you'll blow the cone across the room! Anyway, thanks Myron, and give yourself a pat on the back. Your copy of the Fips book is on the way!

### Leash Tester

Jeffrey Maslin, of Cudahy, WI came up with this one, and we think it's as necessary as a static leash! But let's begin at the beginning. What's a static leash? Why it's one of those conductive wrist straps that connects the human body to ground, so static charges in and around the shop won't blow all your CMOS devices. The tester gives you an at-a-glance indication of how good (or bad) your wrist strap is.

Turn your attention to Fig. 5. As you can see, Q1 and Q2 form a Darlington amplifier, whose bias current comes from V+, passing through the (good) static leash, your hand, the touch plate, and into Q1's base. The high current gain of the Darlington causes an increase in the voltage across R1. U1 is a dual op-amp configured as a comparator whose threshold is set by R2. When the voltage at Q2's emitter is below the threshold voltage (open circuit), the op-amp's outputs go low—causing the red (FAIL) LED1 to light. When Q2's emitter is above the threshold (closed circuit), the op-amp's outputs go high; the green (PASS) LED2 comes on.



**Fig. 5—In the Leash Tester circuit, Q1 and Q2 form a Darlington amplifier. The high current gain of the Darlington causes an increased voltage across R1.**

Jeff wired his tester in a small experimenter's box using a metal plate (made from a peanut can) to close a (normally-open, momentary-contact) pushbutton switch, S1. When S1 is depressed, firing up the circuit, while simultaneously checking the static leash. Since the circuit is on only momentarily, the battery will last a good, long time.

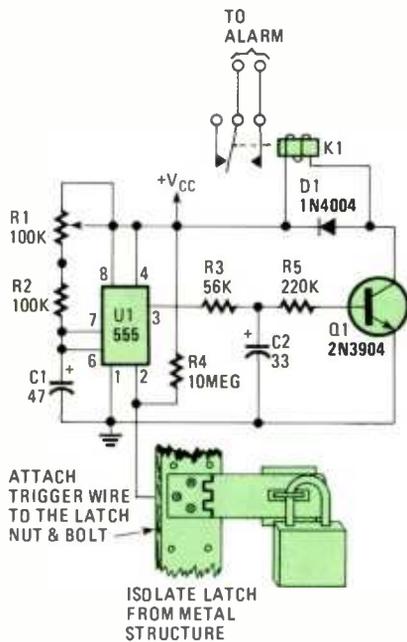
To calibrate the circuit, power it up with no contact to Q1's base. Rotate R2 until the green light comes on, then turn R2 back a hair past the point where the red LED comes on. That's all there is to it. While none of the components are critical, be sure to use 1/2-watt or higher rated resistors for R3 and R4.

Thanks to you too, Jeff. A tip of the hat and a Fips book.

### Time-Delay Touch Switch

I'd like to thank W. Knight, of Renton, WA for his submission on the Time-Delay Touch Switch, and at the same time ask that on future submissions, he also provide us with his first name! We're not all that formal around here. Matter-of-fact, when people call me "Mr. Wells," I always tell 'em that "Mr. Wells is my father—I'm "Byron."

What we actually have here, is a very-clever idea for a burglar alarm system. And it appears that the circuit will work with almost any system. Take a look at the circuit in Fig. 6. Built around a 555 oscillator/timer (which provides a 10-second delay) and a handful of support components, the Time-Delay Touch



**Fig. 6—** The Time-Delay Touch Switch, built around a 555 oscillator/timer (which provides a 10-second delay) and a handful of support components, protects your valuables by stopping the would-be intruder *before* he can actually enter a protected area.

Switch protects your valuables by stopping the would-be intruder *before* he can actually enter a protected area. The circuit is connected to a door with a large latch—the latch serving as the touch-switch contact. If the latch itself is mounted to a metal structure, the latch must be isolated.

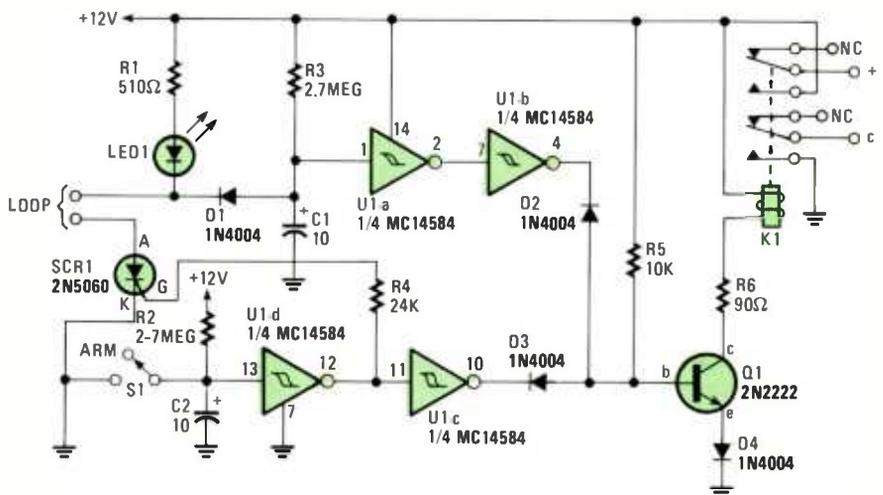
He didn't want the system to be too obvious, so he uses a five-second delay on the output of the 555 timer, which will cause an intruder to assume that something (or somebody) else triggered the alarm.

While the circuit itself is straightforward and has no fancy curlicues, it is standard; no claim is made for its novelty other than the application, which we found to be exceedingly unique. Thanks again Mr. Knight, and do hit us with another! Your Fips book is on the way.

### Another Burglar Alarm

Gordon Reeder, of Greensboro, NC, sent in an unusual burglar alarm schematic, which is shown in Fig. 7. The circuit is built around a pair of delay timers based on an MC14584 Hex Schmitt trigger. Among other things, it features 12-volt DC operation, low standby-current draw, entrance and exit delays, and an uncommitted pair of output contacts.

Intrusion is detected by a series loop of normally-closed switches labelled LOOP. A key switch, S1, is the only required control. A bell or siren can be connected at the output terminals. U1A, R3, and C1



**Fig. 7—** This Burglar Alarm, built around the MC14584 Hex Schmitt trigger, detects intrusions through a series loop of normally-closed switches.

make up the entry-delay circuit, and LED1 is used to monitor the status of the sense loop. Diode D1 keeps LED1 from charging C1 when the loop is broken. U1c, R2 and C2 form the exit delay circuit. S1 is closed to disarm (silence) the alarm. The alarm is armed when S1 is opened and C2 has charged.

Normally, the circuit is disarmed by closing S1, which keeps C2 discharged. The output of U1c will be high, keeping SCR1 in the triggered state. The output of U1d is low, sinking base-current away from Q1, and keeping the relay in the deenergized state. The entrance delay circuit will have no effect in that mode. The LED will still indicate the open or closed status of the protective loop.

To arm the circuit, check LED1 to make certain that all the switches in the sense loop are secured, then open S1. You'll have close to 20 seconds to leave the premises. Following the time delay the output of U1c goes low, removing the trigger voltage from SCR1. The SCR continues conducting because of anode current from the LED. The output of U1d also goes high, removing the current sink from Q1. If you got out in time and the loop is still keeping C1 discharged, U1b provides the current sink to Q1, keeping the alarm silent.

Should the protective loop be broken, SCR1 falls out of conduction and C1 begins to charge. After a 20-second period, the threshold of U1a will be reached. The output of U1b goes high, removing current sink from the base of Q1. Base current through R5 causes Q1 to conduct, activating the relay and providing power to the SIREN terminals. At any time following or during the entrance delay is triggered, S1 can be closed to disarm or silence the alarm.

No type number is given for Q1, which depends on the relay you elect to use. Gordon used a 2N2222 and a small DIP

relay with a 5-volt coil. Radio Shack sells a similar relay with a 12-volt coil and with it, you could eliminate resistor R6.

Thanks Gordon, it's an extremely *interesting* circuit as well as being quite functional.

Well, that brings us to the end of another column, and starts me to collecting the schematics for the next one. Remember, we don't just want clear, easy-to-read schematics, we also want complete descriptions—that means, all components clearly labeled (parts numbers, and values), the circuit's theory of operation (I'm a stickler for knowing how things work) and not just a *here it is, put it together and watch it work* sort of explanation—of the circuits as well. And please, make sure you have the *right* to send in the schematics. Don't just copy 'em out of some book, especially if that book is copyrighted! If you have been procrastinating, get to work. Your copy of the Fips book is here, waiting for you. Send your material to By Wels, *Wels' Think Tank*, Hands-On Electronics Magazine 500-B BiCounty Blvd, Farmingdale, NY 11735. ■





By Marc Saxon

# SAXON ON SCANNERS

## A scanner with a flair for the weather

□ I NEVER FORGOT IT: "WHETHER IT'S cold or whether it's hot, we must have weather, whether or not!" Miss Grundy, my Third Grade teacher made our class repeat it in unison every time there was a rainy or snowy day. Maybe that's why, to this day, I'm always trying to find out the latest weather information.

Perhaps that's why I was so pleased to see that someone finally got around to adding an *instant-weather-information* capability to a full-featured scanner. And that's just part of what the Regency R-1080 scanner has to offer.

The R-1080 features 30-channel reception covering the most popular scanner frequency ranges: 30 to 50 MHz; 144 to 174 MHz, and 440 to 512 MHz. The manufacturer gets the scanning show on the road by thoughtfully pre-programming into the memory all sorts of popular nationwide public-safety frequencies. Of course, you have the option of replacing any or all of those frequencies with those of your own selection.

Reprogramming can quickly and easily be accomplished by means of the front-panel keypad. It's as easy as using a push-button telephone—and the data being entered reads out on a dual-level vacuum fluorescent display. Still, the notion that the unit can be removed from its factory sealed carton, plugged in, and it starts to receive, is tantalizing.

By touching a single front-panel button, the R-1080 instantaneously goes into a WEATHER-INFORMATION SEARCH mode. The weather-information search mode rapidly locates an active NOAA VHF-weather information channel in order to bring you the current weather readings and forecasts. That's an interesting feature that isn't usually included in scanners, and we liked the concept.

Of course, the set also has the standard scanner features, too: priority channel, lockouts, fast/slow scan speeds, memory backup (no battery needed), etc. The volume and squelch controls aren't knobs, they're the slide types.

The Regency R-1080 comes complete with a power cord and a telescoping antenna, and its suggested retail price is \$199.95. For more information on the R-1080, contact Regency Electronics,

Inc., 7707 records St., Indianapolis, IN 46226; or circle 88 on the Free Information Card.

### Quick Fix

The idea of an "instant weather" channel designed into a scanner may be new, but sharp scanner owners have long known how to jury-rig that feature into just about any programmable scanner. I'll be happy to share that how-to information with you. Just be sure that you include a self-addressed, stamped envelope.

Many scanners have their first channel position set aside for use as the *priority* channel. When the unit's priority feature is activated, the scanner will sample the frequency every few seconds when it is either searching or scanning. If you program your local NOAA weather station's frequency into that channel slot, then place that channel on LOCKOUT, whenever you press the key that activates your scanner's priority feature, your scanner drops whatever it was doing, and instantly brings you the weather station's transmissions. To resume the scanner's other activities, simply deactivate the priority feature. Until I learned that trick, I had never used that feature at all!

### Ye Olde Mail Sack

To kick things off this month is a report that one of our readers—Charlie Cotterman, KA8OQF, of Dayton, OH—received a nifty QSL card. Charlie's attractive card displays a vehicle (possibly his own) engaged in what appears to be a road rally or similar activity. We're always happy to receive QSL's and shack photos from our readers.

Maybe you'll send us yours soon.

Manny Esposito of Tallahassee, FL wrote to tell us about a local fellow who was recently arrested in connection with burglaries of almost a dozen area dry-cleaning shops. The police said that when the burglars wanted time for their dirty work, they monitored a police radio to make certain that the neighborhood officers were occupied on assignments.

The oddball twist to the whole thing was that the man arrested worked for the Florida Department of Law Enforcement! The police never said why he always selected dry cleaning establishments. Maybe he found it pressing work.

From California we hear from Bob H. who says that many federal buildings and installations have uniformed security po-

*(Continued on page 95)*



The R-1080—featuring 30-channel reception, front-panel programming, a weather-information search mode, priority channel, lockouts, fast/slow scan speeds, and memory backup (no battery needed)—comes complete with power cord and telescoping antenna, at a suggested retail price of \$199.95. For more information on the R-1080, contact Regency Electronics, Inc., 7707 records St., Indianapolis, IN 46226; or circle 88 on the Free Information Card.

CIRCLE 88 ON FREE INFORMATION CARD

By Don Jensen



# JENSEN ON DX'ING

Isn't it about time that you discarded that 1987 calendar?

☐HEY, IT'S FEBRUARY. SURE, I KNOW you've been busy tuning in all those SW stations during the winter DX season. But, now it's time to take that old 1987 calendar off the wall. And while you are at it, why not replace last year's model with one of the really attractive 1988 calendars that a number of the world's major short-wave broadcasters send to their loyal listeners?

My favorite is the one offered each year by Radio Beijing. It's always a beauty. Some years Beijing's calendar features terrific photos of picturesque China. Other years, it has been lavishly decorated with full color illustrations of Chinese artwork.

Radio Nederland, for another, sends out an attractive calendar, as do the Voice of Free China from Taiwan and Germany's Deutsche Welle. The Voice of the Andes, HCJB has handy desk calendars for members of its audience. There are others too. (It can be a tough choice.)

If you haven't received your 1988 calendar, drop a note to your favorite SW broadcaster and ask. But, remember there's a little give coupled with the gimme—you should at least be a reasonably regular listener to the station that gives out the "goodies."

## Emergency Net

SWL'ing involves broadcasting stations and listeners, of course. It's one-way communication, from them to you; and differs from two-way amateur-radio communication—in which licensed hams communicate with each other, often within the framework of regularly scheduled networks.

The *International Amateur Radio Network* (IARN) is one of those ham nets with a special purpose; to provide worldwide communications in times of emergency. It has a membership of more than 500 radio amateurs worldwide—and some SWL's, as well.

Several months ago, the network went fulltime; meaning that its 20-meter frequency of 14.275 kHz is monitored by a net controller between 1400 and 2200 UTC, weekdays, for emergency traffic. A 10-meter channel, 28.475 kHz, is used for an hour or two beginning at 2300 UTC.



## RADIO "SAN GABRIEL"

Calle General Lanza No. 2001.  
Teléfono: 321174 - 355371  
Casilla 4792  
LA PAZ - BOLIVIA

This little guy with the microphone, in traditional Bolivian garb, is the symbol of Radio San Gabriel in LaPaz.

And there are some other frequencies and hours in the network system as well.

Hams with important messages can simply break-in on the IARN frequency to pass along information. That makes it an interesting spot for shortwave listeners to "watch" when an earthquake, flood or other natural or man-made disaster strikes anywhere in the world.

In addition, some amateur stations also air regular transmissions of news and information that are decidedly one-way in nature. Hams call them bulletins. And except for the fact that they are transmitted in the single-sideband mode, they sound very much like shortwave broadcast pro-

grams.

One such ham bulletin is the IARN broadcast, heard twice daily, at 1530 and 1930 UTC, Monday through Friday, on 14.275 kHz. Recently on the IARN bulletin, I listened to an interview with one of the network's controllers. There was also a newscast covering developments in the world of radio, including a Soviet plan to put an amateur-radio operation in space—perhaps even using slow-scan color TV to communicate with hams around the globe. Not to mention a feature from the pages of QST, a ham magazine, about amateur radio activity during a 1949 natural disaster in Ecuador.

SWL's, as well as hams, are welcomed into this voluntary-service organization. You can get details by listening in the IARN bulletin. There is no membership fee to become a member of IARN. Just send 90 cents in stamps to the International Amateur Radio Network, Belgrade Lakes, ME 04918.

## In the Mailbox

This month we'll field a question from Ramon Fernandez (Puerto Rico) that I could not fit in last month. But before getting to that, a reminder to the rest of you that your letters are always welcome. So, why not share your recent loggings with the rest of us. What are you hearing on SW? On what frequency? At what time? Or perhaps you, like Ramon, have questions or comments about the DX'ing hobby? If so, write to me, Don Jensen, *Jensen On DX'ing, Hands-on Electronics*, 500-B Bi-County Blvd, Farmingdale, NY 11735. Now to this month's query:

"Is shortwave as common in other parts of the world as AM radio (540 to 1600 kHz) or FM is here?" asks Ramon.

The so-called AM band—hobby listeners call it the medium wave (MW) band—is used for broadcasting around the world. In most countries, it is the dominant band—though outside of this hemisphere, the "separation" between stations is not the 10-kHz standard common to this hemisphere. For instance, in Europe, you wouldn't expect AM stations to fall on frequencies ending in 0, as they do here.

Increasingly, however, FM (especially FM stereo) can be found globally. Even in the more remote parts of lesser-developed nations, stereo FM is available. And the reason for its popularity abroad is the same as it is here—superior musical reproduction.

In those same Third World nations—South America, parts of Africa and southeast Asia—domestic shortwave service is very important because of distances between stations and the national audience, or because of the terrain that separates them. In the Andes Mountain valleys, for instance, it is tough for local inhabitants to receive MW signals from beyond their immediate area.

And in places like Brazil and Indonesia, people are accustomed to listening to domestic shortwave stations. Those countries, for example, each have over 150 SW outlets; not as many as medium-wave AM stations (to be sure), but a significant number nonetheless.

Our SWL friend Ramon also passes along the information that the *Voice of America* is putting up a repeater station in Puerto Rico, which VOA plans to use to relay its broadcasts to the Caribbean, Central and South America. The station is scheduled to begin transmitting by 1990, Ramon says.

### Down the Dial

Here are some of the shortwave broadcast stations of the world being logged by SWL's in North America recently. As always, all frequencies are given in kilohertz (kHz) and times are referenced to Universal Time Code/Greenwich Mean Time (UTC/GMT)

**Algeria**—9,510 kHz, *Radio Algeria* tends to pop up in unexpected spots in and out of the shortwave bands. This is a frequency that has been reported heard at

1900 UTC with an English identification, followed by a program of classical or popular music.

**Belgium**—9,675 kHz, *Belgian Radio TV*. Listen for "Brussels Calling," with news and music from 2100 UTC, following the station's interval signal and identification.

**East Germany**—6,010 kHz, *Radio Berlin International* can be heard here in its English-language transmission at 0200 UTC with news and commentary.

**Greece**—7,430 kHz, *Voice of Greece*. This station is not difficult to hear in North America during the evening hours, until about 0350 UTC. It is worth listening to for its terrific music, even though the programming is all Greek to you.

**India**—11,620 kHz, *All India Radio*. The General Overseas Service of the AIR has been heard with English news, beginning at 2045 UTC.

**Mongolia**—12,015, Ulan Bator's radio offers English-language programming here around 1200. You may well find interference, but it is an interesting catch.

**Netherlands Antilles**—21,685 kHz, *Radio Nederland* also makes use of relay transmitters outside the home country. You don't find too many SW stations on that high-frequency band these days. The programs are relayed from the island of Bonaire, off the coast of South America. You can't find RN's English programs at 1830 UTC sign on.

**Peru**—4,996 kHz, *Radio Andina* in Huancayo is offering one of the more consistent signals from that South American country these days. In the evening hours (as well as early in the morning around 0930 UTC), you can hear plenty of the typical and exotic melodies of the Peruvian high country.

**South Africa**—3,955 kHz, *Radio Orion* is one of the home services of the *South African Broadcasting Corporation*, the same folks who bring us the *Radio RSA* external service for listeners abroad. Look for this one in English around 2330 UTC.

Another home service of the SABC is called Radio Five, which can be heard on 4,880 kHz around 0330 UTC with music and commercials.

**Venezuela**—4,980 kHz, *Ecos del Torbes* in the city of San Cristobal has been logged, all in Spanish, of course, with a call-in game show and Latin rhythms around 0000 UTC—call it 2400 hours if you prefer, it's the same thing—on this frequency. ■

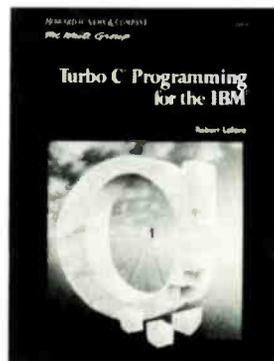
Credits: Norman Bobb, MN; Allan Courtney, KY; John Tuchscherer, WI; Daniel Sampson, WI; David Morby, NY; Frank Orcutt, CA; Peter Dillon, MD; Kenneht Cobb, ME; Steven Walley, CA; North American Shortwave Association, 45 Wildflower Road, Levittown, PA 19057

## BOOKSHELF

(Continued from page 24)

intermediate programmers.

The book is based on Borland's new Turbo C compiler with its powerful integrated environment that makes it easy to edit, compile, and run C programs. The author uses a proven hands-on intensive approach and begins with the fundamentals of C programming followed by intermediate concepts of arrays and pointers, data structures, and the use of the C library. Advanced topics, such as assembly language interfacing using DOS and ROM-based routines are addressed, all in



CIRCLE 95 ON FREE INFORMATION CARD

the context of the IBM programming environment.

Topics covered include: C building blocks, loops, decisions, functions, arrays and strings, pointers, keyboard and cursor, structures, unions, and ROM BIOS, memory and the character display, CGA and EGA color graphics, files, larger programs, and advanced variables.

*Turbo C Programming for the IBM*, No. 22614, retails for \$22.95 and is available at bookstores, electronics distributors or direct from the publisher SAMS, A Division of MacMillan, Inc., 4300 West 62nd Street, Indianapolis, IN 46268; Tel. 800/428-SAMS. ■

### ABBREVIATIONS

<b>AIR</b>	All India Radio
<b>AM</b>	Amplitude modulation (modulated)
<b>DX'ing</b>	Listening to distant shortwave broadcasts
<b>FM</b>	Frequency modulation (modulated)
<b>HCJB</b>	Voice of the Andes
<b>IARN</b>	International Amateur Radio Network
<b>kHz</b>	kiloHertz (1000 Hertz or cycles)
<b>MW</b>	Medium wave
<b>RN</b>	Radio Nederland
<b>SABC</b>	South African Broadcasting Corporation
<b>SW</b>	Shortwave
<b>SWL('s)</b>	Shortwave listener('s)
<b>TV</b>	Television
<b>UTC/GMT</b>	Universal Time Code/ Greenwich Mean Time
<b>VOA</b>	Voice of America
<b>VOG</b>	Voice of Greece



"The mouse you'll be working with in this class is neither a rodent nor an animated cartoon character."

## GET YOUR FCC LICENSE

(Continued from page 68)

### Not for Beginners

I've had a lot of electronics courses and I used a Q&A manual as a guide to review all my old notes and books from college. However, if you're a beginner, you'll find Kaufman's Q&A manual tough to follow. To be sure the manual is loaded with descriptive information, but without a solid background from either college or trade school, you're going to have a difficult time of it. Passing the GROL examination might be uncertain for beginners without any technician experience. There's a lot to know and I studied for the exam for well over a year in my spare time. Kaufman's book reads like an encyclopedia so don't expect to assimilate it all by just reading through it once.

### R&R's a Must

The importance of knowing FCC rules and regulations and radio operating procedures should not be underestimated. You could know all the electronics in the world, but without a solid foundation in the R&R's and proper operating procedures, the probability of passing the exam is slim. A complete R&R listing is available from the FCC, and you may wish to order them directly: International Transcription Service, Inc., FCC Rules and Regulations, Suite 140, 2100 M Street, N.W., Washington, DC 20037. Tel. 202/857-3800. \$20.00 for Domestic R&R, \$25.00 for International R&R.

### Maritime Info

The following are some of the FCC rules you will need to know and a sample FCC type exam question. There are two frequencies which are internationally designated for use by the maritime radiotelephone stations in distress. The medium frequency (MF) distress channel is 2182 kHz and the very high frequency (VHF) distress channel is 156.8 MHz (also known as VHF marine channel 16). Those are the same two frequencies which are used for intership call and reply, (FCC rule 80.369). It is illegal to use selective calling on 2182 kHz or 156.8 MHz (channel 16). Selective calling uses code signals that are transmitted so that only a specific receiving station will receive that transmission. For example, CTCSS or continuous-tone coded sequelch system is not allowed. And, except when making a distress call, it is illegal to transmit a general call on these frequencies; that is, a communication not addressed to a particular station or group of stations, (FCC rule 80.89). Now lets try test question, Q5.

Q5: What two frequencies in the maritime mobile service are used for distress traffic, and for calling intership communications before moving to a working channel.

- a. 2182 MHz
- b. 2182 kHz
- c. 156.8 MHz
- d. 156.8 kHz
- e. Both b and c

The correct answer to question Q5 is (e). That is how you make an intership (ship to ship) call. Turn your radiotelephone on and listen on the appropriate distress and calling frequency, Channel 16 or 2182 kHz, to make sure it's not being used. If it is clear, put your transmitter on the air. That is usually done by depressing the "push to talk" button on the microphone. Call the vessel you wish to communicate with by using its name; then identify your vessel with its name and FCC-assigned call sign. Do not add unnecessary



The Federal Communications Commission won't let you near a board like this without a license.

phrases as "Come in Steve."

Once contact is established on channel 16 or 2182 kHz, you must switch to an appropriate working frequency for further communications. You may only use channel 16 and 2182 kHz for calling and in emergency situations. The actual communications should take place on a working frequency, "chit-chat" is not permitted. You must choose the correct working channel for the type of communications you wish to engage in; either ship-to-ship, ship-to-coast station, public correspondence, commercial communication, or intership safety on coast guard channel 6, etc.

### Taking the Test

You must pass a written examination of 100 multiple-choice type questions covering elements 1, 2, and 3. You must answer at least 75 percent of the questions correctly to pass the examination. All elements (those being elements 1, 2, and 3) must be passed; there is no partial credit, like passing 1 and 2, but failing element 3. The 100 question test contains a mix of all three elements and it's your total final score that counts, 75 and above passes. Should you fail the test you must wait at least two months before you're eligible for another examination.

All FCC field offices publish an exam schedule, you can request that list, which gives the examination dates and final filing date for each exam. The examinations are conducted quarterly, that is, four times a year.

Examinations are conducted by appointment only. Contact your nearest FCC field office to request an application (form 756). The office must receive your completed application by the final filing date. There is no application fee.

A week before the exam date you will receive an Admittance Pass stapled to your original 756 form, on which you will find all the information you will need like date, time, place, examination type-GROL, etc. You may use a regular calculator during the test, however, pocket calculators containing programmable memories, magnetic card memories, or printing calculators are prohibited. Also, bring proper identification, like a drivers license, because you must prove that you are the applicant whose name is written on the Admittance Pass.

The actual examination procedure is rather straight forward. You're handed the GROL exam and a sheet of scrap paper for calculating your answers. During my exam which started at 8:45 a.m. there were about 50 persons taking the exam. The room was very quiet and everyone was anxious to get started. We were all there for one reason, to get our FCC license. About 3-½ hours after I started the test, I completed the last question. The one terrific aspect of the exam procedure is they mark your test and tell you on the spot if you passed or failed. I hope everything goes well for you if you decide to go for your license. Good luck. ■



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## UTILITY SOFTWARE

(Continued from page 58)

ENCRY, figuring that anything on encryption had to include those letters. (*Seekeasy* is not case sensitive.) In less than the blink of an eye *SEEKEASY* provided the five quotes shown in Fig. 27.

Now the first match is rather obvious, because it's about encryption. But how did the others get there? Well, in the second listing the first word, *science*, has the letters ENC, which is close to ENCRY, so *Seekeasy* said "that's close enough."

Similarly, the third listing has the word *difference*, again ENC, while the fourth listing has *patience*, again ENC. The fifth listing has the name *Lawrence*, again ENC.

*Seekeasy* will list up to 100 entries, with the closest match for the entered search word or characters at the top of the list. Sometimes you might wonder how in the heck it finds anything, but it does because it seeks out the closest match possible.

For example, if the keyboarded search word is RASPUTIN, in my database of quotes the first one listed will be "FISH AND VISITORS STINK IN THREE DAYS—Benjamin Franklin." Now where does that quote fit the search word RASPUTIN? Simple, it's the IN at the end of RASPUTIN. The quote itself has the word "IN," and there's an IN in the word "Franklin." See how hard *Seekeasy* tries for a match?

### Summing Up

Well, we've given you a smorgasbord of utilities: free

ones, expensive ones, small ones, large ones, and some that are really full-scale programs in themselves. We don't necessarily recommend any of them for everyone; the whole idea of this special feature was simply to show the broad range of utilities that are available; the kind that take some of the drudgery out of personal computing. And most important, examples of the kind of computing power available to the non-hacker, applications-oriented user. If you have a favorite we've overlooked, please write and tell us so. If it appears to have broad appeal we'll try to cover it the next time we do a special section on utilities. ■



"Let's see you shoot the Apple!"

## E-Z MATH

(Continued from page 73)

ohms is  $3.6 \times 10^3 = 3600$  ohms. The K is replaced with  $10^3$  or 1000. A value of 1.5 megohms is  $1.5 \times 10^6$  or 1,500,000 ohms. The meg is replaced by multiplying by  $10^6$  or 1,000,000.

Now consider the formula for computing the inductive reactance ( $X_L$ ) of a coil (L) at a specific frequency (f).

$$X_L = 6.28 fL$$

Remember, we must use basic units: reactance in ohms, frequency in Hertz (Hz), and inductance in henries (H). Suppose we want to compute the coil value at a given frequency for a desired value of reactance. To do this, we rearrange the formula.

$$L = X_L / 6.28f$$

Now, what inductance value will give us a reactance of 7K ohms at a frequency of 5 MHz? First the  $X_L$  must be expressed in ohms, 7K = 7,000 or  $7 \times 10^3$  ohms. The frequency is 5 MHz or 5 megahertz. That is 5,000,000 or  $5 \times 10^6$  Hz. The computation looks like this:

$$\begin{aligned} L &= 7 \times 10^3 / 6.28(5 \times 10^6) \\ L &= 7 \times 10^3 / 31.4 \times 10^6 \\ L &= 7 \times 10^3 / 3.14 \times 10^7 \end{aligned}$$

Dividing the values:

$$7/3.14 = 2.23$$

Subtracting the exponents:

$$\begin{aligned} 10^{3-7} &= 10^{-4} \\ L &= 2.23 \times 10^{-4} \text{ Henries} \end{aligned}$$

Coil values are usually given in millihenries (mH) or microhenries ( $\mu$ H). Let's use  $\mu$ H here. Micro ( $\mu$ ) is one millionth so the power of 10 must be  $10^{-6}$ . We then adjust the numerical value accordingly.

$$\begin{aligned} L &= 2.23 \times 10^{-4} = 223 \times 10^{-6} \\ L &= 223 \mu\text{H} \end{aligned}$$

The formula for computing capacitive reactance is:

$$X_C = 1/6.28fC$$

(Continued on page 94)

## Electronic Calculators

Electronics math is infinitely faster and easier if you use a calculator. Any standard, inexpensive, four-function (add, subtract, multiply, and divide) calculator will do. A square-root function is also highly desirable since it is such a common electronic math operation.

The best calculator for electronic calculations is a scientific calculator. If you plan to do much electronic math, then by all means get one. Here are the features you should look for: Scientific notation; Trigonometry functions (sine, cosine, tangent); Logarithms; Exponentials ( $X^Y$ ,  $10^Y$ ,  $e^X$ , etc.); Square and square root Even sophisticated calculators with these functions are relatively inexpensive. You should be able to get one for less than \$20. It will save you lots of time and make all calculation faster and easier.

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(Continued from page 92)

where  $X_C$  is in ohms,  $f$  is in Hz and  $C$  is in farads. What is the reactance of a  $.1\text{-}\mu\text{F}$  capacitor at  $20\text{kHz}$ ?

First, we convert to basic units:

$$.1\mu\text{F} = .1 \times 10^{-6}\text{F} \text{ and} \\ 20\text{kHz} = 20 \times 10^3 \text{ Hz}$$

Therefore,

$$X_C = 1/6.28(20 \times 10^3)(.1 \times 10^{-6}) \\ X_C = 1/12.56 \times 10^{-3} \\ X_C = .0796 \times 10^3 \\ X_C = 79.6 \text{ ohms}$$

### Answers to Practice Problems

- |                               |                          |
|-------------------------------|--------------------------|
| 1. a) $10^3 = 1,000$          | b) $10^{-6}$             |
| b) $10^9 = 1,000,000,000$     | c) $.2 \times 10^3$      |
| 2. a) $10^{-6} = .000001$     | d) $.25 \times 10^{-7}$  |
| b) $10^{-12} = .000000000001$ | 4. $9.1 \times 10^8$     |
| 3. a) $10^2$                  | 5. $8.25 \times 10^{-9}$ |

### Practice Problems 16–18

The following will test all you have learned.

16. Use Ohm's law ( $I = V/R$ ) to find the current in a circuit where the voltage is 150 volts and the resistance is 3 megohms. Express the current in microamperes.  
17. Find the power ( $P = I^2R$ ) in a circuit where:

$$I = 70 \text{ mA and } R = 15\text{K ohms.}$$

Express the power in watts.

18. At what frequency ( $f$ ) does a tuned circuit resonate with an inductance ( $L$ ) of  $.0015 \mu\text{F}$ ? Express the frequency if you can, in kHz.

- |                            |                           |
|----------------------------|---------------------------|
| 6. 9500                    | 13. $7.62 \times 10^3$    |
| 7. .000000003303           | 14. $3.26 \times 10^5$    |
| 8. $830 \times 10^3$       | 15. $2.23 \times 10^{-2}$ |
| 9. $.015 \times 10^{-3}$   | 16. $50\mu\text{A}$       |
| 10. $6.923 \times 10^{-1}$ | 17. 73.5 watts            |
| 11. $1.62 \times 10^{-1}$  | 18. 29.072 kHz            |
| 12. $4.84 \times 10^{-8}$  |                           |

## BUILD A MAXWELL INDUCTANCE BRIDGE

(Continued from page 32)

positions of the RANGE switch, S1, as indicated in Figure 2.

### Accessories

If you don't already have a 10kHz sinewave oscillator, Fig. 3 shows a schematic of one you can build on a piece of perforated circuit board. The 1000-ohm trimpot must be adjusted for the best sinewave output, using an oscilloscope. You should be able to get about 6 volts peak-to-peak of sinewave amplitude at the output before clipping starts.

A small audio amplifier may be of value between the bridge and the headphones to bring up the volume near the null point. Or the reader may wish to install a power amplifier and loudspeaker to hear the audio tone. If so, be sure to keep the amplifier circuit completely isolated from the oscillator circuit. If their grounds were common, for example, part of the bridge would be short-circuited.

### Measuring an Inductor

Connect a 1,000-Hz sinewave oscillator and a pair of headphones to the Maxwell bridge. Adjust the oscillator amplitude control for a comfortable tone level in the phones.

Connect an inductor to the bridge binding posts and turn the dials, listening for a null. If no null is found, try other settings of the range switch and keep looking for the null. As the null is approached you will notice that the settings of the L and Q dials interact with each other; keep adjusting first one and then the other until the deepest null is found.

As the volume of the tone gets less and less, keep increasing the amplitude of the oscillator output so you can pinpoint the null better. When finished with the adjustments, multiply the reading of the L dial times the setting of the range switch to find the inductance. For example, if the range switch is set at .01 henry; and the L dial reads 8, the inductance value is .08 henry; or 80 millihenries.

The Q of the inductor is read from the Q dial. Keep in mind that that is the value of Q at 1 kHz; Q can have quite a different value at a much higher or lower frequency. A 1- $\mu\text{H}$  RF choke might have a Q of 2 at 1 kHz, but its Q at 1 MHz could be in the range of 50 to 100.

### Expanding the Range

The next step in the project is to see if I can get the Maxwell bridge to work at higher frequencies and measure inductors from one millihenry down into the nanohenry range. If not, try adding a switch to select from different values of  $C_B$ . You can expand this project as much as you like to obtain the range that suits your needs. That's enough inducement for now, enjoy the building the project and have fun. ■

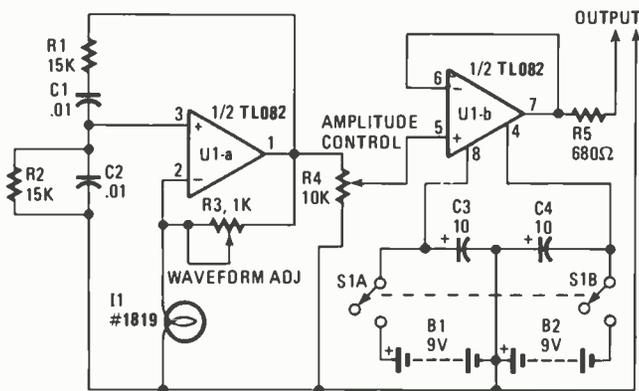


Fig. 3—This sinewave oscillator will work perfectly with the inductance bridge. The variation of resistance in I1 with current changes helps the circuit produce clean output.

### PARTS LIST FOR THE AUDIO OSCILLATOR

- U1—TL082 dual FET opamp (Radio Shack 276-1715)
- R1, R2—15-ohm, 1/4-watt, 1% metal film resistor (Radio Shack 271-309)
- R3—1000-ohm trimmer potentiometer
- R4—10,000-ohm, audio-taper potentiometer
- R5—680-ohm, 1/4-watt, 5% resistor
- C1, C2—.01- $\mu\text{F}$  disc capacitor
- C3, C4—10- $\mu\text{F}$ , 35-WVDC electrolytic capacitor
- S1—DPDT toggle switch
- I1—28-volt, 40-mA pilot lamp #1819, (Radio Shack 272-1119)
- B1, B2—9-volt alkaline battery

## SAXON ON SCANNERS

(Continued from page 87)

lice using two-way radios. Their badges and shoulder patches identify them as being from the GSA, and he wonders what that is and why nothing has ever been published concerning the frequencies they use.

Actually, the GSA (General Services Administration, a federal agency) operates nationwide and has a large communications system. Among the many duties of this low-profile agency is guarding about 8,500 federal buildings against crimes, such as vandalism and theft, riots, terrorism, or attacks upon government officials who work in those buildings.

Two of the more popular GSA frequencies are 415.20 and 417.20 MHz, although there are many others in the VHF and UHF spectrum. A roster of the GSA's

## FRIEDMAN ON COMPUTERS

(Continued from page 80)

boards. (The supplied manual is very thorough on how to get the clock up and running.)

### Almost a Perpetual Calendar

The SMT module, whose CMOS memory is maintained by the computer's 5-volt power supply, or internal lithium batteries (which have a rated life of more than 10 years) when the computer is off, provides time-keeping information: hundredths of seconds, seconds, minutes, hours, day, date, month, and year.

The date at the end of each month is compensated for months with less than 31 days, and there is an automatic correction for leap years. The only thing that it can't do automatically is correct for Daylight Savings Time: twice a year you must move the time one hour forward or back.

### Plug-in and Whoops!

The hardware installation of the clock/calendar module is finished as soon as the clock snaps into its socket. There are no wires to solder, no jumpers to connect, nothing! Figure 2 shows the SMT clock/calendar installed in the last ROM socket on an XT-clone motherboard. Notice that there is an empty ROM socket immediately to the right of the clock.

All that you have left to do after installing the SMT module is to re-install the adapters in their slots and program the clock. The problem is, re-installing the adapters isn't as easy as it reads. I don't know about IBM XT's or other XT-clones, but mine does not have enough clearance above the ROM socket containing the clock/calendar module. Normally, the bottom of the adapters just skim over the tops of conventional ROM's. There is no way to seat an adapter if the

(Continued on page 97)

frequencies, known call signs, locations, etc., is contained in the 6th Edition of *The Top Secret Registry of U.S. Government Radio Frequencies*. So far as we know, that large volume (containing details of more than eighty agencies) is the first time information has been published about the GSA's communications system. The 192-page book retails for \$17.95 (plus \$2 postage) from CRB Research, PO Box 56-GP, Commack, NY 11725.

Ed Mamoulain of Arvada, CO asks that we remind scanner owners that the American Red Cross (in all areas) relies heavily upon 47.42 MHz as that organization's

primary-operations frequency. Listen there during any type of severe weather, natural disaster, or major environmental/transportation accident. Ed says that many hundreds of stations are authorized on that frequency and sometimes skip reception brings in Red Cross activities from across the nation.

Please send along scanner-related newspaper clippings, photos, ideas, questions, reception reports, new frequencies, and what-have-you. Our address is: Marc Saxon, *Saxon On Scanners*, Hands-on Electronics, 500-B Bi-County Blvd., Farmingdale, NY 11735. ■

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## FRIEDMAN ON COMPUTERS

(Continued from page 95)

clock/module is installed because it's a smidgen higher than a conventional ROM; and the adapter certainly can't be installed if there's a ROM piggybacked on the clock/calendar.

The thing to do is to use a short, or a half-size adapter in the slot in front of the socket containing the SMT module. In my case, I used the original short serial adapter from my IBM/PC in the slot. If all your adapters are full size, you'll have to install the SMT module on one of the daughterboards, piggybacking a daughterboard ROM on the clock module.

### Software Programming

The clock/calendar module is supplied with software for both the IBM- and Apple-compatible computers. The IBM software consists of two programs: one to initialize the clock—meaning it puts the date and time into the clock's memory; the other program sets the computer system's clock from the SMT module.

Normally, you enter the date and time from the keyboard into the computer system. When using the SMT clock, the software automatically answers the TIME? and DATE? queries with the data from the SMT clock/calendar. Actually, that's an oversimplification. The TIME? and DATE? entries aren't prompted. The SMT software simply copies the clock/calendar data into the appropriate memory.

The proper way to handle entering the date and time is to make the supplied XTCLOCK.COM (set clock) program part of your AUTOEXEC.BAT file. In that way, the date and time are automatically loaded into the system when the computer is first booted.

If you have ever used a clock/calendar adapter of any kind, you'll be surprised to find that the SMT module doesn't have some kind of trimmer adjustment to "zero" (correct) the time. All clock adapters that I've used before seem to drift a few minutes every month unless the trimmer is properly adjusted.

Normally, I prefer to fuss with the trimmer once or twice because I don't like fussing with most clock-setting software—they require too many entries and procedures. The SMT clock—which doesn't have a trimmer—drifts about a minute a month. I don't miss the trimmer because all it takes is IBM's original TIME entry to correct the SMT clock. The SMT software automatically does the reset without my answering a string of questions. The SMT clock is priced at \$49 at some computer equipment distributors. It can also be purchased direct from SMT (1145 Linda Vista Dr., San Marcos, CA, 92069) for \$49.00, plus postage and handling. For more information circle No. 52 on Free Information Card. ■

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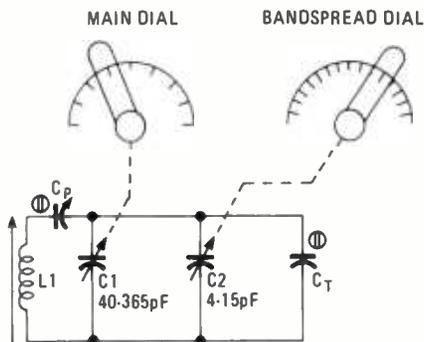
## CARR ON HAM RADIO

(Continued from page 79)

the main dial. The reason is that the bandspread capacitor tuned a much smaller segment of the spectrum.

Figure 8 shows the bandspread tuning circuit. Inductor L1 is the only inductor in the circuit. There are, however, several capacitors ( $C_p$  and  $C_t$  are the padder and trimmer capacitors used to improve tracking). Capacitor C1 is the main tuning capacitor, and makes up the majority of the capacitance in the circuit. The bandspread dial is connected to a smaller variable capacitance, C2.

In normal operation, the bandspread capacitor is set to either maximum or minimum capacitance, and a SET mark appears on the dial to indicate that point. The main dial is then set at one end of the band of interest, usually to a specific calibration point marked on the dial. Sometimes, an internal or add-on 100-kHz or 1000-kHz crystal calibrator was used to assist the operator in finding the correct point.



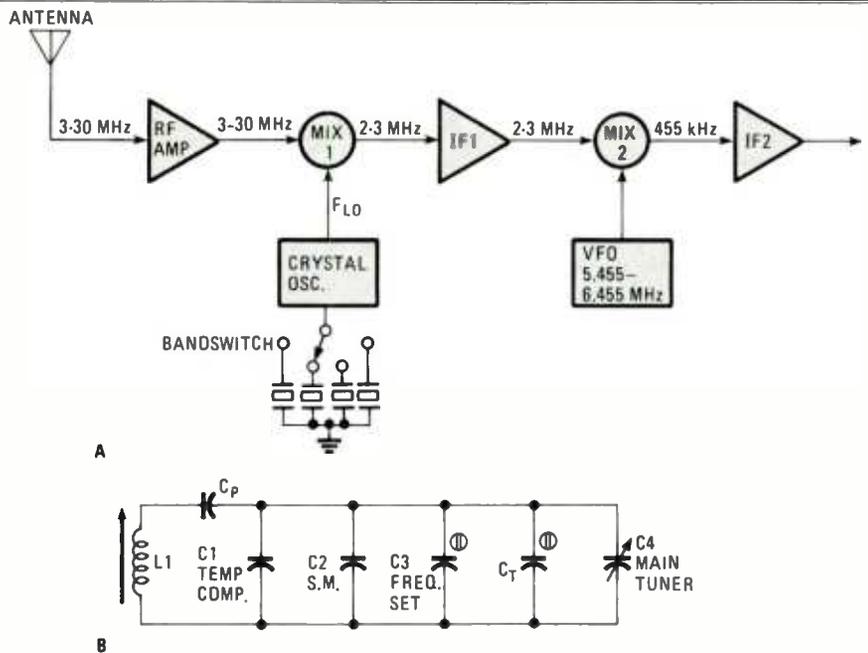
**Fig. 8**—In this bandspread, tuning circuit, L1 is coupled with several capacitors ( $C_p$  and  $C_t$  are the padder and trimmer capacitors used to improve tracking). Capacitor C1 makes up the majority of the circuit capacitance.

On some receivers, the bandspread dial was calibrated with the amateur-radio band frequencies. On all other radios, including the "ham" types, a LOGGING SCALE (0 to 100) was provided to help relocate specific frequencies or stations. Once the main dial was correctly adjusted, the bandspread dial was used to tune in stations.

At one time ham-band only receivers were designed like general-coverage receivers with one exception. Most of the capacitance in the tuning circuits was in the fixed capacitors and trimmers, while the "main tuning" control was what would be the bandspread capacitor in general-coverage receivers.

### Double Conversion Design

Many modern receivers are double-conversion models, as shown in Fig. 9A.



**Fig. 9**—Many modern receivers use double-conversion (as shown in "A"). But, by using a circuit like the one shown in "B," we can linearize the dial markings.

In that type of radio, there are two different frequencies. The first of those (IF1) will tune a certain frequency range, such as 2 to 3-MHz. The LO converts that frequency range to 455-kHz in a manner similar to any single-conversion receiver. The shortwave frequencies (3 to 30-MHz) are down-converted to 2-3 MHz. Thus, all bands have equally-spaced bandspreading. Furthermore, by using a circuit like the one shown in Fig. 9B, we can linearize the dial markings.

There are several capacitors in Fig. 9B, some of which have functions similar to those of other figures. In this case, however, the main tuning capacitor has a capacitance range that is only a small percentage of the total capacitance used to resonate the inductor (L1). If that capacitor is a straight-line frequency type, then linearity is even further improved.

The most modern double or triple-conversion receivers replace the variable frequency oscillator (VFO) of Fig. 9A with a digitally-synthesized oscillator to tune the same range. The synthesizer uses a phase-locked loop (PLL) to force the output of a voltage-controlled oscillator (VCO) to operate on a fixed multiple of a crystal-controlled reference oscillator. If that reference frequency is small enough, then we can smoothly tune the entire range.

### Modern Designs

Modern radio receivers used in amateur receivers, and by shortwave listeners, use digital readouts. Most of those designs are simply double-conversion receivers similar to the illustration above. The converter section that down-converts (or in some designs up-converts) the ham-band signal to the "variable IF" is phase-locked loop

(PLL) controlled, rather than just crystal controlled.

In addition, the VFO is a PLL. The tuning control is not a capacitor, but rather a digitally-encoded drum (or similar mechanism) that is varied by the tuning knob. The encoded drum produces a binary word that controls the phase-locked loop's divide-by-N converter.

### Future Topics

In an upcoming column, we'll review a simple and low-cost station accessory that will allow you to cut through the QRM on today's crowded bands. Another upcoming issue will discuss how to check the operation of 2-meter (and higher band) FM transceivers.

As always, you are invited to send your tip, suggestion, photos to Joe Carr, K41PV, at PO Box 1099, Falls Church, VA 22041. ■



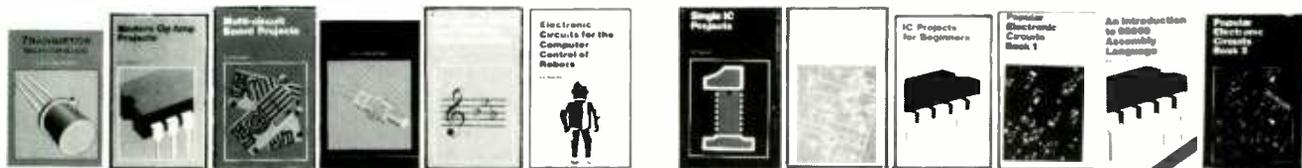
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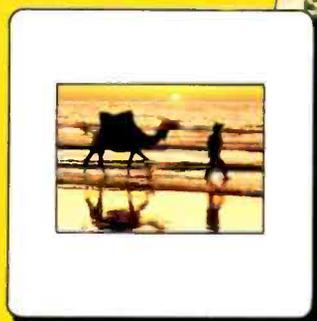
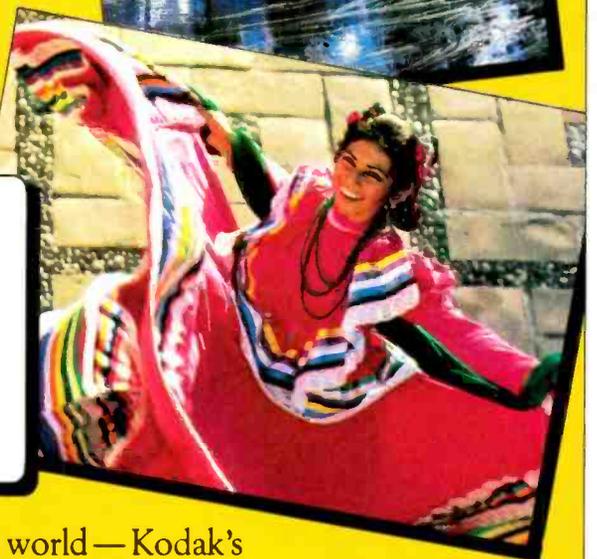
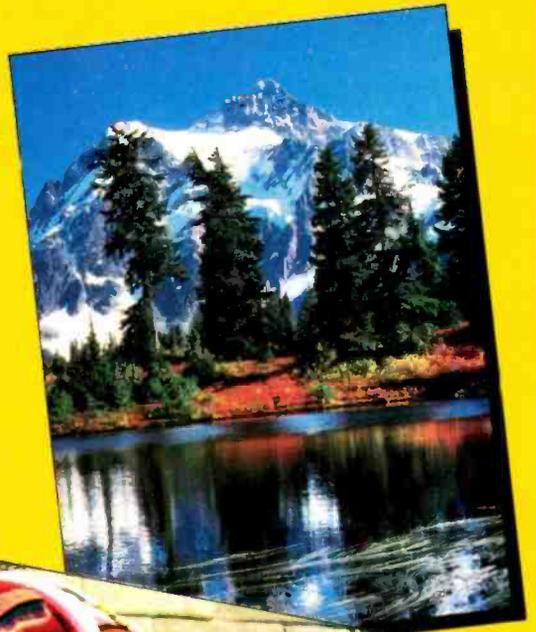
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