14278

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SIX CMOS CIRCUITS FOR EXPERIMENTERS

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"LIGHT GENIE" CONSTRUCTION PROJECT

Light beam switches appliances on or off

HOW ANALOG-TO-DIGITAL CONVERTERS WORK

TEST REPORTS:

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Garrard DD75 Direct-Drive Turntable
Tennelec MCP-1 Memory Scanner
Shure 526T Base-Station CB/Ham Mike

HOW TO DX EARTH RADIO FROM OUTER SPACE

0 14024 14278
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The 40-channel Cobra 29XLR. From the sleek brushed chrome face to the matte black housing, it's a beauty. But its beauty is more than skin deep. Because inside, this CB has the guts to pack a powerful punch.

The illuminated 3-in-1 meter tells you exactly how much power you're pushing out. And pulling in. It also measures the system's efficiency with an SWR check. In short, this Cobra's meter lets you keep an eye on your ears.

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And the added protection of Cobra's nationwide network of Authorized Service Centers with factory-trained technicians to help you with installation, service and advice.

The Cobra 29XLR. It has 40 channels. And it has what it takes to improve communications by punching through loud and clear on every one of them. That's the beauty of it.

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CIRCLE NO. 15 ON FREE INFORMATION CARD

PUNCH AND BEAUTY

HOT

A new consumer concept lets you buy stolen merchandise if you're willing to take a risk.

We developed an exciting new consumer marketing concept. It's called "stealing." That's right, stealing!

Now if that sounds bad, look at the facts. Consumers are being robbed. Inflation is stealing our purchasing power. Our dollars are shrinking in value. The poor average consumer is plundered, robbed and stepped on.

So the poor consumer tries to strike back. First, he forms consumer groups. He lobbies in Washington. He fights price increases. He looks for value.

So we developed our new concept around value. Our idea was to steal from the rich companies and give to the poor consumer, save our environment and maybe, if we're lucky, make a buck.

A MODERN DAY ROBIN HOOD

To explain our concept, let's take a typical clock radio retailing for $39.95 at a major retailer whose name we better not mention or we'll be sued. It costs the manufacturer $9.72 to make. The manufacturer sells the unit to the retailer for $16.

THE UNCLE HENRY PROBLEM

Let's say that retailer sells the clock radio to your Uncle Henry. Uncle Henry brings it home, turns it on and it doesn't work. So Uncle Henry trudges back to the store to exchange his "lousy rotten" clock radio for a new one that works ("lousy" and "rotten" are Uncle Henry's words).

Now, the defective one goes right back to the manufacturer along with all the other clock radios that didn't work. And if this major retail chain sells 40,000 clock radios with a 5% defective rate, that's 2,000 "lousy rotten" clock radios.

CONSUMERS PROTECTED ALREADY

Consumers are protected against ever seeing these products again because even if the manufacturer repairs them, he can't recycle them as new units. He's got to put a label on the product clearly stating that it is repaired, not new, and if Uncle Henry had his way the label would also say that the product was "lousy" and "rotten."

It's hard enough selling a new clock radio, let alone one that is used. So the manufacturer looks for somebody willing to buy his bad product for a super fantastic price. Like $10. But who wants a clock radio that doesn't work at any price!

ENTER CONSUMERS HERO

We approach the manufacturer and offer to steal that $39.95 radio for $3 per unit. Now think of it. The manufacturer has already spent $9.72 to make it, would have to spend another $5 in labor to fix and repackage it, and still would have to mark the unit as having been previously used. So he would be better off selling it to us for $3, taking a small loss and getting rid of his defective merchandise.

Consumers Hero is now sitting with 2,000 "lousy rotten" clock radios in its warehouse.

Here comes the good part. We take that clock radio, test it, check it and repair it. Then we life test it, clean it up, replace anything that makes the unit look used, put a new label on it and presto—a $39.95 clock radio and it only cost us $3 plus maybe $7 to repair it.

Impossible-to-trace ★ ★ Guarantee ★ ★

We guarantee that our stolen products will look like brand new merchandise without any trace of previous brand identification or ownership.

We take more care in bringing that clock radio to life than the original manufacturer took to make it. We put it through more tests, more fine tuning than any repair service could afford. We get more out of that $10 heap of parts and labor than even the most quality-conscious manufacturer. And we did our bit for ecology by not wasting good raw materials.

NOW THE BEST PART

We offer that product to the consumer for $20—the same product that costs us $3 to steal and $7 to make work. And we make $10 clear profit. But the poor consumer is glad we made our profit because:

1) We provide a better product than the original version.
2) The better product costs one half the retail price.
3) We are nice people.

BUT THERE'S MORE

Because we are so proud of the merchandise we refurbish, we offer a longer warranty. Instead of 90 days (the original warranty), we offer a five year warranty.

So that's our concept. We recycle "lousy rotten" garbage into super new products with five year warranties. We steal from the rich manufacturers and give to the poor consumer. We work hard and make a glorious profit.

To make our concept work, we've organized a private membership of quality and price-conscious consumers and we send bulletins to this membership about the products available in our program.

Items range from micro-wave ovens and TV sets to clock radios, digital watches, and stereo sets. There are home appliances from toasters to electric can openers. Discounts generally range between 40 and 70 percent off the retail price. Each product has a considerably longer warranty than the original one and a two week money-back trial period. If you are not absolutely satisfied, for any reason, return your purchase within two weeks after receipt for a prompt refund.

Many items are in great abundance but when we only have a few of something, we select, at random, a very small number of members for the mailing. A good example was our $39.95 TV set (we had 62 of them) or a $1 AM radio (we had 1257). In short, we try to make it fair for everybody without disappointing a member and returning a check.

EASY TO JOIN

To join our small membership group, simply write your name, address and phone number on a slip of paper and enclose a check or money order for five dollars. Mail it to Consumers Hero, Three JS&A Plaza, Northbrook, Illinois 60062, %Dept. PE.

You'll receive a two year membership, regular bulletins on the products we offer and some surprises we would rather not mention in this advertisement. But what if you never buy from us and your two year membership expires. Fine. Send us just your membership card and we'll fully refund your five dollars plus send you interest on your money.

If the consumer ever had a chance to strike back, it's now. But act quickly. With all this hot merchandise there's sure to be something for you. Join our group and start saving today.

CONSUMERS HERO®

JS&A NATIONAL SALES GROUP Consumers Hero has been made possible by grants from the JS&A National Sales Group.

CIRCLE NO. 59 ON FREE INFORMATION CARD

Old Fashion VALUE in the U.S.A. Tradition

Our 6800 computer system represents the best value available today, with no sacrifice in performance.

I would like to explain why this is true. The most basic reason is that the 6800 is a simpler, more elegant machine. The 6800 architecture is memory oriented rather than bus oriented as are the older 8008, 8080 and Z-80 type processors. This is an important difference. It results in a computer that is far easier to program on the more basic machine language and assembly language levels. It also results in a far simpler bus structure. The 6800 uses the SS-50 bus which has only half the connections needed in the old S-100 (IMSAI/MITS) bus system. If you don't think this makes a difference, take a look at the mother boards used in both systems—compare them. The SS-50 system has wide, low impedance 0.1 lines with good heavy, easily replaced Molex connectors. The S-100 bus, on the other hand, has a very fine hair-like lines that must be small enough to pass between pins on a 100 contact edge connector. I'll give you one guess which is the most reliable and noise free. As for cost—well any of you who have purchased extra connectors for your S-100 machines know what kind of money this can run into. The 6800 is supplied with all mother board connectors. No extras, or options like memory, or connectors for the mother board are needed in our 6800 system.

The 6800 is not beautiful, but "Oh Boy" is it functional. That plain black box is strong and it has an annodized finish. This is the hardest, toughest finish you can put on aluminum. Most others use paint, or other less expensive finishes. The 6800 does not have a pretty front panel with lights and multicolor switches. This is because the lights and switches are not only expensive, and unnecessary, but also a great big pain to use. We don't crank up the 6800; we use an electric starter—a monitor ROM called Mikbug. He automatically does all the loading for you without any time wasting switch flopping. So in the 6800 system you don't buy something expensive (the console) that you will probably want to stop using as soon as you can get your hands on a PROM board and a good monitor.

That's another thing. Mikbug® is a standard Motorola part. It is used in many systems and supported by the Motorola software library in addition to our own extensive collection of programs. It is not an orphan like many monitor systems that are unique to the manufacturer using them and which can only run software provided by that manufacturer. Check the program articles in Byte, Interface and Kilobaud. You will find that almost all 6800 programs are written for systems using a Mikbug® monitor. Guess how useful these are if you have some off-brand monitor in your computer.

The 6800 will never win any beauty prizes. It is like the Model "T" and the DC-3 not pretty, but beautiful in function. It is simple, easy to use and maintain and does its job in the most reliable and economical way possible. What more could you want?

Mikbug ® is a registered trademark of Motorola Inc.

SwTPC 6800

Computer System
with serial interface and 4,096 words of memory $395.00

☐ Enclosed is $395 for my SwTPC Computer Kit ☐ Send Data

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POPULAR ELECTRONICS, April 1977, Volume 11, Number 4, Published monthly at One Park Avenue, New York, NY 10016. One year subscription rate for U.S., $9.98; U.S. Possessions and Canada, $12.98; all other countries, $14.98 (cash orders only, payable in U.S. currency). Second Class postage paid at New York, NY and at additional mailing offices. Authorized as second class mail by the Post Office Department, Ottawa, Canada, and for payment of postage in cash.

POPULAR ELECTRONICS including ELECTRONICS WORLD, Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature.

Editorial correspondence: POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. Editorial contributions must be accompanied by return postage and will be handled with reasonable care; however, publisher assumes no responsibility for return or safety of manuscripts, art work, or models.

Forms 3579 and all subscription correspondence: POPULAR ELECTRONICS, Circulation Dept., P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address. Include your old address, enclosing, if possible, an address label from a recent issue.

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Editorial

ELECTRONICS AIDS SECURITY

We're living in an age when thefts are more commonplace than ever before and disastrous fires are destroying more and more property and lives. Thankfully—and as every security-minded person knows—we now have electronic devices to provide at least some measure of prevention against such disasters.

A sophisticated example of an electronic theft-prevention device, for example, is the digital combination lock described in this issue. The fastest-growing part of the home security industry, however, is in residential electronic smoke detectors.

More and more people are concerned about fires starting while they sleep. And they should be! Reports indicate that a fire breaks out in someone's home in the U.S. every 57 seconds. Moreover, 75 percent of the fatalities that result occur at night. Since smoke can be detected in the early stages of a fire, it can be an ally to save your life rather than take it. So it's no surprise to learn that electronic smoke detectors are selling in the millions of units, rocketing upward at a 45-degree angle, with no end in sight.

There are a variety of fire alarms, of course. Heat-sensitive alarms, for instance, provide an audible warning when they detect a temperature above 135 degrees Fahrenheit (57.2°C). But unless a fire occurs in the immediate vicinity of this type of alarm, a warning won't be provided until the fire (including smoke) has reached a very serious stage. An electronic photoelectric detector, in contrast, can sense visible smoke, issuing an earlier warning of impending disaster. Ionization sensors (containing a minute, "harmless" particle of radioactive material), however, provide an earlier warning when the combustion product is barely visible. And the highly sensitive Taguchi sensor employed in a construction project here last year (August 1976) can quickly detect paint fumes, gas leaks, carbon monoxide, and other noxious fumes, too.

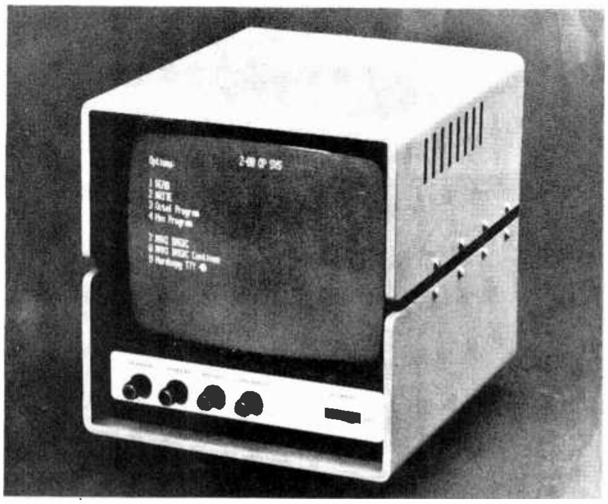
According to *Consumer Reports* (January 1977), one should install two types of fire detectors: an ionization type *and* a photoelectric type. Their reasoning is based on the fact that the latter are very sensitive to smoke from smoldering fires (the causes of the majority of residential fire deaths) but react slowly to hard-to-see combustion products from flaming fires (the second largest cause of fatalities). The ionization detector is said to perform essentially in the opposite manner. CU also takes issue with the Public Citizen's Health Research Group's report that urges a ban on ionization-type smoke detectors due to its radioactive metal. In CU's judgement, the fears are unwarranted.

At this time, there are some 66-million households in America without a smoke- or fire-warning system. That seems a shame when one considers that in 1974, according to GE, more than 300,000 Americans were injured or died from fires, while property loss exceeded $3 billion. State code requirements springing up across the country are sure to change these frightening statistics in time by requiring smoke alarms in all new homes and apartments. Half of the states, however, have no such smoke-alarm code (though most states do for mobile homes).

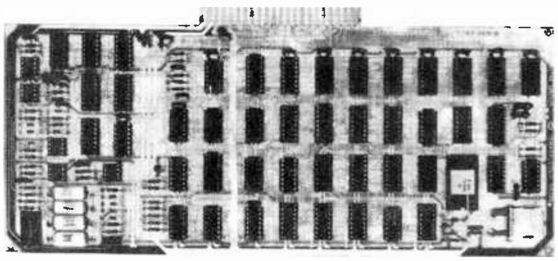
With so many moderately priced ($35 to $60) smoke detectors on the market, both battery-powered and wired, there's no reason why people shouldn't take full advantage of this electronic safety device to reduce the risk of tragedy. Our sense of values should certainly place these electronic devices ahead of the new coffee makers—whose unit sales now almost triple those of smoke alarms. Life before pleasure, I say.

Art Salsberg

The Digital Group adds character(s).



64, to be exact.



The Digital Group's computer systems have a lot of character already. Just one quick look at any of our products in their unique custom cabinets confirms that. But we believe it never hurts to add a bit more.

So, the Digital Group has added character in a big way to give an added dimension to the operation of our video-based computer systems. We are pleased to announce our new TV readout with a 64-character line. It will give your system a great deal more capability. Give it more character, if you will.

Here are the specifics on the Digital Group TV Readout and Audio Cassette Interface:

1024 Character TV Readout

- 64 characters horizontal by 16 lines
- 7x9 character matrix (effectively 7x12 due to character shifting)
- 1K on-board RAM for buffer storage—requires no main memory—completely independent
- 128 character ASCII
  - Upper case alpha
  - Lower case alpha with base line extenders (g, j, p, y)
  - Numbers and extended math symbols
  - Greek alphabet
- Software driven cursor—forward and backward
- Compatible with most microprocessors; Interfaces with 1 8-bit parallel output port
- Timebase may be driven with an external timebase (may be synchronized to TV camera, TV set, etc.)
- Readout timebase available at connector (can be used for graphic driver, etc.)
- White characters on black, and/or black on white; software selectable
- Plugs into standard dual 22-pin TVC connector on Digital Group Systems

Improved Audio Cassette Interface:

- Reliable FSK recording technique
- Uses standard unmodified audio cassette recorder
- Write cassette system uses a digitally synthesized frequency shift system, derived from TV system's master crystal oscillator
- Read cassette system easily aligned using the write system as an alignment aid.
- Runs at 1100 baud (100 characters/second)—loads 16K in 3 minutes

512 TVC to 1024 TVC Upgrade Kit:

As always, when the Digital Group extends the capabilities of our systems, it doesn't mean obsolescence for any products. We are offering an upgrade kit for present Digital Group system owners who wish to go to the longer line length. This kit uses most of the IC's from our TVC-F readout. No unsoldering is required; all new sockets, capacitors, resistors, PC board and other necessary parts are supplied.

Prices:

TVC-64—Full 64-character TV Readout & Audio Cassette Interface:

Kit — $140   Assembled — $205

TVC-64UPG—Upgrade kit from TVC-F:

Kit — $65

If you already own a Digital Group system, our 64-character line will definitely enhance its operation. If you're just looking, you might want to keep in mind that the Digital Group has a lot of characters.

Write or call now for details on our new 64-character TV readout and all our other exciting products.

the digital group inc

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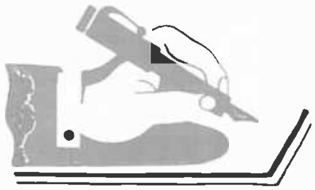
CIRCLE NO. 21 ON FREE INFORMATION CARD



Letters

SWEEPING OUT THE "BUGS"

In my article "Current 'Foldback' Protects Power Supply and Load" (p 59, February 1977), two small bugs seem to have crept into the published form. In the next-to-last line of the fourth paragraph, the minimum voltage differential should be 3.0 V, not 30 V.

In the second paragraph under "Calculations," the equation for *R2A* is not really needed, but there should have been an open-parenthesis mark before V_{REF}.—*Jerome May, Chicago, IL.*

CONTACTING THE GALAXY

In reading the December 1976 Editorial, I noticed a small but significant error in the last paragraph. The message we transmitted into space was at a frequency of 2380 MHz, not 1420 MHz as stated in the Editorial. There is a lot to be said about the advantages and disadvantages of sending messages to outer space at 1420 MHz, but as far as I know, the only serious intent has been the Aricebo message, and it was on 2380 MHz (12.6 cm).—*Rafael Morales, National Astronomy and Ionosphere Center, Aricebo, Puerto Rico.*

The 1974 Arecibo "digital" message was indeed the most serious effort made. However, 1420 MHz was proposed as early as 1959 since it's the spontaneous frequency generated by the most abundant constituent in the universe, hydrogen. Some scientists argue also for twice or half its frequency, others for slightly below 1700 MHz. The latter is associated with OH molecules which, combined with H, makes H_2O, leading to the interesting thought of a potential universe radio meeting at the "water hole."

CATCHING GREMLINS

The article "Propagation Delay—The Logic Gremlin" (December 1976) was very informative. I would, however, like to call your attention to the timing diagram in Fig. 4. The waveform shown in Fig. 4B is labelled "NOR" when it should have been labelled "OR." The proper waveform would be exactly inverted, of course.—*John Simmons, Birmingham, AL.*

ORGAN TUNING

I note under the heading "Electronic Organ Tuning Advance" in the "News Highlights" section of the December 1976 issue that Schober Organ has introduced a digital IC tone generator that eliminates the need for tuning adjustments. This single-oscillator divider-type tone generator has been standard in all Hammond organs since 1973 and has appeared in some Lowery organs for three years. —*Phil MacArthur, Austin, TX*

Your piece on "Electronic Organ Tuning Advance" in December 1976 is in error. What is incorrect is the statement: "Before the development of [the Schober] digital IC system, only organs with rotating mechanical generators did not require tuning." The Allen Organ Company's Digital Organs have not required tuning for more than five years.—*David L. George, National Service Manager, Allen Organ Co., Macungie, PA*

LOGIC ANALYZER ADDRESS

Due to an oversight, the complete address was omitted from the Parts List for the "Low-Cost Digital Logic Analyzer" (February 1977, p 40). It should be: Paratronics Inc., Dept. 100, 150 Tait Ave., Los Gatos, CA 95030. Incidentally, a complete assembled and tested Analyzer (Model LA-100AT) is also available.—*I. Spector.*

INTERFACING TYPEWRITER

In your January "Computer Bits" column, the author mentioned using a converted Selectric typewriter for an output terminal. I am interested in doing this but don't know quite where to start.—*Stuart C. Kramer, Fairborn, OH.*

A book, Interfacing Selectrics to the 8080, *is available for $12, prepaid, from the Center for the Study of the Future, 4110 N.E. Alameda, Portland, OR 97212. It includes hardware schematics, timing, and interface software. The Selectric mechanism can serve as a terminal for applications such as word processing, mailing labels, stencil preparation, newsletter composing, correspondence, information retrieval, etc.*

GRAPHIC ERROR

After checking the distortion curves on pages 30 and 32 of your January issue, I find the following errors: On page 30, the captions for the top two diagrams are reversed and the top three curves in the left-hand diagram should be deleted. On page 32, in the upper left diagram, the lower dashed and the lower solid curves should be deleted and the numbers on the abscissa should be divided by 10.—*Alex Azelickis, Morton Grove, IL.*

So much for Christmas parties!

Out of Tune

In the "Conference Talk Timer," February 1977, P.63, the following connections to *S2* in the schematic should be deleted: Pin 5 of *IC1* at the 35-minute position; Pin 5 of *IC1* at the 50-minute position. The following connection to *S2* should be added: Pin 5 of *IC1* at the 45-minute position.

If You're Still Playing Games It's Because You Haven't Seen Our Software Library

This Library is the most comprehensive work of its kind to date. There are other software books on the market but they are dedicated to computer games. The intention of this work is to allow the average individual the capability to easily perform useful and productive tasks with a computer. All of the programs contained within this Library have been thoroughly tested and executed on several systems. Included with each program is a description of the program, a list of potential users, instructions for execution and possible limitations that may arise when running it on various systems. Listed in the limitation section is the amount of memory that is required to store and execute the program.

Each program's source code is listed in full detail. These source code listings are not reduced in size but are shown full size for increased readability. Almost every program is self instructing and prompts the user with all required running data. Immediately following the source code listing for most of the programs is a sample executed run of the program.

This Library is destined to become one of the reference bibles for the small computer field, due to its versatility and uniqueness and the ease of operation of the programs it contains. These volumes are deductible as a business expense when purchased by a company. Send your remittance for prompt delivery, while supplies last. Volume discounts are available to qualified dealers.

The entire Library is 1000 pages long, chock full of program source code, instructions, conversions, memory requirements, examples and much more. ALL are written in compatible BASIC executable in 4K MITS, SPHERE, IMS, SWTPC, PDP, etc. BASIC compilers available for 8080 & 6800 under $10 elsewhere.

This LIBRARY is a complete do it yourself kit. Knowledge of programming not required. EASY to read and USE. Written in compatible BASIC immediately executable in ANY computer with at least 4K, NO other peripherals needed.

VOLUME ONE

Part 1

BOOKKEEPING

Bond
Building
Compound
Cyclic
Decision 1
Decision 2
Depreciation
Efficient
Flow
Installment
Interest
Investments
Mortgage
Optimize
Order
Pert Tree
Rate
Return 1
Return 2
Schedule 1

Part 2

GAMES

Animals Four
Astronaut
Bagel
Bio Cycle
Cannons
Checkers
Craps
Dogfight
Golf
Judy
Line Up
Pony
Roulette
Sky Diver
Tank
Teach Me

PICTURES

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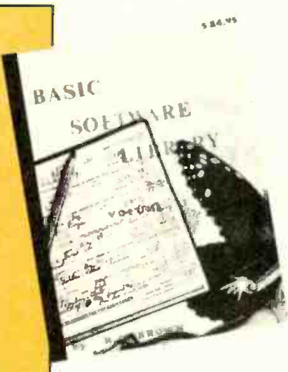
J.F.K.
Linus
Ms. Santa
Nixon
Noel Noel
Nude
Peace
Policeman
Santa's Sleigh
Snoopy
Virgin



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Bull
Enterprise
Football
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Funds 2
Go-Moku
Jack
Life
Loans
Mazes
Poker
Popul
Profits
Qubic
Rates
Retire
Savings
SBA
Tic-Tac-Toe

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Part 3

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Conv.
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Fit
Integration 1
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Intensity
Lola
Macro
Max. Min.
Navaid
Optical
Planet
PSD
Rand 1
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Sphere Trian
Stars
Track
Triangle
Variable
Vector

Part 4

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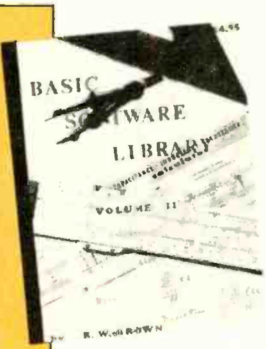
Coeff
Confidence 1
Confidence 2
Correlations
Curve
Differences
Dual Plot
Exp-Distri
Least Squares
Paired
Plot
Plotpts
Polynomial Fit
Regression
Stat 1
Stat 2
T-Distribution
Unpaired
Variance 1
Variance 2
XY

APPENDIX A
BASIC
STATEMENT DEF



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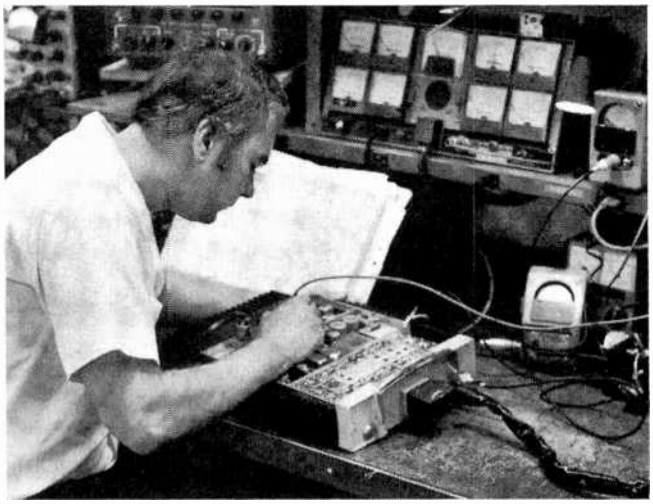

special instruction so you can go on the air.

The complete course includes 48 lessons, 9 special reference texts, and 10 training kits. Included are: your own electronics Discovery Lab, Antenna Applications Lab, CMOS Frequency Counter, and an Optical Transmission System. You'll learn at home, progressing at your own speed, to your FCC license and into the communications field of your choice.

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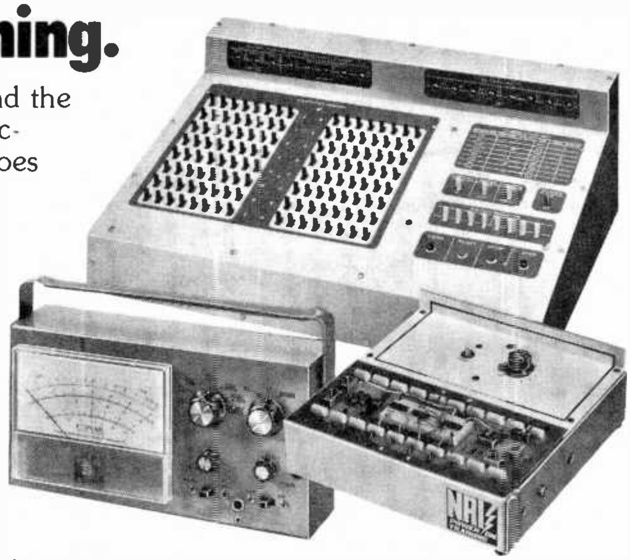

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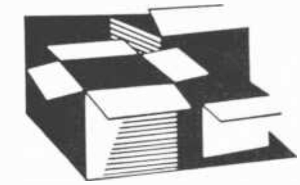
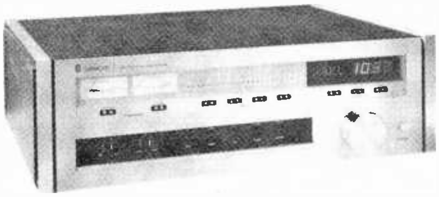


New Products

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Reader Service Card inside the back cover or write to the manufacturer at the address given.

SHERWOOD "COMPUTERIZED" FM TUNER

Modern computer technology in the Micro/CPU 100 FM tuner from Sherwood provides features not found in other tuners. One is a unique call-letter indicator that can be user programmed for stations in his area. With it, stations can be quickly located even when the frequencies are not known. A computer-controlled auto-scan function allows the user



to scan up or down the FM band in either the mono/stereo or stereo-only mode. There is also a user-programmable memory system for instant recall of any of up to four preselected stations. An infrared laser tuning system substitutes for the conventional flywheel system. Additionally, the tuner has what is claimed to be the most advanced digital detector in use today and PLL's in the tuning system and multiplex decoder. Backing up the call-letter display are numeric LED displays for station frequency identification and a separate analog dial scale that uses LED's to eliminate moving parts. $2000.

CIRCLE NO 89 ON FREE INFORMATION CARD

TRAM 40-CHANNEL CB TRANSCEIVER

The Tram D42 is a mobile, 40-channel AM rig with 4 watts r-f output, 100% modulation capability, 0.5 μV receiver sensitivity for 10 dB (S + N)/N and adjacent channel rejection of more than 70 dB, according to the manufacturer. It features r-f and mike gain controls, an illuminated SWR/"S"/r-f meter, variable ANL, switchable noise blanker, and a 3-kHz delta tuning control. The unit also boasts a

dual-conversion receiver circuit, a tone control, and PA capability. Dimensions are 2⅜"H × 7"W × 9¼"D (6 × 17.5 × 24 cm). $250.

CIRCLE NO 91 ON FREE INFORMATION CARD

O.K. WIRE-WRAPPING TOOL

The new BW-630 Hobby Wrap from O.K. Machine and Tool Corp. is a battery-powered tool for wire-wrapping #30 AWG wire onto standard DIP-socket terminals (0.025" square). The tool comes complete with a built-in bit and sleeve for producing the "modified"-style wrap, as well as a device to prevent overwrapping. Designed for the serious amateur, the tool weighs 11 ounces and runs on any standard or rechargeable C-size batteries. $34.95.

CIRCLE NO. 92 ON FREE INFORMATION CARD

AM/FM/CB "DISGUISE" ANTENNA

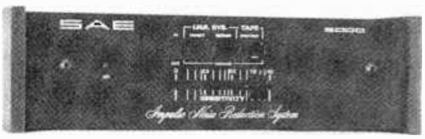
"The Little Fooler," an AM/FM/CB antenna by Anixter-Mark, is said to deter theft simply because it doesn't look like a CB antenna, but rather like an ordinary three-section telescopic antenna that extends from 22" to 57". The antenna assembly, Model AAF-11-4, includes an "out-of-sight" universal mounting

coupler that is said to allow tuning for a VSWR of 1.2 to 1 on any of the 40 channels, coax cable with connectors, and cowl antenna. $34.95.

CIRCLE NO 93 ON FREE INFORMATION CARD

SAE NOISE-REDUCTION SYSTEM

The Model 5000 from SAE is said to have been specifically developed to reduce the clicks and pops (impulse noise) commonly found in phonograph records. Called the Impulse Noise Reduction System, it uses a logic circuit that monitors the program material for the parameters that describe the presence of impulse noise. When the noise-removal circuit is activated, the program is turned off for



less than 0.001 second; a reconstruction circuit then insures program integrity. The system is claimed to reduce impulse noise without modifying bandwidth or dynamic range. Frequency response is reported to be 20 to 20,000 Hz ±1 dB; THD and IM distortion are both rated at 0.1%; S/N at 90 dB below the rated 2.5-volt rms output. Insertion loss is stated at less than 1 dB. A sensitivity control is provided. $200.

CIRCLE NO 94 ON FREE INFORMATION CARD

SPARKOMATIC 40-CHANNEL CB CONVERTER

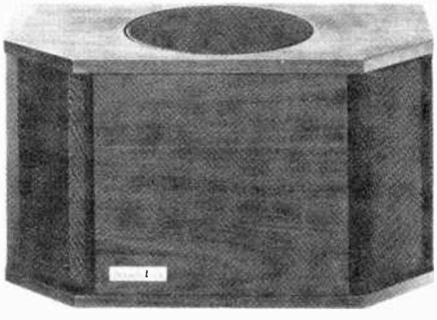
A new converter that enables any user to convert a mobile AM or AM/FM receiver to tune in the 40-channel Citizens Band has been introduced by Sparkomatic Corp. Fea-

tures include: adaptability to any standard AM receiver (between antenna and receiver); 40-channel selector; AM/CB switch that allows selection of desired signal; fine-tune control for the CB channels; noise silencer, sensitivity control, and a CB-mode LED. $39.95.

CIRCLE NO. 95 ON FREE INFORMATION CARD

ALLISON SPEAKER SYSTEM

The Allison:Four "bookshelf" speaker system features "Stabilized Radiation Loading," which is said to minimize reflected impedance variations that cause proportional changes in acoustic output power at middle-bass frequencies. The result is said to be a uniformity in bass power distribution in listening rooms. The system contains an 8" (20.3-cm) top-mounted and upward-facing woofer and two 1" (2.54-cm) Convex Diaphragm



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CIRCLE NO. 29 ON FREE INFORMATION CARD

tweeters. The 9-ohm (nominal) speaker system requires 30 watts/channel of amplifier power to produce 100 dB SPL in most domestic listening rooms. Crossover is at 2000 Hz. Size is 19⅜"W × 11"H × 10"D (49.2 × 27.9 × 25 cm) and weight is 23.5 lb (10.7 kg). $175.

CIRCLE NO. 96 ON FREE INFORMATION CARD

EICO COLOR-BAR PATTERN GENERATOR

Eico has introduced a 12-oz, hand-sized Model 388 color-bar pattern generator for testing and aligning color and monochrome TV receivers. Designed around an LSI IC circuit, it provides nine different patterns, includ-

ing gated rainbow, single dot, dot raster, single and multiple horizontal and vertical line, single crossbar, and crosshatch. Operates from two 9-V batteries or NiCd cells, and features a power-on LED indicator and a crystal-controlled oscillator. $99.95.

CIRCLE NO. 97 ON FREE INFORMATION CARD

THORENS TURNTABLES

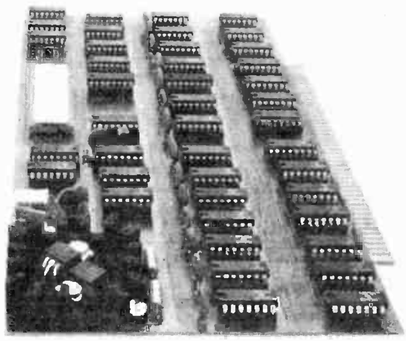
The new line of turntables from Thorens features reduced effective tonearm mass. To accomplish this, the turntables use plug-in "Isotrac" tonearms that move the plug-in connection from the stylus shell to near the tonearm pivot, resulting in an effective mass of only about 7.5 grams. At the top end of the line is the three-speed Model TD-126C transcription turntable ($625). It has illuminated pushbutton controls for speed selection, operating modes, and cueing. Solid-state switching provides speed selection and end-of-play tonearm lift, with or without motor shutoff. The speed of the motor is governed by a stable solid-state Wien-bridge oscillator that is unaffected by line variations. An "Elec-

tronic Velocity Sensor" circuit provides automatic tonearm lift and motor shutoff. Wow and flutter is 0.04% (DIN), weighted rumble is −70 dB. Dimensions with dustcover are 19⅞" (50.5 cm) × 15½" (39.5 cm). Prices of other models range from $215 to $325.

CIRCLE NO. 98 ON FREE INFORMATION CARD

CROMEMCO Z-80 CPU CARD

Cromemco's new CPU card is said to use selected versions of the Z-80 microprocessor, with a clock rate of 4 MHz. The card, compatible with the Altair bus, also has a switch-



selectable 2-MHz clock rate. The card is designed to be used with slower memory or I/O devices even when using the 4-MHz rate, by incorporating jumper-selectable wait states in the design. The card also permits jumping to any 4k boundary in memory when power is turned on, avoiding the use of panel switches to select a desired memory location. The Z-80 MPU has 158 instructions, compared with the 8080 MPU's 78.

CIRCLE NO. 99 ON FREE INFORMATION CARD

ADVENT CASSETTE DECK

The Model 201A is a new cassette deck from Advent. It uses a new record/play head made of Sendust alloy that is said to combine the preferred performance characteristics of Permalloy with the durability of ferrite. Also, a headphone amplifier is now built into the deck. The Model 201A retains the Dolby noise-reduction system and equalized peak-indicating metering system first used in the Model 201. Among the new deck's more important specifications are: 28 to 15,000 Hz ±2 dB frequency response; 0.15% wow and flutter, better than 60 dB with CrO_2 and 57 dB with regular tape S/N (referred to 0 dB with Dolby system on and A weighting); and less than 0.1% distortion. The deck is fully automatic, with end-of-tape shut-off that disengages the pinch roller and heads from the tape. $399.95.

CIRCLE NO. 100 ON FREE INFORMATION CARD

Editor's Note: In the February, 1977, New Products, page 12, the price of the Heathkit "Computer" Color TV was given as $279.95. It should have been $699.95.

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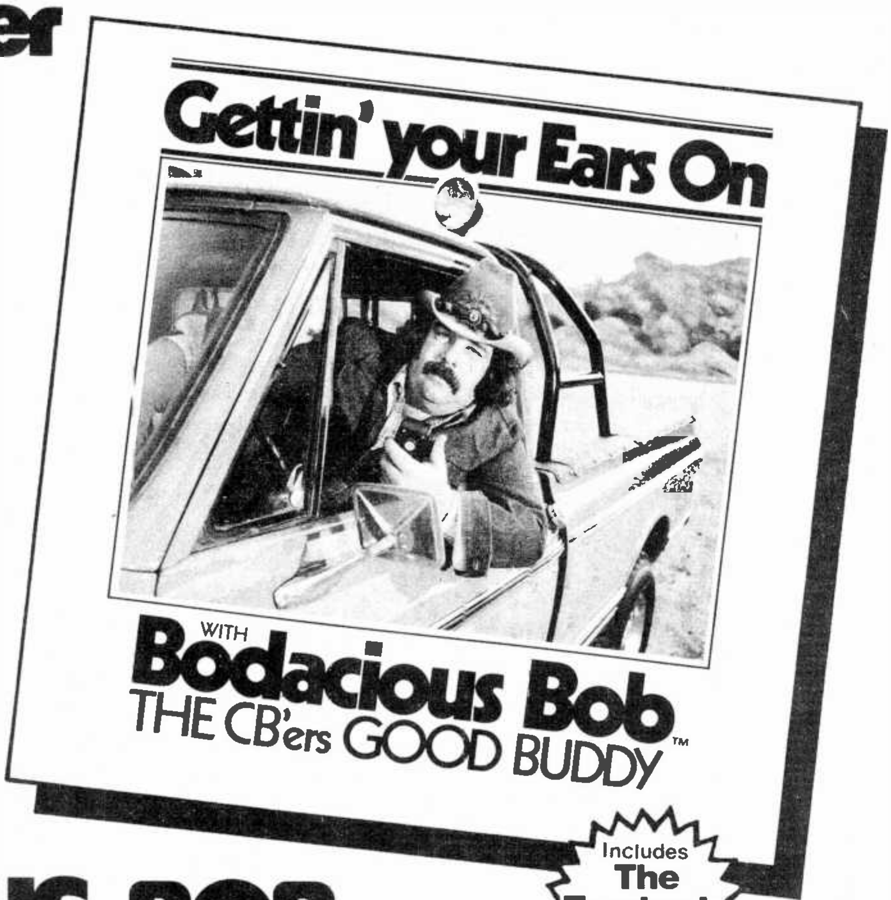

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New Literature

SURGE-SUPPRESSION DATA SHEET

Designing surge suppression circuits to protect thyristors from load-induced faults is the topic of a new application data sheet from Westinghouse. The six-page "Thyristor Surge Suppression Ratings" (No. 54-550) application sheet contains graphs that help the designer to choose the proper device for a given surge suppression requirement. Proper use of the graphs is out-lined by an easy-to-follow design example. Address: Semiconductor Div., Westinghouse Electric Corp., Youngwood, PA 15697.

STEREO EQUIPMENT CATALOG

The complete line of open-reel recorders, cassette decks, and stereo receivers is listed in Tandberg's new Hi-Fi Stereo 76/77 catalog. Consisting of 28 pages, the catalog illustrates all products listed in full color and includes brief descriptions and technical specifications of each product. Address: Tandberg of America, Inc., Labriola Ct., Armonk, NY 10504.

POLICE CALL DIRECTORY

The Hollins Radio Data "1977 Police Call Radio Directory" is published in nine regional volumes, each containing four sections. Listed both alphabetically and by frequency, Parts I and II contain police, fire and other FM radio systems, with supplemental data including callsign, transmitter location and type of station. Part III is an allocation table of land-mobile radio usage. It contains some of the U.S. Government channels. Part IV provides the base and mobile frequencies used in the U.S. National parks and forests. These include shore resorts and recreation areas. Price per volume, $4.95. Address: Hollins Radio Data, P.O. Box 35002, Los Angeles, CA 90035.

CB ACCESSORIES FOLDER

A new folder from RMS Electronics describes many CB accessories, such as a CB window antenna mount, a CB antenna trunk mount designed to prevent theft and damage, slide lock mounts, speakers, cables, connectors, dummy loads, microphones, filters, etc. Address: RMS Electronics, Inc., 50 Antin Place, Bronx, NY 10462

DIGITAL TIMING PRODUCT CATALOG

Chrono-Log offers a condensed catalog of its digital timing products, including digital clock/calendars, time-code generators and readers, as well as video character generators, output buffers, up/down digital clock/counters, and communications couplers. Address: Chrono-Log Corp., 2 West Park Rd., Havertown, PA 19083.

MICROCOMPUTER CATALOG

A 64-page microcomputer catalog from Newman Computer Exchange lists everything from disk-based microcomputer systems to individual IC's, plus a variety of peripherals, software and components. They stock computers from Imsai, MOS Technology, DEC (LSI-11), OSI, HAL, and others. Address: Newman Computer Exchange, 1250 North Main St., Ann Arbor, MI 48104.

COMPUTER SERVICES DIRECTORY

Telenet Communications Corp. offers a 42-page directory of data banks, commercial service bureaus and colleges and universities that provide dial-up access to their computer facilities over the nationwide Telenet network. More than 40 organizations are cross-referenced by application specialties, programming languages, and data-base offerings. Address: Marketing Services, Telenet Communications Corp., 1050 17th St., NW, Washington, DC 20036.

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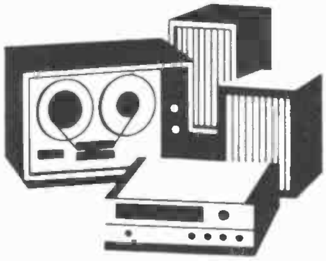

Stereo Scene

By Ralph Hodges

THROUGH THE MICROPHONE

LAST month's column raised the question of live music and whether it bears any resemblance to what we hear from recordings. This month's column raises the question of why it might, or might not. The music we listen to on our phonographs and tape decks is a package assembled by a group of people generally recognized as having some talents along these lines. They have the opportunity (or at least some of them do) to hear the sound as it comes from the live musical instruments, and they make the decisions as to what's to be done with it before it is committed to vinylite or ferric oxide.

We know that the recording arts are capable of perpetrating grotesque distortions, both deliberate and accidental, on musical sound. Also, the will or the whim of the producer, artists, and sometimes the engineer generally prevails in these matters. What about these people? Do we share any philosophical or aesthetic grounds with them? What are their priorities when they approach a recording job? Do they care—in the sense that we'd like them to care—about what they are doing?

The answers to these questions, if there are any, lie in the recording sessions, and what follows is a blow-by-blow description of one that took place just recently. The events are typical only insofar as no recording session is typical. Fundamentally, this attempts to be an account of what happens when a group of intelligent, experienced, and very serious people go about putting a little bit of music on tape.

The Setting. St. George's church in the Gramercy Park section of Manhattan, is the grandiose setting for the session. It has a high, peaked roof and a generously proportioned apse behind the pulput, where the orchestra is arrayed. I arrive in time for the first afternoon session, which is just beginning to pull itself together amidst the wreckage of pastrami sandwiches and coffee cups. Everybody is highly stimulated by the sound that is coming from the old church, and indeed it is fabulous—bril-

The control-room setup, showing the console, a corner of the tape transport (right), the scope and voltmeter (far left), and the mysterious cassette deck.

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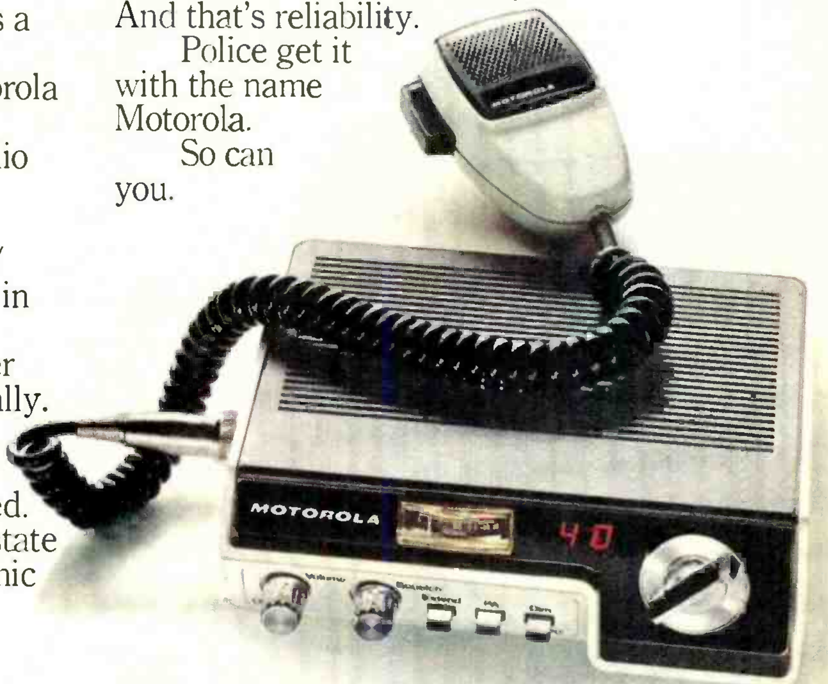

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liant, spacious, and instantaneous in its dynamic response. One of the cellos is tuning up on the platform, and the glossy brown timbre of the instrument envelops and penetrates you with its warmth and vigor.

The orchestra is the Philharmonia Virtuosi, a string ensemble of perhaps twenty pieces, and the occasion is four LP sides—two for Columbia and two for Vox—to be recorded one after another, marathon-wise. The orchestra knows its business, and has been through it all before. Nerves, heartburn, and temperament notwithstanding, it should be able to get through it all again.

Judy Sherman, the producer, is on the platform supervising the seating of the orchestra. It has been decided, pretty much against customary practice, to exploit the antiphonal effects of the music by placing the second violins on the right. It is also hoped that this will result in something close to an ideal balance of the ensemble's overall sound. As much as possible the balancing will be achieved by moving musicians around; the microphone positions, until proven less than optimum, will be disturbed as little as possible.

The engineer, John Woram, is galloping back and forth between the church proper and the control room, which has been set up in a passage leading to a small chapel off to the side. Periodically he halts to peer quizzically at the microphones, as if they were disputing the evidence of his own ears as to the activity on stage. Since it would be folly to throw away the free gift of the church's sound by close miking, the mikes have been placed well away from the orchestra. The principal mikes, three condenser cardioids, are perhaps twenty-five feet from the violins, perched on stands and booms that raise them about that distance from the floor. The spread between left and right is about fifteen feet (the center mike is of course mixed into both channels equally.)

Some fifteen feet behind these is a pair of cardioid dynamic mikes, spread just a bit wider than the front principal mikes. These can be mixed into the left and right channels at will to provide more "church". To judge from the setup of the mixing console, these mikes contributed at a level about 15 or so dB lower than that of the principal mikes throughout the session.

The Control Room. The trip to the control room is something like a journey on a Möbius strip. You leave the church only to re-enter the church, so close is the sound from the monitor loudspeakers to that of the real thing. The control room set-up is orthodox. The mikes directly feed a twelve-in/four-out semi-portable console, made by Sound Workshop. From it a two-channel signal emerges to feed the Dolby processors and a hefty studio recorder (half-track stereo) off to the side. However, in his infinite shrewdness John has put an oscilloscope and an ac voltmeter across the output of the console. If anything goes wonky in the recording chain he will be in an excellent position to say what, and quickly. There is also a piece of gear that you'd never expect to find in such surroundings: a cassette deck (!), of well-known make and reputation. Presumably John uses this to make a reliable record of the sequence of takes, to assist in the editing job. Or maybe he sells cassette recordings to record companies. In any case, one doesn't ask idle questions of a man whose time (in this context) is worth about a zillion dollars per minute, so the method in his madness must remain a secret. (Your madness wouldn't remain secret for long if you tried to make a tape without giving the artist a copy. The cassettes were for the conductor, Dick Kapp—*J.M. Woram.*)

The orchestra begins rehearsing the first piece, a charming little baroque march that requires exacting ensemble work. The oscilloscope (providing an X-Y stereo display) reveals the obvious: except for attacks, the sound being picked up by the mikes is totally random-phase, rich in depth and perspective. Judy is getting herself settled at a card table between the monitor speakers. On the table are a score and a microphone. The microphone feeds a "talk-back" system by which, at the press of a button on the console, she can address the orchestra in the church via an on-stage loudspeaker. (In some recording sessions, monitor loudspeakers are set up on-stage so that the orchestra can hear an instant playback. This saves time, but in an acoustic environment as glamorizing as St. George's it could be deceptive, so all playback listening will be done in the control room.)

The orchestra finishes its run-through, the conductor is satisfied, and it's time for the button-pushing. Judy says . . .

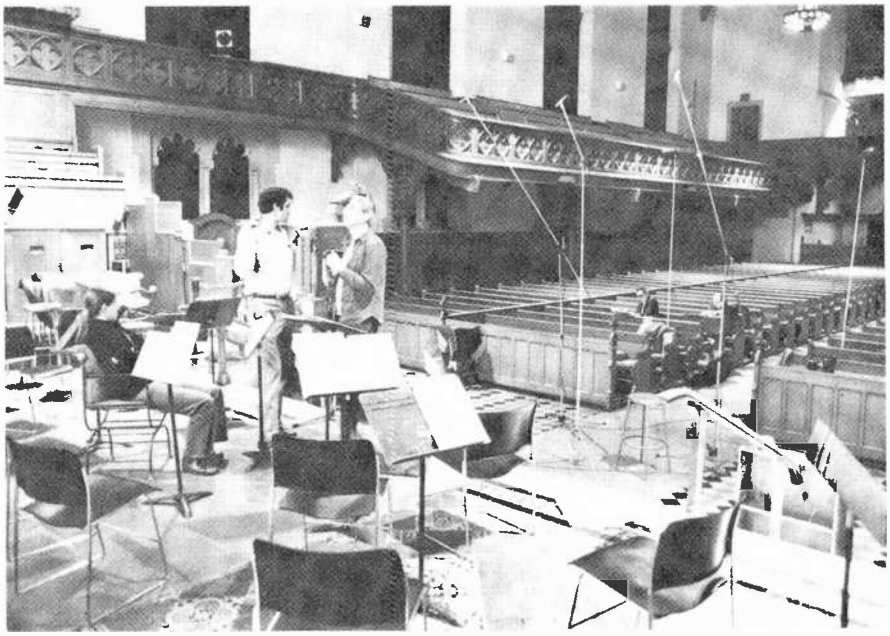
"Take One." An unaccountable transformation takes place in the sound of the orchestra now that it's playing "for keeps." The opening bars are dull and without exuberance. An early decrescendo is so abrupt that for a minute I think that the orchestra has decided to stop and begin again. Yet it plays through to the end, to the accompaniment of some grave faces in the control room. A playback audition is announced immediately, and soon the conductor and several orchestra members bustle in. Yes, it's bad. "Boxy-sounding," says the conductor. One of the orchestra members comments that he can't hear the second violins at all. (Technical point: when violins play on stage right, facing the conductor, their instruments project *away* from the audience area rather than toward it. It's by the grace of the hall's acoustics that their sound reaches you at all with any force. Picking up that sound via microphones can be tricky.)

Now we're in a bind. The people in the control room are inclined to think they've just heard a bad performance. The people from the orchestra are certain they've just heard a bad recording. Who has the answer? John does. Right after lunch he had profitably spent his time listening to the principal and secondary microphone arrays separately, and he had noted (while I was there) that the sound from the front mikes was "very dry" (without reverberation). Almost diffidently he proposes this as a solution, and out he goes into the church to rectify matters.

It's perhaps a cause for embarrassment when, having called upon an orchestra to play its little heart out, you then have to announce that your technical bag of tricks went awry and the whole thing will have to be done over again. But this orchestra is understanding, and its members fall into easy conversation as John emerges and begins to drag mike stands around. He pulls the principal mikes back a little over a foot (for a microphone that's a considerable shift in position), and does the same with the secondary pickups. Judy stands on the platform and confirms the aiming of the cardioids. There is a deliberate attempt to seem calm and casual. There are many pages of music to be recorded, and nobody can afford a nervous breakdown over this minor hitch.

Once again the record button is hit, and there is quiet rapture in the control room. The sound is well-nigh perfect (another inexplicable transformation), with none of the anomalies that troubled take one. The orchestra has maintained its head of steam, and it looks as if it will all be over in another minute. But then. . . .

Take Three and Etc. Judy is by this



The church during a lull in proceedings. Note comparatively remote mike locations.

time well and truly into it, mumbling over the score and beating time with her hands. I never heard whatever it was that pulled her to a halt, but she certainly did. "You're not in time," she told the orchestra, and back came a sheepish admission of the fact. The succeeding takes involved shorter and shorter bits of the music, trying to save time in getting the critical part right and yet avoiding an orphaned fragment on the tape, bereft of a proper acoustical build-up in the church and a sense of propulsion from the orchestra. "You're winding up in tune but you're not starting there," Judy cajoles. She is concerned about one of the violinists. "He's a master under ordinary circumstances, but under pressure he goes sharp." Should the retakes continue, perhaps souring the ensemble on the vast expanse of music yet to come, or should we take what we've got and be grateful for it? On about take eight the question is decided. Her hands stop, her breath is held, the music swells up and slides effortlessly into a tutti, and she exults: "Yes!" As the last notes of the march sound she counts a slow four to let all the reverberation die away and then activates the talkback system to congratulate the orchestra.

For the Record. This ended my participation (or presence) at this particular recording session. If things turn out as planned, the march will be presented to the consumer essentially intact, except for one splice toward the end to introduce music that was played long after the beginning of the piece (not that long, however; the whole drama as I have described it took not more than about thirty minutes).

What conclusions can be drawn? First, it's clear that the quality of sound going down on the tape is of vital importance to everyone involved in a recording session. Second, it's clear that once that quality has been achieved to everyone's satisfaction, all subsequent activities revolve around musical values.

Third, it's plain that, in matters of sound quality, the producer (and/or the performer) proposes and the engineer disposes. There are plenty of people at the session in a position to say the sound is bad, but it's the engineer who's usually looked to for the fix. If the engineer can't satisfy his critics, there may be general unrest, desperate experiments, and quite possibly a new engineer on the job next time around. But this is not to suggest that every bad record is the victim of inept engineering. It may be the victim of hopeless acoustics. And there have certainly been instances in which eccentric performers or tasteless producers have insisted on some procedural point that ultimately proved anti-musical in recorded form.

But here we have a recording session unclouded by this grief (or so it seemed at the time). All parties and circumstances came together on a common objective: closely recreating, from perhaps a row-three perspective, the magnificent sound that was already present at the performance. When the records are relased we'll be able to consider how successful they've been, along with how successful we can be in doing justice to their efforts. ◇

Julian Hirsch Audio Reports

HIRSCH/HOUCK LABORATORIES

FM TUNER SELECTIVITY RATINGS AND MEASUREMENT

FOR MANY people, *sensitivity* is the key specification in judging the worth of an FM tuner. Actually, this is one of the least important ratings for the majority of people (those who live within 50 or 75 miles of the FM stations serving their area). It is also relatively easy to design a tuner (which may have serious deficiencies in other respects) to have an impressively good sensitivity rating. Thus sensitivity is a poor index of overall quality.

A more meaningful specification, perhaps, is *selectivity*. This is the measure of a tuner's ability to receive a relatively weak FM signal, close in frequency to a much stronger one, without interference. The latest IHF Standard on FM Tuner Measurement details the procedure for measuring both *alternate channel* and *adjacent channel* selectivity, and a growing number of manufacturers are including at least the former rating in their published specifications.

FM station assignments in the United States are made at 200-kHz intervals. However, frequency assignments are distributed so that, in any one receiving area, stations will be heard only on alternate channels, 400 kHz apart. (There are obviously exceptions such as in certain locations situated between two major service areas.) Alternate channel selectivity—the ability of a tuner to reject a strong signal 400 kHz removed from a desired signal—is therefore the most important selectivity characteristic for most listeners. In those locations where stations can be received on adjacent channels, the selectivity for a 200-kHz spacing may become important as well. Resistance to station bleedover is much inferior to alternate channel selectivity, naturally, but if the difference in signal strength between the desired and the interfering signals is not too great, satisfactory reception may still be possible.

The test conditions for selectivity measurements are explicitly defined in the IHF standard. Two signal generators are required, with their outputs combined through a dummy antenna and applied to the tuner's antenna terminals. One is the reference generator, simulating the desired signal, and the other is the interfering signal source. First, the reference generator is set to a moderate output level (such as 45 dBf, or 100 μV) with 100% modulation at 1000 Hz. The tuner or receiver is set accurately to its frequency and its audio output level is noted. The modulation is then turned off, leaving the unmodulated carrier. The interfering generator, modulated 100% at 1000 Hz, is moved off the tuner's frequency by either 400 kHz or 200 kHz (depending on the measurement being made) and its output level is increased until the 1000-Hz audio output from the tuner is 30 dB less than that obtained with the modulated reference signal generator. The test is made with the interfering signal both above and below the desired signal frequency. The selectivity rating, expressed in dB, is the ratio of the output levels from the two generators.

The basic measurement sounds straightforward, but in practice it is one of the more difficult FM tuner measurements to make accurately, or even repeatably. According to the IHF standard, the measurements should be made at a number of (desired) signal levels, from the usable sensitivity up to as much as 80 dBf (more than 4000 μV). Since the alternate channel selectivity of any reasonably good tuner should be at least 50 dB, it can be seen that the latter case would require the interfering generator to have an output of more than 1 volt. This is beyond the capabilities of any standard signal generator, unless an external power amplifier is used.

The standard recognizes this difficulty and merely requires that the measurement be made within the capabilities of the test equipment (with a power amplifier if available and necessary). Most FM signal generators are limited to not more than 200,000 μV output (this is the maximum available from our Boonton 202B, which we use as the interfering signal generator). With that as the upper limit of available signal voltage, a tuner selectivity of 80 dB (typical of some of the better FM tuners and receivers) can be measured only if the desired signal level is set to 20 microvolts or less. As a practical matter, therefore, we use a low input level from the desired signal generator, usually in the range of 10 to 20 μV. Even so, there are a few high-performance tuners with alternate channel selectivity as great as 90 or even 100 dB. This is completely unmeasurable, and we have to content ourselves with noting that fact.

The standard also recognizes that many tuners have an asymmetrical i-f band-pass response, so that the selectivity ratings above and below the desired signal frequency can be quite different. In this case, the two decibel figures can be given or they can be averaged. It is not uncommon to find a difference of 20 dB or so between the two measurements, but their average is still fairly representative of the tuner's actual performance.

Implicit in the measurement is an accurate knowledge of the generator frequencies, or at least their spacing. Few FM signal generators are calibrated well enough to allow an accurate 400-kHz separation to be read directly from their dials (and fewer still are suited to making a 200-kHz measurement). Consequently, a frequency counter is usually required to monitor the interfering generator frequency. Also, depending on the tuner's characteristics, the interference audio output may not be a clearly identifiable 1000-Hz tone. It is often mingled with interfering noises that can completely obscure the audio tone. The standard calls for the use of a 1000 Hz band-pass filter in the tuner output. The measurement is therefore of the interfering generator's modulation, not from any spurious heterodyning effect. We use a spectrum analyzer to read the 1000-Hz output, and this gives an unambiguous reading. Occasionally, the 1000-Hz signal is so thoroughly masked by other noises that it cannot be seen at the −30-dB level; in that case, we adjust the interfering generator until the total noise output from the tuner is 30 dB below the reference modulation level (this, we feel, is within the intent of the IHF standard).

The adjacent channel measurement is easier to make, but just as difficult to do with accuracy (a small tuning error, such as 10 kHz, might have little effect with a 400-kHz spacing, but could have a significant effect on a 200-kHz measurement). Offsetting this, there is never any problem with signal levels or with recognizing the 1000-Hz tone in the tuner's output. Of course, an adjacent channel rating is unimpressive compared to a tuner's alternate channel selectivity. This is reasonable, since an i-f amplifier with a 150- or 200-kHz bandwidth cannot be expected to discriminate strongly against signals only 200 kHz removed from its center frequency. Nevertheless, it is easy to understand why manufacturers whose FM tuner products achieve an alternate channel selectivity of 80 dB or more are sometimes reluctant to publicize the adjacent channel specification, which is more likely to be 5 or 6 dB!

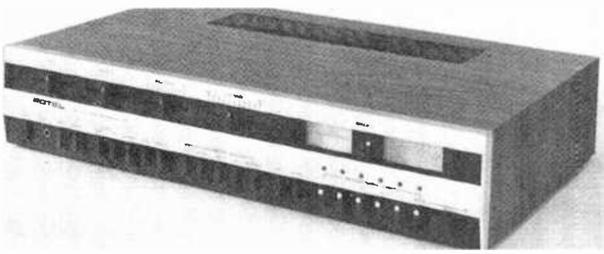
It might seem that a tuner with only 6-dB adjacent channel selectivity could not give clear reception of stations 200 kHz removed from other signals, but this is not necessarily so. The inherent immunity of FM to interference from co-channel or other signals (the capture effect) makes it possible to receive programs with little or no interference even if the two signals are on the *same* frequency, let alone spaced by 200 kHz. All it requires is that the desired signal be a few decibels stronger than the other one.

The question of how much selectivity one needs is difficult to answer, depending as it does on specific receiving conditions. We have made comparisons in the crowded New York metropolitan area with a tuner having switchable selectivity (such as the Sansui TU-9900 and Yamaha CT-7000). Since at least 50 stations are always receivable here, almost every 400-kHz channel spacing is occupied, and the range of signal strengths is considerable. Even so, we have rarely had difficulty receiving a weak signal 400 kHz removed from a much stronger one when using the "wide band" mode of these tuners (corresponding to about 15 or 20 dB of selectivity). Obviously, conditions can be imagined where one would not be so lucky, but it does offer hope to those people who cannot or will not invest in an expensive tuner and have to settle for the 50 dB or so of alternate channel selectivity that is typical of lower-priced units. If you are an FM "DX'er" there is no such thing as too much selectivity (or sensitivity either, for that matter—this being one of the few instances where sheer sensitivity can be important). Otherwise, the very high selectivity of a good FM tuner or receiver can be considered as a bit of extra insurance against possible interference between channels.

Since high selectivity, unlike high sensitivity, requires greater circuit complexity (and consequently higher cost), it is closely related to overall tuner performance. If you are looking for a single "figure of merit" for an FM tuner—a questionable approach, but one which many people employ—selectivity probably comes closest to meeting that need. □

ROTEL MODEL RX-7707 AM/STEREO FM RECEIVER

Electronic touch tuning permits preprogramming or scanning.

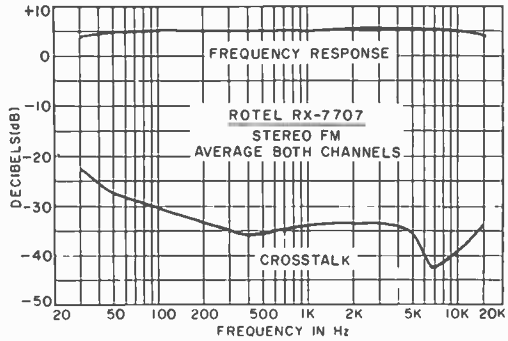


HIRSCH-HOUCK LABS REPORT

The Rotel Model RX-7707 AM/stereo FM receiver's external appearance is quite different from what we have come to expect on the U.S. market. At first glance, it resembles nothing more than an integrated amplifier because it apparently has no tuning dial. The reason for this is that the receiver is tuned electronically by means of Varactors (diodes whose capacitances are controlled by means of a dc voltage applied to them). The tuning "dial" is actually a dc voltmeter that monitors the voltage; it is calibrated in megahertz (MHz) for FM and kilohertz (kHz) for AM. Near this is a similar-size meter that indicates center-channel tuning for FM and relative signal strength for AM.

The receiver has built into it a touch tuning system that allows the user to select any one of five preprogrammed FM channels with the touch of a finger. Alternatively, the user can scan across the band in the usual manner by turning the tuning dial knob, the only rotary control on the front panel. All other controls are either horizontal slide potentiometers or pushbutton switches.

The receiver itself is rated to deliver 35 watts/channel of power into 8-ohm loads from 20 to 20,000 Hz with less than 0.5% THD. It measures 22¼"W × 12¼"D × 4¾"H (56.5 × 31.1 × 12.1 cm) and weighs 18.7 lb (8.5 kg). Value is $500.



Frequency response and crosstalk averaged for both channels in stereo FM.

General Description. The main operating controls are four horizontal slide-type potentiometers arranged end-to-end across the top-left two thirds of the front panel. They include the BASS and TREBLE tone and BALANCE controls, all of which are detented at their center positions, and the undetented VOLUME control. The right third of the upper part of the panel contains the two meters, between which is a green LED that glows when a stereo FM signal is received.

Across the bottom of the panel are 15 black pushbutton switches. These control POWER, SPKR-1 and SPKR-2 selection, LOW and HIGH FILTER, LOUDNESS compensation, MODE select, tape MONITOR in/out switching, FUNCTION selection, and AFC and MUTING in/out switching. The five source selector switches in the FUNCTION group are labelled AUX, PHONO, AM, FM, and FM STEREO.

Directly to the right of the plain black pushbutton switches are what appear to be six more pushbutton switches with small metallic "bumps" on them. Actually, these are fixed contactors for the FM TOUCH TUNING system. They are labelled 1 through 5 and MANUAL. At the far right of the lower portion of the panel, next to the FM TOUCH TUNING buttons, is the AM/FM tuning knob. The last item on the front panel is the PHONES jack, located to the right of the POWER switch.

Touching any of the button contacts in the touch tuning system causes a green light above the touched button to light. Recessed into the bottom of each of the tuning "buttons" is a small knob that allows the user to pretune to an FM channel. Thereafter, whenever a given button contact is touched, the FM tuner automatically switches to the preselected channel, whose frequency is indicated on the tuning "dial" meter. To defeat the touch tuning system, the user simply touches the contact on the MANUAL button, which transfers tuning control to the tuning knob. Each time the receiver is turned on, it automatically goes into the MANUAL mode.

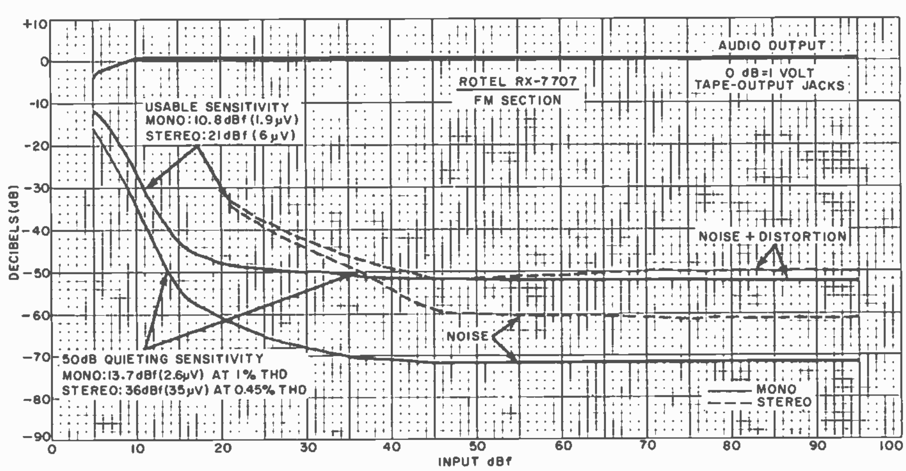
Not only is the switching action of the touch tuning system silent, the receiver's audio also mutes the instant a contact is touched and gradually comes on again over a period of a few seconds after it has reached the selected frequency. The muting action is equally smooth and silent in manual tuning, with not a trace of noise. The instructions state that the afc should be defeated when using the touch tuning system, presumably to avoid accidentally locking on to a nearby signal in the event there should be a small tuning error.

Spring-loaded insulated clips are used for the 300- and 75-ohm FM and AM wire antenna connectors and the two pairs of speaker outputs. The preamplifier outputs and main amplifier inputs are joined together by jumper links. There is also a coaxial socket for a 75-ohm FM antenna feeder and a hinged AM ferrite rod antenna. Both of the accessory ac outlets on the rear apron are switched. Finally, the receiver is supplied in a walnut-grained vinyl-clad plywood cabinet.

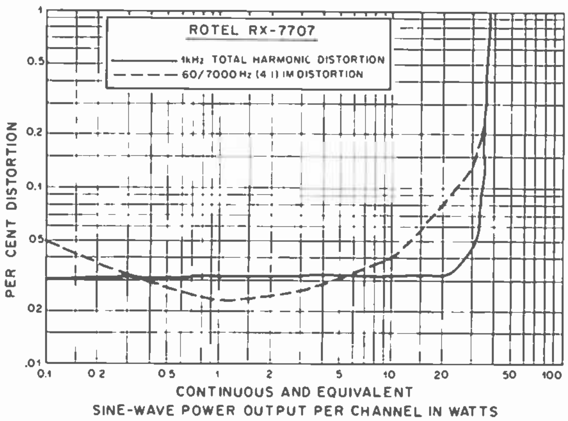
Laboratory Measurements. Following the usual one hour preconditioning period at one-third rated power and five minutes at full power, the audio amplifiers clipped at 35.3 watts/channel driving 8-ohm loads at 1000 Hz. The clipping point was 39.7 watts into 4 ohms, and 23.3 watts into 16 ohms. The 1000-Hz THD was a constant 0.032% from 0.1 watt to 20 watts output. It rose to 0.11% at the rated 35 watts. The IM distortion measured between 0.023% and 0.05% from 0.1 to 13 watts and reached 0.225% at 35 watts. At the rated output, the THD was about 0.1% from 80 to 2000 Hz and rose at higher frequencies, to 0.54% at 20,000 Hz. It also increased at low frequencies, to the rated 0.5% at about 27 Hz and 1.8% at 20 Hz. At half power and one-tenth power, the distortion was much less than 0.1% (typically about 0.03%) from 20 to 20,000 Hz.

The input signal required for a 10-watt reference output was 72 mV at the AUX inputs and 1.35 mV at the PHONO inputs. The respective S/N ratios were 77 and 69 dB. The phono input overloaded at 76 mV, a relatively low level though quite adequate for almost any modern cartridge.

The frequency response was flat within ±0.25 dB from 20 to 20,000 Hz with the tone controls centered. The tone controls provided a cut of about 10 dB at the frequency extremes, but the maximum boost was about 7 dB. The filters had gradual 6-dB/octave slopes, with their −3-dB points at 110 and 10,000



Noise and sensitivity curves for FM section



Total harmonic distortion and 60/7000-Hz IM distortion.

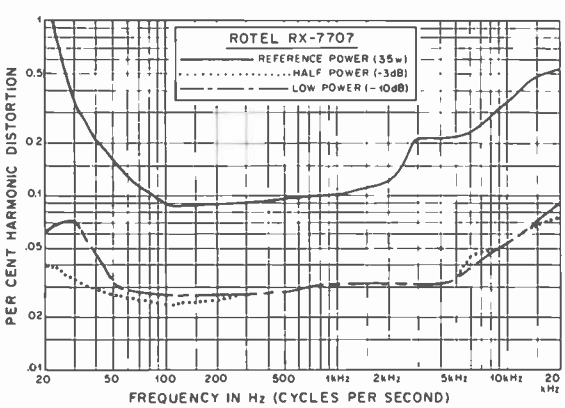
Hz. Both were relatively ineffective, removing too much program (in the case of the LOW filter) or not enough noise (in the case of the HIGH filter). The loudness compensation boosted both low and high frequencies.

The RIAA phono equalization was accurate within ±0.5 dB from 60 to 20,000 Hz and rolled off slightly at lower frequencies to −2.5 dB at 30 Hz. There was negligible interaction with phono cartridge inductance, which boosted the frequency response in the 3000-to-10,000-Hz range by about 1 dB but did not affect higher frequencies.

The FM tuner had an IHF sensitivity of 10.8 dBf (1.9 μV) in mono and a 50-dB quieting sensitivity of 13.7 dBf (2.6 μV), with 1% THD. Both figures were somewhat better than the ratings. In stereo, the IHF sensitivity was set by the switching threshold of 21 dBf (6 μV), and 50 dB quieting was reached at 36 dBf (35 μV), with 0.45% THD. The ultimate quieting at 65 dBf (1000 μV) was 71.5 dB in mono and 70.5 dB in stereo. Distortion at that input level was 0.25% in mono and 0.31% in stereo. The stereo distortion with 100-Hz modulation was 0.5% (with 6000-Hz modulation, 0.067%).

The stereo FM frequency response was within ±1 dB from 30 to 15,000 Hz. Channel separation was about 40 dB or better (the rated value) over most of the audio range up to 15,000 Hz, and it reduced to 28 dB at 30 Hz. The AM frequency response was down 6 dB at 55 and 4500 Hz. There was a moderate increase at higher frequencies, reaching a maximum at 7000 Hz before descending steeply.

The FM capture ratio was 1.6 dB at a 45-dBf (100 μV) input and a very good 1.05 dB at 65 dBf. The respective AM rejection figures were excellent at 74 dB and 68 dB. Image rejection at 100 kHz was 42 dB, slightly poorer than the 50-dB rating. The i-f selectivity was asymmetrical, with alternate-channel readings of 58 and 71 dB above and below the signal frequency. (The average of 64.5 dB was considerably better than the 50 dB rating.) Adjacent-channel selectivity was minimal, averaging 2.7 dB.



Harmonic distortion at three power levels.

The muting threshold was 25 dBf (10 μV), 19-kHz pilot carrier leakage was 68 dB below 100% modulation, and the hum level in the tuner was −70 dB.

User Comment. Preselected pushbutton tuning has been used in the past in hi-fi receivers, first with mechanical switches that connected trimmer capacitors to the tuned circuits and then with voltage-variable capacitors, like the system in this receiver. Switching without physical motion, by means of stray hum pickup from the user's body when a contact is touched (or similar means), has also been used, principally to defeat the afc when tuning in a station. A major difference between the Rotel touch tuning system and others we have seen is the former's exceptional stability.

In our experience, all previous attempts at pushbutton tuning (with the exception of synthesized or crystal-controlled receivers) have been plagued by drifting that has made return to the selected channel a random occurrence. Even without afc, the Rotel receiver was as drift-free as any receiver known to us. It never failed to return to the previously selected channel, in spite of wide temperature variations and the passage of time. As the centering of the tuning meter revealed, it simply did not drift by any detectable amount over any period of time. The smoothness and complete silence with which the system changed channels were equally impressive.

We cannot be as enthusiastic about the manual tuning mode. Although it is as smooth and noncritical as can be desired, the meter scale was quite inadequate for use in a crowded metropolitan area. It is calibrated at only 2-MHz intervals, each of which occupies about ¼" (6.35 mm) of the scale. This calls for a trial-and-error process to identify stations. The AM scale is equally crowded, although the relative signal strength of many AM stations made identification a little less difficult. We also appreciated the quietness and relative freedom from background "buzz" in AM reception.

If your FM listening is confined to fewer than six stations (the MANUAL setting can be used to preselect one more station), this receiver can be one of the easiest and most pleasant ones to use.

As our tests reveal, this receiver does not have exceptional specifications in its price class. We've come to expect higher power output, for example. They are, however, quite satisfactory for most listening conditions, as borne out by our actual listening efforts on a variety of program material. Where it shines is in user convenience. So, if you are concerned with sound quality, rather than specification numbers, the Model RX-7707 is a first-rate receiver, assuming you are not using very-low-efficiency speakers or have a very large, highly sound-absorbent listening room.

CIRCLE NO 101 ON FREE INFORMATION CARD

GARRARD MODEL DD75 DIRECT-DRIVE RECORD PLAYER

Moderately priced single-play manual turntable.

HIRSCH-HOUCK LABS REPORT

The Model DD75 is the first direct-drive turntable to bear the Garrard name. Compact and attractive, it is a relatively inexpensive ($229.95) single-play manual player. Its only concessions to automation are an end-of-play arm lift that is initiated by a photocell under the motorboard and a motor shut-off.

The player is supplied on a teak veneer wooden base to which is attached a plastic dust cover that can be left open at almost any angle or be completely removed. The entire turntable is supported on four compliant rubber feet that isolate it from external vibration. Operating speeds are 33⅓ and 45 rpm directly from the shaft of the eight-pole dc servo-controlled drive motor, which also serves as the record spindle.

With its cover closed, the record player measures 17¼"W × 14⅞"D × 6¼"H (43.8 × 37.8 × 15.9 cm). Weight is 16 lb (7.3 kg).

General Description. The player's machined die-cast nonferrous platter measures 12" (30.5 cm) in diameter and weighs 4 lb (1.8 kg). Stroboscope markings on the bottom of the platter are internally illuminated and can be viewed from above the player through a mirror and window arrangement. A vernier speed (PITCH) control permits a limited speed adjustment range. While a single knob is used for the PITCH control on both speeds, separate rings of stroboscope markings are provided for the two speeds.

The power to the turntable is turned on and off by means of a push-push switch located near the stroboscope viewing window at the left-front of the motorboard. A red LED near the power switch lights whenever the power is turned on.

Most of the remaining controls are grouped across the right-front of the turntable. From left to right, these include the PITCH control, speed-selector pushbutton, momentary-action motor STOP and START pushbuttons, and a small CUE lever.

The S-shaped tonearm has a screw-on counterweight that has a stylus pressure scale on it with a 0-to-3-gram range in 0.5-gram intervals. After the arm is balanced, the scale is zeroed and the entire weight is rotated to align the mark for the desired force with a mark on the arm's tube.

Near the base of the tonearm is a small antiskating force dial that has separate scales for elliptical and CD-4 styli. The combined rest post and retaining clip for the tonearm is located just forward of the base on the tonearm.

The plastic cartridge shell slips in and out of the front end of the tonearm. A cartridge mounting jig simplifies the initial overhang adjustment. The friction of the tonearm is rated at 15 mg (0.015 g) both horizontally and vertically. The minimum recommended tracking force is 0.75 gram.

Laboratory Measurements. Installing and adjusting a Shure Model M95ED phono cartridge in the tonearm of the player was a simple and straightforward procedure. After balancing the tonearm according to the instructions provided with the player, we noted that the tracking force dial's calibrations were exact. The tracking error was very low over most of the record, measuring from 0 to 0.33°/in. for radii from 2½" to 4" (6.35 to 10.16 cm). It increased to a maximum of 0.7°/in. at a 6" (15.24 cm) radius. Coming at the outside of the record, this is not a serious error. The error could probably have been reduced by readjusting the stylus overhang, but we chose to set this critical dimension with the supplied jig as closely as possible by eye, just as any other user would.

The antiskating dial, which can be adjusted while playing a record (a very desirable feature), had to be set slightly higher than the tracking force for equal distortion in both channels. At the 1-gram force we used, a 1.5-gram setting was optimum. The tone arm lift was very abrupt, bouncing the pickup and shifting its lateral position. However, when the lift lever was held firmly and moved slowly to the rear (up) position, instead of flipped like the toggle switch it resembles, the lift was slow and accurate. In either case, the well-damped descent brought the arm down without any shift in position.

The measured capacitance of the arm and cable wiring was 100 pF, an ideal value for CD-4 cartridges. The low-frequency arm resonance was at 8 Hz, with a 6-dB amplitude. This is close to the optimum frequency for tracking warped records. However, the resonance was very broad, giving a boost of 7 dB at the 4-Hz lower limit of the test record, which would seem to negate some of this advantage.

At 33⅓ rpm, the turntable speed adjustment range was +0.8 to −3.5%; at 45 rpm it was from +6.3 to −2.5%. The speeds did not change with line voltage. However, the visibility of the stroboscope markings was quite poor. The unweighted rumble was exceptionally low, measuring −38 dB with vertical components included, and −44 dB with the vertical response cancelled by paralleling the cartridge outputs. With ARLL weighting, the rumble was −60 dB, a typical but not exceptional figure for a direct-drive turntable. Spectrum analysis revealed that the rumble was predominantly in the 5-to-10-Hz region, probably accentuated by the resonance of the tonearm. The combined wow and flutter was 0.065% (unweighted rms), while the weighted rms flutter was 0.05%. These figures cannot be compared with the manufacturer's rating of 0.04% weighted peak flutter, due to the different measurement systems employed. Similarly, the rated −70 dB rumble is based on the DIN "B" standard, which gives "better" readings than the ARLL weighting.

The immunity of the turntable to base-conducted vibration was about average for a direct-drive player. Its only significant response was at 30 Hz, which is unlikely to be excited by most loudspeakers; so, for all practical purposes, it is isolated from the possibility of acoustic feedback. (Many players have a significant response at frequencies of a few hundred hertz, giving rise to the "howling" type of feedback if they are placed too close to the speakers.)

User Comment. In spite of its relatively low price (for a direct-drive turntable) the Garrard Model DD75 is an excellent performer. It should be considered as a purely manual record player, even though the automatic end-of-play shut-off worked as intended. (The power must be shut off manually, however, since the automatic operation merely turns off the motor drive.) The very low unweighted rumble of the turntable makes the possibility of overloading either the amplifier or the speakers at subsonic frequencies very remote.

We had mixed feelings about the arm cueing device, although it functioned superbly when moved with deliberation. The temptation to flip the control is powerful (since it moves with a toggle-like action, and the instructions do nothing to dissuade the user of that notion), and the result is an excessive arm bounce and position shift. Otherwise, the arm handled beautifully, and could hardly be better for upper-medium-priced cartridges such as the Model M95ED we used. (Of course, it is equally well suited to more compliant cartridges, since no cartridge can be used at forces lower than the 0.75-gram rating of the arm.)

The dust cover remained open at angles less than 90° to the horizontal, but it had no restraint when it was moved past vertical, where it had a tendency to fall over backward. If the turntable is placed near a wall or other surface, this will present no problem. But where no restraint is available, the cover can fall back until it contacts the rear edge of the base (about 135° from its normal closed position). The blonde teak finish of the base, we felt, was a welcome departure from the conventional walnut or black finished turntable base.

Although there are a number of direct-drive record players in the same general price range as the Model DD75, this one is "different" enough in styling and handling "feel" to stand out from the crowd. Its overall performance is as appealing as its appearance, and it is one of the easiest record players to set up and adjust that we have seen. Altogether, it is an auspicious entry by Garrard into the direct-drive field.

CIRCLE NO. 102 ON FREE INFORMATION CARD

news HIGHLIGHTS

Home Television Programmer

RCA has announced its entry into the video game field with the introduction of a home TV programmer called "Studio II." With national distribution scheduled for the middle of 1977, the product can be programmed to reproduce games and instructional material on the screen of any size black-and-white or color TV set. A control console is connected to the TV antenna terminals and contains two keyboards for the players. Heart of the programmer is a COSMAC microprocessor, with

five games built into the control console and provision for add-on cartridges containing other games and educational programs. The five built-in programs are bowling, freeway (car racing), patterns, doodles, and a competitive math game. Add-on cartridges come in three series: TV School House, TV Arcade, and TV Casino. Optional retail price of Studio II is $149.95. Add-on cartridges are priced at $14.95 and $19.95.

Touch-Activated Controls

Touch-activated switching can now be used by hobbyists or evaluated by product designers with a new TouchControl kit offered by AMI (American Microsystems, Inc.). The $29.95 kit consists of a pre-wired control panel, instructions, and what is said to be the first microcircuit that is available off-the-shelf for operating touch-activated (body-capacitance) control panels. Up to 16 touch-switches can be operated with a single IC, which can be interfaced with virtually any electrically operated product or apparatus, including computers, TV sets, other home-entertainment systems, appliances, power tools, games, machines, keyboards of all types, etc. The switches, which combine conventional capacitance-sensing touch controls with a MOS IC, are electrically safe because of an insulator layer separating the circuitry from the touch surface.

10 Million CB Radios Sold

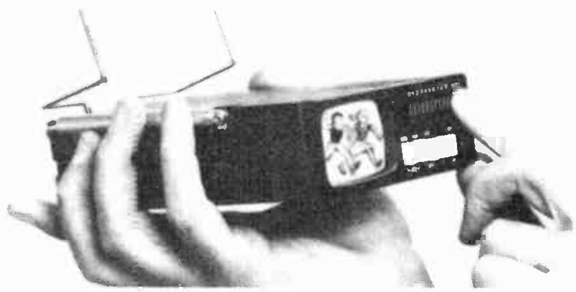
More citizens band radios were sold last year than in all the previous 28 years since the birth of CB, according to the Electronic Industries Association. Sales were said to approach the 10-million mark for the year, more than double the record volume set in 1975. Total dollar value of CB radios, antennas and accessories was set at over $2 billion. The CB industry estimates that only about 3 million CB sets were sold between 1958 (when the FCC set aside 23 channels for citizen use) and 1973, when sales started a rapid rise due to wide publicity given to CB use in the truckers' strike and gas shortage. Sales were over 1 million in 1973, doubling each year thereafter, reaching nearly 5 million in 1975.

Computerized Prescriptions

An automated system for dispensing drug prescriptions by independent chain pharmacists has been launched in several cities by the Healthcom subsidiary of A.C. Nielsen. The Unidrug System features automatic bookkeeping and inventory control, and can provide a "patient profile" (an individual patient's one-year prescription-drug-use history). Estimated cost, based on 3,000 monthly prescriptions, is 20¢ per prescription.

World's First "Pocket" TV

The tiniest TV receiver yet has been introduced by Sinclair Radionics, Inc. Called "Microvision," it measures only 4"W × 6"D × 1½"H (10 × 15 × 4 cm) and weighs about 1½ lb. Featuring a 2" diagonal electrostatic deflection picture tube with a low-power heater that has a 15-second warmup time, power dissipation is said to be extremely low. Four 1.5-V AA nickel-cadmium batteries have a claimed life of four hours per charge and they can be recharged with a supplied adaptor while being operated from house current. Solid-state circuitry includes keyed agc, flywheel sync, black-level clamping, and automatic frequency control. Four printed-circuit board modules plug together to simplify servicing. Pushbutton switches permit selection of British, Euro-



pean or USA standards, so it can be used anywhere in the world. Audio output is 50 mW to the internal speaker or an earphone can be plugged in. The black-and-white picture when viewed from one foot, is said to be of equivalent size and brilliance to that of standard portables at a distance of six feet. Includes two built-in antennas (vhf and uhf). $300.

Unique full-function 8-digit wrist calculator... available <u>only</u> as a kit.

A wrist calculator is the ultimate in common-sense portable calculating power. Even a pocket calculator goes where your pocket goes—take your jacket off, and you're lost!

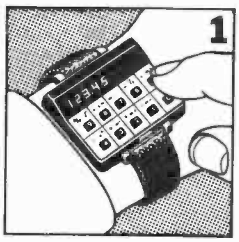
But a wrist-calculator is only worth having if it offers a genuinely comprehensive range of functions, with a full-size 8-digit display.

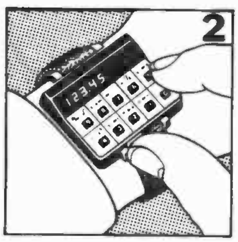
This one does. What's more, because it *is* a kit, supplied *direct* from the manufacturer, it costs only a very reasonable $19.95. And for that, you get not only a high-calibre calculator, but the fascination of building it yourself.

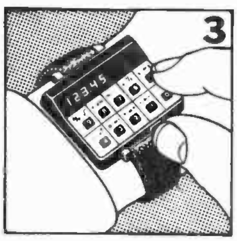
How to make 10 keys dothe work of 27

The Sinclair Instrument wrist calculator offers the full range of arithmetic functions. It uses normal algebraic logic ('enter it as you write it'). But in addition, it offers a % key; plus the convenience functions $\sqrt{x}$, $1/x$, x^2; plus a full *5-function memory.*

All this, from just 10 keys! The secret? An ingenious, simple three-position switch. It works like this.







1. The switch in its normal, central position. With the switch centered, numbers—which make up the vast majority of key-strokes—are tapped in the normal way.

2. Hold the switch to the left to use the functions to the left above the keys. . .

3. and hold it to the right to use the functions to the right above the keys.

The display uses 8 full-size red LED digits, and the calculator runs on readily-available hearing-aid batteries to give weeks of normal use.

Assembling the Sinclair Instrument wrist calculator

The wrist calculator kit comes to you complete and ready for assembly. All you need is a reasonable degree of skill with a fine-point soldering iron. It takes about three hours to assemble. If anything goes wrong, Sinclair Instrument will replace any damaged components *free*: we want you to enjoy assembling the kit, and to end up with a valuable and useful calculator.

Actual Size

KIT ONLY $19.95

Contents

Case and display window.
Strap.
Printed circuit board.
Switches.
Special direct-drive chip (no interface chip needed).
Display.
Batteries.

Everything is packaged in a neat plastic box, and accompanied by full instructions. The only thing you need is a fine-point soldering iron.

All components are fully guaranteed, and any which are damaged during assembly will be replaced free.

The wrist-calculator kit is available only direct from Sinclair Instrument. Take advantage of this 10 day money-back offer.

Send the coupon today.

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Hicksville, N.Y. 11801

To: **Sinclair Instruments Inc.** PE-4
6 Commercial Street
Hicksville, NY 11801

Please send me

_____ Sinclair wrist calculator kit(s) at $19.95 $__________

Sales tax (NY residents) __________

Shipping & handling ($2.50 per unit) __________

Enclosed is check/MO (payable to Sinclair Instruments Inc.) TOTAL $__________

Name ______________________

Address ______________________

City ______________________

State ______________ Zip __________

I understand that you will refund the purchase price of the kit in full if I return it in saleable conditiion within 10 days of receipt.

Popular Electronics
APRIL 1977

HOW TO DX EARTH RADIO FROM OUTER SPACE

A PRACTICAL ANALYSIS OF HOW RADIO AND TV DX'ERS CAN, ONE DAY, PURSUE THEIR HOBBY ON THE MOON OR OTHER COLONY IN SPACE

BY GLENN HAUSER

Some day in the not-too-distant future, permanent human colonies will be established in space and on the surfaces of other planetary bodies. The colonists inhabiting them will, naturally, be interested in what's happening on earth. An ideal way to find out will be to tune in domestic broadcasts from earth.

There will doubtlessly be direct communications links using giant dish antennas, but these will carry only selected programs. Here is a futuristic—but practical—analysis of how DX'ers might pick up earth broadcasts not deliberately beamed into space.

Practical Considerations. Besides the obvious limitations of receiver and antenna gain, several factors will determine which earth stations can be received. Let's take as the most likely example a DX'er on the moon. Radiated signal power, frequency, channel usage, geography, and ionospheric conditions are all important.

All signals, of whatever frequency, become progressively weaker with distance according to the inverse square law. You might think that, at a distance as great as 400,000 kilometers, hardly any signal would be left. But that isn't so! A 100,000-watt station (the common effective radiated power of U.S. FM broadcasters) would still put in a 4.5-μV/meter signal as far away as the moon—and that's plenty for any good FM tuner on the market today.

We obtain the 4.5-μV/m field strength by the standard inverse-square formula for the ideal line-of-sight case. We approach line-of-sight in the earth-moon case more closely than over single-planet paths where the curvature of the body and the distance of the radio horizon are all-important. However, atmospheric scattering before the signal enters free space will diminish the 4.5 μV/m figure by an unknown, but not unmanageable, amount. In fact, the moon is constantly bombarded by a cacophony of earth signals. The problem will not be to pull them in, but to discriminate between them.

Antennas. On the moon there is lots of room to put up the most efficient receiving antennas possible. In fact, huge high-gain arrays could be erected much more easily in the moon's one-sixth gravity. Because the apparent position

of the earth in the lunar sky varies only slightly, antennas could be permanently aimed toward earth, never having to track the planet. However, extremely directional antennas capable of picking out signals 2° apart would have to be slightly movable. Two degrees is the apparent diameter of the earth as seen from the moon—four times the size of the moon in the terran sky. Apart from this, lunar libration causes the position of the earth to oscillate very slightly in the sky.

The ideal receiving antenna for the mediumwave band, the Beverage, would be easier to build on the moon because it would weigh less and require fewer support poles. But because of the moon's greater curvature, it would be more difficult to keep it going in an absolutely straight line over several kilometers. As it receives off its end, rather than broadside, it would have to be built near the moon's limb where the earth hangs near the horizon. Alternatively, it could be run up a mountain slope so it would still point toward earth.

Earthlings seldom consider the fact that almost all transmissions, whether vertically or horizontally polarized, are broadcast into the horizontal plane. Very little of the signal goes straight up, or at angles much above the horizon. There has never been a marketable audience in those directions! True, there are occasional manned satellites, and airplanes; but they pass quickly out of range, and even most satellites are no farther over a station than their fringe-area listeners on earth.

Although the earth looks like a disc from the moon, we know it's a sphere. As seen from the moon, the earth rotates once about every 24 hours—which means there's a regular daily cycle of stations to be heard one after another, for perhaps an hour at a time, depending on the effective radiated power and the broadness of each signal beam vertically above its horizon.

The stations near the approaching and receding limb of the earth put out the most power towards the moon when the moon is near the horizon as seen from the earth. (Unless, of course, there are nulls in the stations' directional patterns where the moon happens to be.)

Frequencies. Now we come to the advantages and disadvantages of different frequency bands. Let's look at mediumwave first. We've all heard speculation about the sphere of broadcasts expanding from the earth at the speed of light, with the leading wavefront already some 55 light years distant. This sphere is announcing to the universe that creatures in the solar system have reached a technological level capable of broadcasting. Any intelligent beings of the same or greater technological level within this sphere have probably begun to acquaint themselves with human civilization as portrayed in our broadcasts. But the earliest broadcasts were on mediumwave. It turns out this is the worst band of all for reaching the cosmos—for the same reasons that it is the best one for reliable domestic broadcasting beyond the horizon! When it is night on the earth, MW signals are for the most part returned back to earth by the upper regions of the ionosphere. Relatively little of their energy escapes into space. When it is day on the earth, most of the signals are absorbed by the D layer, again preventing escape into space. For these reasons, there may be less pre-1940 AM radio from earth floating around in space than we might like. Longwave broadcasts (currently from Eurasia and Africa only) have about the same characteristics as mediumwave, except for much greater groundwave range. The greater number of superpower transmitters on LW might improve the chances for escape into space. But all is not lost, thanks to shortwave and vhf!

Back in the 1920's, shortwave frequencies were thought to be useless so all early broadcasts were on medium or longwave. Yet unintentional harmonics from mediumwave stations did get out on shortwave. In fact, it was receiving these harmonics which piqued interest in exploring the higher frequencies.

Because AM broadcasts signals are the least ideal to penetrate space, it may well be that the now-almost-forgotten shortwave simulcasts of AM stations in the 1920's and 1930's—KDKA, WLW, WIOD, and the New York flagship stations—are the signals carrying news of humanity into the cosmos. The early FM simulcasts in the 40-MHz band serve even better. This assumes that the mediumwave harmonics, shortwave and FM relays were above the MUF (maximum usable frequency) much of the time, as seems likely.

Just as the ionosphere makes possible long-distance communication between different points on earth, it is an obstacle to communication from earth to other planets. We can divide the ionosphere into three different basic conditions: transparent, refractive/reflective and absorptive. We've already noted that it's either refractive/reflective or absorptive on mediumwave. But it behaves much differently at higher frequencies. At a constantly changing shortwave frequency we find the MUF. Above this frequency, most radio energy escapes into space. Fortunately for our DX'ers in space, the ionosphere at SW is a much less reliable refracting medium than it is at MW. It is also much less subject to absorption.

On earth, the ionosphere causes such wide variations in propagation efficiency, that even the lowest power SW transmitter has an occasional chance of reaching the other side of the world. But how well are shortwave broadcasts likely to get through to the moon? When we're talking about a distance of some 400,000 km, a few thousand kilometers, one way or another is insignificant. Here is where raw power could really pay off. On earth, a great fraction of a 500-kW shortwave transmitter's output goes to waste; that's why a 5-kW station on the next frequency can be heard just as well, depending on conditions. But the 500-kW SW transmitter is going to have a much better chance of being heard on Luna than the 5-kW outlet, because the inverse square law will provide more usable signal.

SW broadcasters stick to a fixed schedule, from day to day, initiating major changes four times a year. This means that on a given day they may be putting out hundreds of kilowatts on frequencies which happen to be above the maximum usable frequency under existing conditions. So most of this radiation goes right out into space, where lunar colonists can make good use of it!

Because SW is the band which normally propagates from one side of the earth to the other, it follows that not all SW stations received on the moon would be on the visible side of the earth. The first hop or two could be bent around the "terran limb," just so the last one 'hops out' into space.

Time of day on earth has a great bearing both on terran SW frequency usage and on propagation. That is, they depend on whether the path is in darkness, in light or both. We should also consider this from our lunar vantage point. Our lunar days and nights are each 14 earth days long. As we observe the earth, we can see its phases changing at exactly the same rate that the lunar phases change as viewed from earth. This means that the proportion of the terran disc in darkness changes gradually, waxing and waning. Thus, there would be a month-long cycle of reception dominated by daytime, higher-frequency SW transmissions from the region of the illuminated limb, and lower frequencies from the region of the limb in darkness. However, since the earth is rotating through day and night each 24 hours, all countries would be 'in view' each day.

The moon has no significant ionosphere, so any changes in reception will be due to variations at the earth end of the path—except during solar disturbances, when both earth and moon receive the same effects. But the sun can still cause problems when it's quiet. It normally radiates a great deal of noise at certain frequencies. Using directional antennas trained on earth, solar noise should only be a problem when the earth is near its 'new' phase, with the terran disc a thin crescent or totally dark. That's when the sun is in almost the same direction. During total solar eclipses on the moon (by the earth, of course), both earth and sun are in exactly the same direction. We'd have the same problem on earth receiving lunar stations, if there were any, when the moon is new or eclipsing the sun.

As soon as there is a significant permanent population on the moon or elsewhere, there will be local broadcasting stations—hot targets for earthbound DX listeners, just like the remote American Forces Antarctic Network is today. The only transmitters which have operated from the lunar surface to date have been in the tens-of-watts range—just enough for communications efficiency with an orbiter, or a giant dish receiving antenna back on earth.

Next we come to the vhf and uhf broadcasting bands, which are used for television and FM radio. Under normal circumstances, these signals go off into space after they pass the 'radio horizon' of their coverage area. The ionosphere is normally transparent at these frequencies, and powers as high as 5000 kW ERP are used! Receiving such signals on the moon should be easiest of all. Furthermore, the higher the frequency, the smaller the antenna, which means a high-gain antenna can be constructed more economically at uhf than at hf.

There are circumstances when some vhf signals do get trapped in the ionosphere and sent back to earth. Sporadic E is the most common example. These swiftly moving patches of ionization, increasingly restricted geographically with higher frequencies, are the prime means of vhf DX on Earth. But from the spatial point of view, they are potential interruptors of reception. True, they could on rare occasions bring in a TV or FM signal from beyond the limb of the earth, but so what? The same station could be received direct a few hours earlier or later, as the earth's rotation brings it into position.

Another obstacle to both vhf and uhf signals penetrating into space is the occasional inversion layer causing widespread 'tropo' DX on earth. However, it's doubtful that *all* of a station's signal is trapped on earth by tropo.

"Selectivity." On vhf and uhf, the major problem is likely to be *too many* stations coming in at once—with roughly equal signal strength—on the same channels. This will be alleviated by the 'limb effect', when stations on the limb of earth at any given moment dominate since most of their power is radiated into the plane in which the moon lies. But because high-power FM and TV broadcasting is concentrated in relatively small areas of the globe (North America and Europe), there will be no way to separate stations by antenna directivity. All is not lost, however.

The FM "capture effect" would save the day when there is a significant difference in signal strength. The one strongest signal would be heard, and all the others rejected. However, this has its limits, as we can observe here on earth. There have been sporadic E openings blanketing a major portion of the United States, bringing in dozens of FM stations at the same time on each channel, and at such similar strengths that only occasionally would one rise sufficiently above the hash to be identified. It couldn't be much better at a reception point where all these stations would put through signals continuously. And the capture effect applies only to FM transmission, used for FM radio and TV audio only. TV video would be a huge conglomeration of beat bars, completely unviewable, unless we pick our targets very carefully.

Though all these stations would be reaching the moon, there still would be a great deal of DX challenge in picking individual stations out of the melange. There would be several ways to do it. The best would be to tune at a time when only one station happens to be on the air on its channel in a wide geographical area—such as the still small number of all-night TV stations in North America. But this is hardly prime-time television. Those intelligent beings somewhere in the 5-to-20 light year range from earth are most likely viewing old movies on all-night TV stations, no doubt getting an even less reliable impression of life on earth than they would get from prime-time or 'daytime' viewing, when every TV station is on the air simultaneously!

Another way to get intelligible video from earth is to pick a channel which happens to be sparsely occupied. In practice, this means the high end of uhf or the low end of vhf. In earthly terms, any station relegated to the high end of the uhf band feels it's got a raw deal, and does everything possible to move to a lower uhf channel, or preferably vhf. For example, a Washington, D.C. TV station on channel 53 recently went on channel 14 as well, where fewer people would be likely to miss it.

But for interplanetary television, those stations on isolated higher channels suddenly are at a great advantage! There's only one channel 68 station in North America (other than low-powered translators), an independent in Los Angeles running a million watts. They'll be a big draw on the moon. Down one, at channel 67, viewers can get PBS through the Baltimore station running only 650,000 watts ERP. All the lower channels have more than one U.S. station, though there are certainly times when only one is on the air, or on the visible side of the earth, or both.

A similar situation exists in Europe. British ITA from Dover would come through on European channel 66 without interference, if its paltry 100,000 watts video ERP could achieve an adequate signal-to-noise ratio at lunar distance. France's program 2 from Aurillac is on another exclusive channel, 65. This one has 500,000 watts. But all the lower uhf channels are occupied by several powerful transmitters in each country. They usually carry the same program per country, but that wouldn't keep them from mutually interfering.

Brazil is another country with some uhf broadcasting, and it is sufficiently far from North America and Europe to be the only visible uhf area at certain times. Our latest reference shows single station occupancy of channels 17, 19 and 22, though each uses only a 50-kW transmitter. Of course, these happenstance "unique" channels may be long gone by the time lunar colonists have settled and have some spare time for TV DX'ing!

Japan is the only other major uhf TV area in the world so far. Unfortunately, powers are relatively low, and the only exclusive channels are occupied by low-power stations. So getting viewable Japanese TV on the moon would be doubtful, depending on whether it was the only country on the air at a given hour, and if there was only one station on the air on a given channel.

Besides the exclusive channels on the high end of the uhf TV band, there are others at the bottom of the vhf range. For example, on 45.0 MHz video/41.5 MHz audio, there is one high-power TV station in London, and a number of lower-powered repeaters. Although these frequencies are used for two-way communication in other parts of the world, nowhere else on earth are there TV stations on these frequencies. Also, it's unlikely that any of the interference sources would have a power output approaching 200,000 watts. Unfortunately, this BBC channel is considered antiquated and due to be phased out in favor of uhf.

Another maverick TV station that might be seen on the moon better than in most of Australia is the only station in the world on 138.25/143.75 MHz, Australian channel 5-A—ABWN, with 100/20 kW of output, at Wollongong, N.S.W.—if *it* still exists. The forces of standardization are cruel! Actually, the 2500-MHz Instructional Television Fixed Service band (as it is called in the U.S.) is at a more favorable frequency range for interplanetary DX than even uhf TV. Unfortunately, powers are low and directionality is extreme, so like TV microwave links on even higher bands, it's doubtful that they could be seen at lunar distances.

Lest you think this is all too far-fetched, ham operators have been working each other by EME (Earth-Moon-Earth) or "moonbounce," for many years—with the limitations on power inherent in amateur radio. If hams can make contact by reflecting off the moon on the 432-MHz band (near channel 14) as well as 1296-MHz band (above channel 83)—frequencies at which a large fraction of the transmitted power is absorbed and scattered—it seems a certainty that broadcasting stations with much higher power could be received on the moon. In fact, there's a marginal chance that intercontinental uhf TV DX (at least the audio channel) would be possible via moonbounce. The best way to find out would be to dedicate a huge radio telescope to moonbounce TV DX during the brief periods when the moon is in a favorable position.

Certain channels in the FM educational band (88–92 MHz) contain only one powerful station in North America along with many lower-powered ones. This means that the one strong station would be essentially free of interference on the moon due to the capture effect. For example at 88.1 MHz (which is avoided by FM stations in most areas because it is close to TV channel 6) there is a single 98-kW station: WMPR, Sumter, SC. The next strongest at that frequency is in Lubbock, TX, with only 18.5 kW. At 89.1 MHz, there is the 100-kW WVWR in Roanoke, VA, which is followed by an 11-kW station in Schenectady, NY.

It's a safe bet that these stations haven't realized what a potential competitive advantage they have in space! Even greater advantages are held by some Canadian stations operating what the U. S. calls "Class A" channels. U. S. stations are uniformly limited to 3kW, while Canadians such as CKY-FM, 92.1, in Winnipeg runs 360 kW; CKSO-FM, 92.7, Sudbury, has 100 kW; CBW-FM, 98.3, Winnipeg, 354 kW; CBZF, 102.3, Fredericton, 100 kW. A number of other Class-A channels harbor more than one high-power Canadian.

It's a shame that no lunar expedition to date has included a multi-band receiver to check for Earth DX. The Manned Spacecraft Center informed me they were aware of no such experiment, although ESP definitely was tried!

Relays and Receivers. Once there are permanent habitations on the moon and travel there becomes more routine, it will be hard to resist using it as a relay base for international broadcasting. There may be international treaties preventing it, but this is not a real obstacle. A station doesn't need to reveal where it is being relayed from. Radio Moscow never admits that it is relayed from two sites in Bulgaria, for example, so why not set up a lunar relay, using FM on the 25-MHz band? Of course, a lunar relay site would be useful only 12 hours a day when the moon is in view—and the 12 hours would shift over the entire 24-hour day during a month's time.

The BBC keeps putting up new relay sites, despite budget cuts, so the moon is a logical projection of this trend. Again, should there be any political reasons for broadcasting from the moon without admitting it, the BBC also has a precedent—its regular use of relays by the VOA, never specified as such in its published schedules.

The far side of the moon is the ideal place to monitor for broadcasts from other civilizations, for only on the far side is the cacophony from earth shielded. However, even on the near side, it may be possible to receive messages from other worlds. This is an improvement from trying to do it from earth. But there's another reason. We take our basic unit of time, the second, completely for granted, though it is arbitrary. There is really no chance at all that any other civilization would have precisely the same time unit, unless they derived it after hearing our broadcasts. Thus, any physical quantities involving time, such as radio frequency, would not be in increments referenced to our seconds. This means that even if they used the decimal system (which is another unwarranted assumption), and used the same absolute frequency band for FM broadcasting (88–100 MHz), their channel spacing would inevitably be different from ours. Two hundred kHz is 200,000 cycles per second, and their cycles would be measured against something other than a second! Therefore, most or all of their transmissions would be on what DX listeners call "split" frequencies—allowing them to be heard between earth-based frequencies.

Cities in space would encounter exactly the same reception conditions from earth as those on the moon. However, the logistics of antenna building and aiming would be quite different in a rotating, free-fall environment.

Earth reception on Mars or the Jovian satellites would be similar, but presents greater problems—greater distances, Martian atmospheric effects, the earth as a point source (allowing no practical discrimination between approaching- and receding-limb stations), and the fact that earth would never stray too far in the sky from the sun (a considerable noise source against the intrinsically weakened earth signals). R-f from the planet Jupiter itself would be capable of blotting out broadcast reception from earth on some frequencies. In fact, we can hear that noise right here on earth if we know where to tune and how to recognize it.

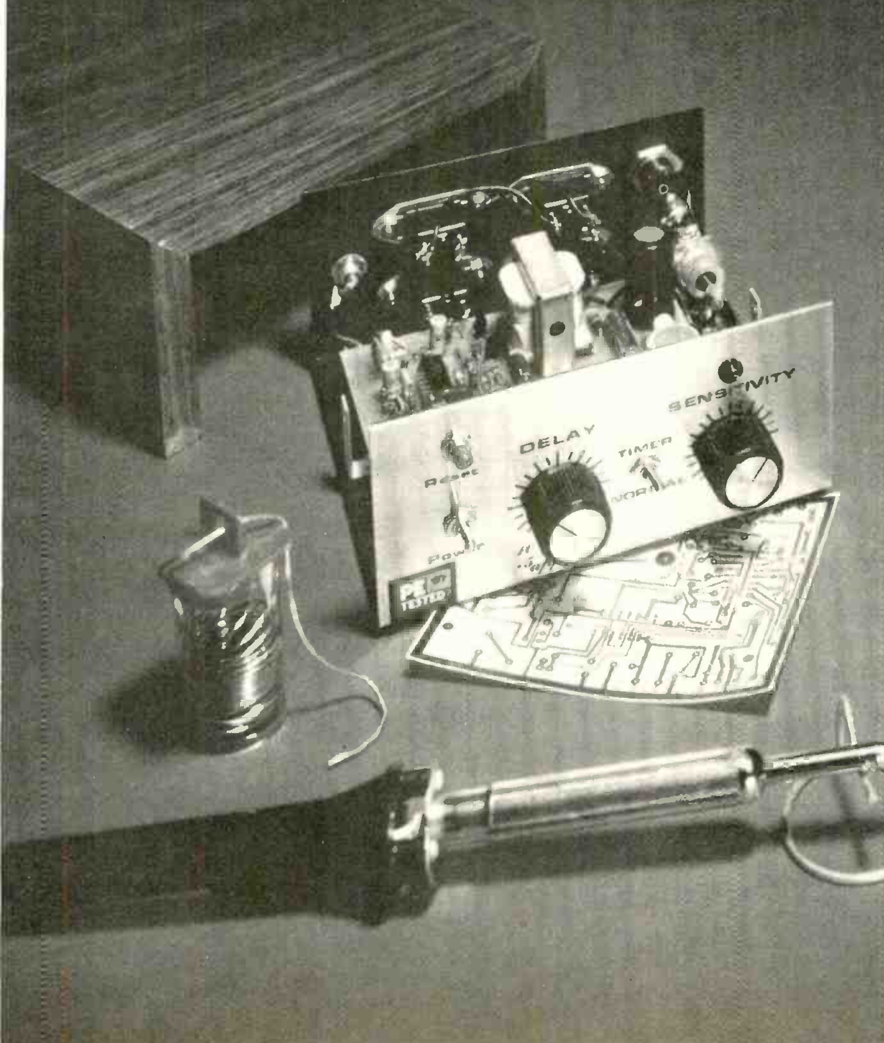
Monitoring earth broadcasts on Mars would underline the tremendous distance involved. One would presumably have an atomic clock running on earth time (UTC), but even so there would be a signal propagation delay ranging from 3 to 22 minutes. The delay would vary so widely because the distance between the two planets varies more, in fact, than the distance from earth to any other planet. If earth-based TV programs were observed to start a given number of minutes late, the distance to earth at that particular instant could be easily calculated.

People with many different avocations have walked on the moon already. It's about time a skilled DX listener/viewer had a chance. NASA and other agencies, please note—I volunteer! ◇

BUILD THE HI-FI/TV AUDIO-MINDER

- SHUTS A C POWER WHEN AUDIO ENDS
- ADJUSTABLE TIME DELAY
- CONVENTIONAL TIMER USE
- CONNECTS TO SPEAKER

BY CURT KOBYLARZ



IF YOU EVER left an expensive stereo system or a TV receiver operating all night because you forgot to shut it off take heart. Here is a low-cost, automatic shutoff controller for home entertainment equipment that does *not* require any internal circuit changes or connections. Shutoff is activated by the absence of an audio signal, not by a pre-set time interval, as with mechanical devices. Accordingly, the controller can be connected to speaker terminals or to a tape output monitor jack.

An adjustable delay system avoids premature shutoff providing the user with enough time to change a record on a manual record player or a reel of tape on a recorder before the system is turned off. Shutoff time range is 50 seconds to 20 minutes after the signal level has dropped below a predetermined setting. At about 60,000 ohms impedance, the controller will not load most circuits. Noise filtering is provided to remove AM and FM interstation hiss to ensure against false shutoff triggering when using either of these signal sources.

Furthermore, the controller can be used as a standard non-audio timer for

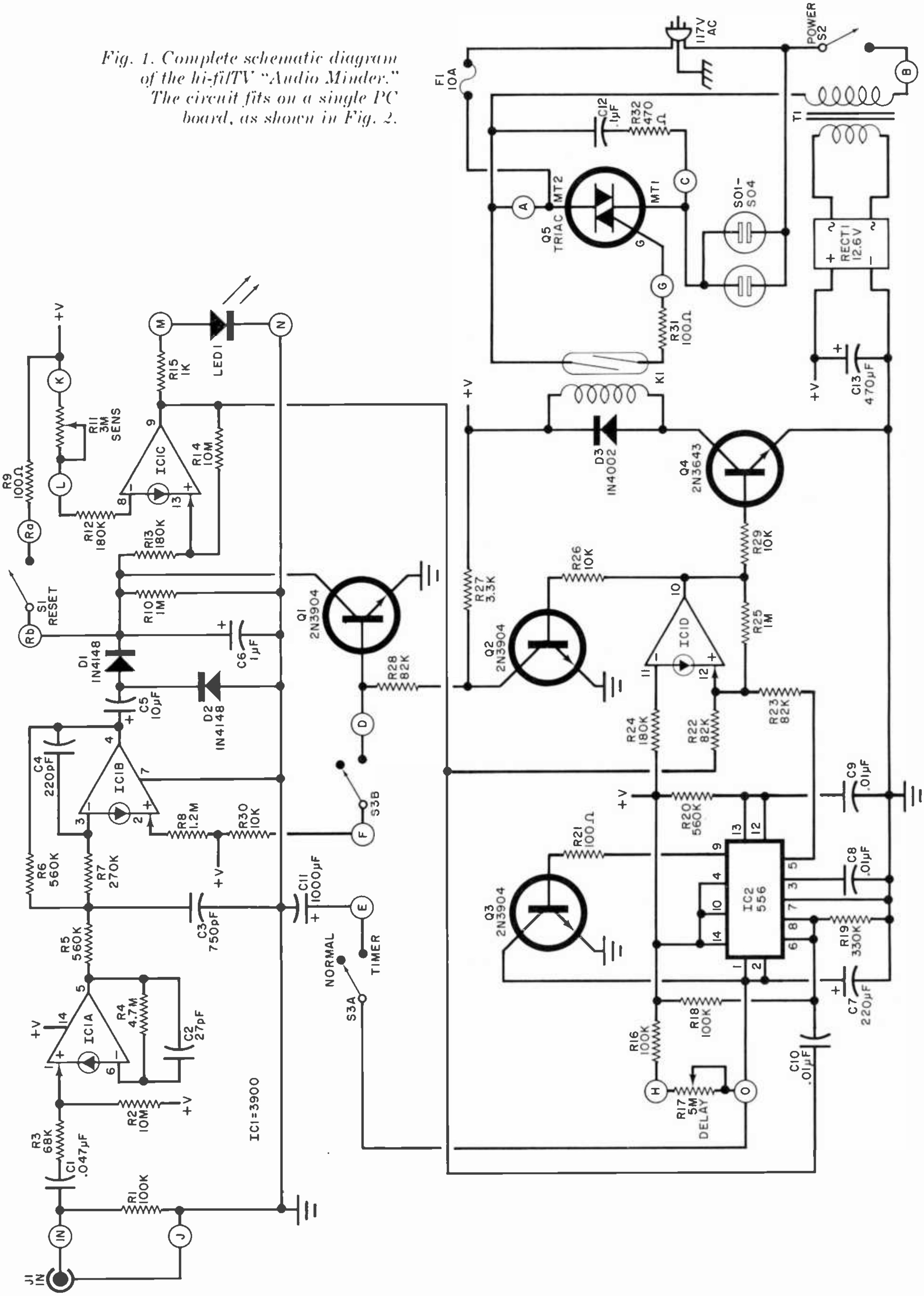


Fig. 1. Complete schematic diagram of the hi-fi/TV "Audio Minder." The circuit fits on a single PC board, as shown in Fig. 2.

PARTS LIST

All capacitors disc or Mylar unless otherwise noted.
C1—0.047 µF capacitor
C2—27-pF capacitor
C3—750-pF capacitor
C4—220-pF capacitor
C5—10-µF, 15-volt electrolytic capacitor
C6—1-µF, 15-volt electrolytic capacitor
C7—220-µF, 15-volt electrolytic capacitor
C8,C9,C10—0.01-µF capacitor
C11—1000-µF, 15-volt electrolytic capacitor
C12—0.1-µF, 200-volt capacitor
C13—470-µF, 25-volt electrolytic capacitor
D1,D2—1N4148 diode
D3—1N4002 diode
F1—10-ampere fused and holder
IC1—LM3900 quad op-amp
IC2—556 dual timer
J1—Phono connector
K1—Reed relay, 500-ohm, 12-volt coil, normally open contacts
LED1—Any light-emitting diode
Q1,Q2,Q3—2N3904
Q4—2N3643
Q5—Triac, 20-A, 200 PIV
RECT1—Full-wave rectifier bridge
All resistors ¼-watt, 10% unless otherwise noted.
R1,R16,R18—100,000-ohm resistor
R2,R14—10-megohm resistor
R3—68,000-ohm resistor
R4—4.7-megohm resistor
R5,R6,R20—560,000-ohm resistor
R7—270,000-ohm resistor
R8—1.2-megohm resistor
R9—100-ohm resistor
R10,R25—1-megohm resistor
R11—3-megohm linear potentiometer ("Sensitivity")
R12,R13,R24—180,000-ohm resistor
R15—1000 ohm resistor
R17—5-megohm linear potentiometer ("Delay")
R19—330,000-ohm resistor
R21—100-ohm resistor
R22,R23R28—82,000-ohm resistor
R26,R29,R30—10,000-ohm resistor
R27—3300-ohm resistor
R31—100-ohm, ½-watt resistor
R32—470-ohm, ½-watt resistor
S1—Pushbutton switch, momentary contact, normally open ("Reset")
S2—Spst switch ("Power")
S3—Dpdt switch ("Normal/Timer")
SO1 to SO4—Ac power receptacle (sockets)
T1—Transformer: 12.6-volts, 300-mA, PC mount
Misc.: Suitable cabinet, heat-sink material, IC sockets (optional), strain relief, press-on type, mounting hardware, etc.
Following are available from WEI, 4921 N. Sheridan Rd., Peoria, Illinois 61614: complete kit (SO-1) includes all components, PC board, metal case, power cord, ac receptacles, etc. at $39.95; PC board (SO-2) at $6.00; metal case (SO-3) at $8.50. All orders postpaid to the Continental United States only. Illinois residents please add 5% sales tax. Allow four weeks for delivery.

any electrical appliance, TV receiver, etc. up to its rated 1200 watts. In this mode, the controller will turn power off at a pre-set time ranging from 10 minutes to two hours. The complete circuit is shown in Fig. 1.

How It Works. The selected audio input is applied via phono connector, *J1*, to the first amplifier and filter *IC1A* where it is amplified and filtered with roll-off occurring about 1.25 kHz at −6 dB per octave. The second stage, *IC1B*, is a two-pole filter whose cutoff frequency is approximately 1 kHz with unity gain. The two stages combined roll off is about 18 dB per octave to remove noise and filter out any high-frequency hiss if an FM or TV station goes off the air (if this is to be the audio source).

The filtered signal is rectified to a dc level by *D1, D2,* and *C6*, with *R10* "bleeding" the charge from capacitor *C6* when a signal is not present. *IC1C* is used as a comparator having fast "snap action" (positive feedback) so that when the rectified signal applied to the non-inverting (+) input exceeds the level set by the SENSITIVITY control, *R11*, the output switches off very rapidly. Note that the 3900 op amps used here are current devices rather than voltage devices represented by conventional op amps, therefore all voltages must be converted to currents. This will explain why high-value resistors are used in many places in this circuit.

When *IC1C* output is high (audio signal present), *LED1* is turned on and current-limited by *R15*. The *IC1C* output signal also turns on the OR gate formed by *IC1D* which, in turn, causes *Q4* to saturate and draw current through the coil of the reed relay, *K1*. With the reed relay contacts closed, gate power is applied to the triac, *Q5*, and power is present across the multiple power sockets, *SO1* through *SO4*. This turns on any equipment connected to these sockets.

When the input audio signal either disappears or falls below the pre-set SENSITIVITY threshold, comparator *IC1C* switches off very rapidly. This action also starts one of the timers in *IC2* whose output (pin 5) keeps the OR gate operating until the timer times out. Power remains on the four sockets. If another audio signal should appear within the time-out interval, the second timer within *IC2* will generate a 5-millisecond pulse which will turn on *Q3* and discharge the main timing capacitor *C7*. This resets *IC2* back to zero and ensures that the last audio signal is always the one that begins the time-out delay. Transistors *Q1* and *Q2* act as a "quench" circuit by grounding the comparator signal an instant before shutdown. This is necessary because some audio power amplifiers generate a "thump" when turned off and this may retrigger the timer and never allow system shutdown.

Reed relay *K1* is necessary for complete isolation between the circuit and the triac. Snubbers circuit *C12* and *R32* protect *Q5* from line transients and surges generated when inductive loads (such as the power transformers in high-wattage power amplifiers) are suddenly switched off. The triac should be heat-sinked.

The timer function is determined by the setting of NORMAL/TIMER switch *S3*, which disables the input circuit by turning on the "quench" transistor, *Q1*, and connecting a larger capacitor (*C11*) in parallel with the main timing capacitor *C7*. Potentiometer *R17* sets the timer delay in either case, although the range for NORMAL and TIMER positions of *S3* is different.

Construction. The circuit is easily assembled on a single PC board, as shown actual size in Fig. 2, which also shows the component installation. Connections to off-board components are made via the lettered pads on the foil pattern. Note that some resistors are mounted "end up."

The triac is mounted on a metal bracket, which acts as the heat sink, and mounted as selected within the cabinet. If a metal case is used, make sure that the triac is electrically isolated, but thermally bonded to the heat sink. Use at least 18-gauge wire between the triac, power outlet sockets, and the power line. A three-wire line cord is recommended with the ground (green) lead connected to the metal chassis. Almost any type of cabinet may be used.

The switches, *J1*, potentiometers, and *LED1* can be mounted on the front panel, while the four controlled sockets can be mounted on the rear apron. Although four controlled power outlets are used, more can be added provided that the triac can handle them.

Operation. The selected audio input signal can be taken from the tape monitor output of either channel (use a "Y" connector if necessary), or di-

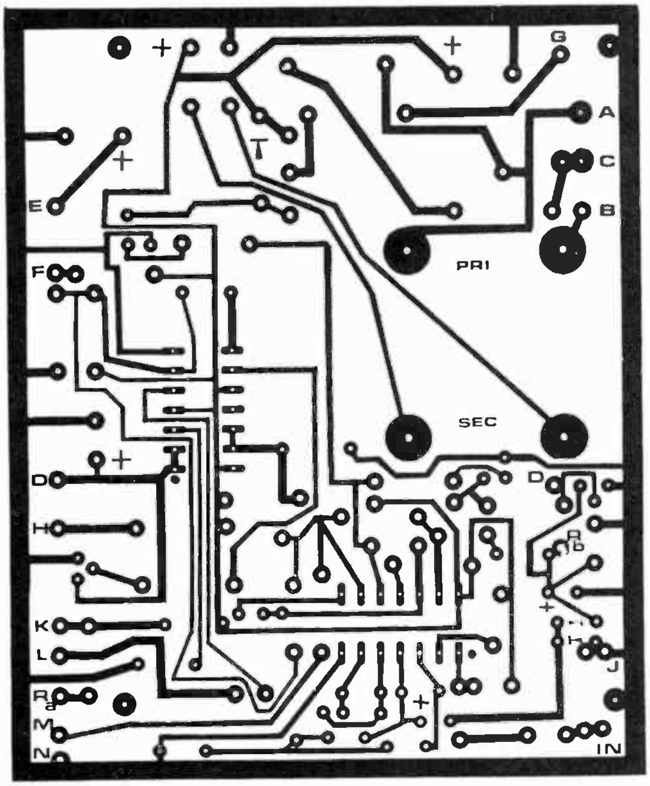
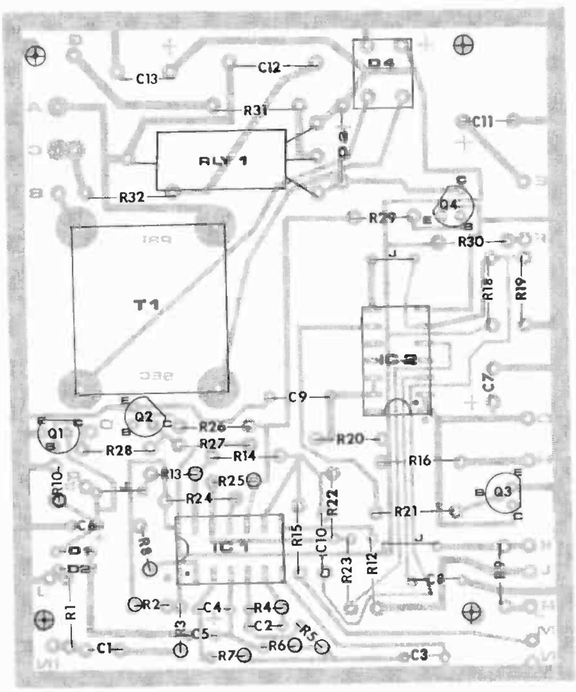


Fig. 2. The printed-circuit board's foil pattern is shown at left, while the flop side below illustrates component installation. Note that resistors installed on pads with a drawn circle are to be mounted end up.



rectly off the speaker terminals of either channel. The monitor output has the advantage of a constant level irrespective of volume control settings so the SENSITIVITY control need be set only once.

Connect the selected devices (tuner, amplifier, etc.) to the controlled sockets *SO1* through *SO4* and turn on their power switches. Connect the controller to the power line, place *S3* in the NORMAL position, and turn POWER switch *S2* on. Place both potentiometers in their mid positions, then depress RESET pushbutton *S1*. *LED1* should glow and the ac outlets should be energized. With no signal connected to *J1*, *LED1* will go out after *C6* discharges, but the delay timer will keep the outlets energized, until it times-out—determined by DELAY potentiometer *R17*.

Connect the selected signal source to *J1*, reset the controller, and adjust SENSITIVITY control *R11* until the LED remains on continuously. The DELAY potentiometer is adjusted as required. When the input signal is removed, the system should shut down after the delay period.

To shut down the system when an FM or TV station is used as the signal source and the station goes off the air, use the following setup procedure. Tune in the station and adjust the SENSITIVITY control until the LED just goes out, then bring it back until the LED remains on most of the time. Tune the receiver off-station for the hiss and observe that the LED goes out. The system is now adjusted so that it will automatically shut down after a station goes off the air for the night.

Use of the tape monitor output for the signal source is necessary when headphones are being used and the amplifier is disabled from the speakers. Since the input impedance of the controller is approximately 60,000 ohms it will not load the signal to the tape deck.

For use as a timer, place *S3* in the TIMER position, set the DELAY time as desired (10 minutes to 2 hours), and operate the RESET pushbutton *S1*. In this case, the input is not being monitored; the ac outlets will be de-energized only after the selected time interval has been reached. This mode is used to turn off any appliances or TV receiver automatically. ◈

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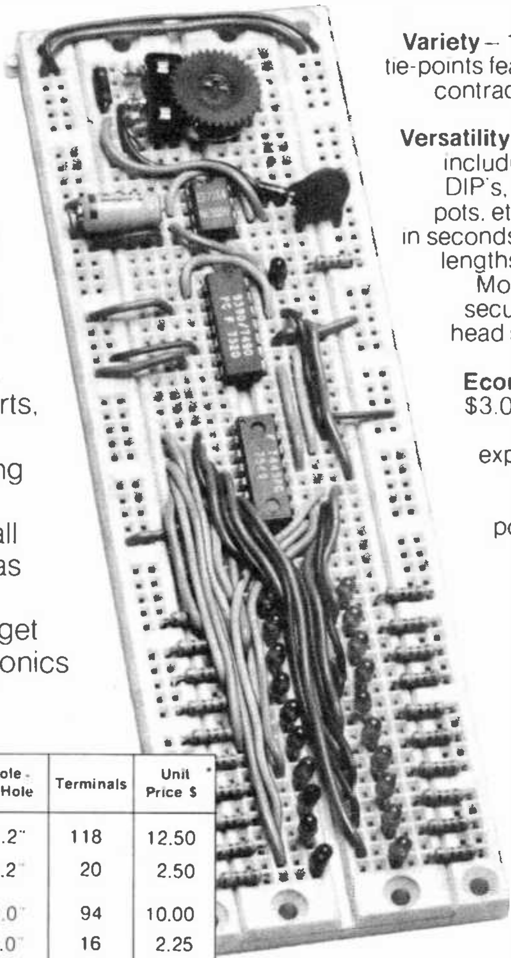

Length / Hole-to-Hole	Length	Hole-to-Hole	Terminals	Unit Price $*
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QT-59B	6.5"	6.2"	20	2.50
QT-47S	5.3"	5.0"	94	10.00
QT-47B	5.3"	5.0"	16	2.25
QT-35S	4.1"	3.8"	70	8.50
QT-35B	4.1"	3.8"	12	2.00
QT-18S	2.4"	2.1"	36	4.75
QT-12S	1.8"	1.5"	24	3.75
QT-8S	1.4"	1.1"	16	3.25
QT-7S	1.3"	1.0"	14	3.00

1.32"

.7"

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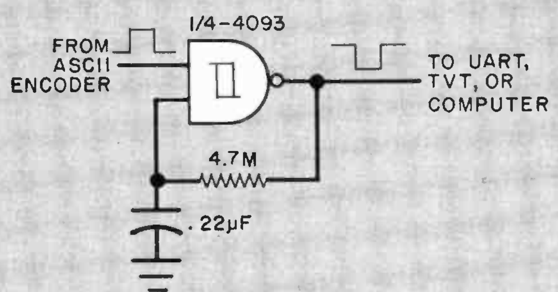
CIRCLE NO. 17 ON FREE INFORMATION CARD

SIX CMOS CIRCUITS FOR EXPERIMENTERS

Using CMOS digital integrated circuits can simplify designs, cut costs, and reduce power supply requirements. Here are six basic examples of how the use of CMOS can "do more for less"—circuits every experimenter should have in his bag of tricks.

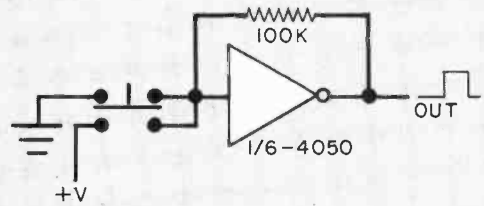
BY DON LANCASTER



Automatic Keyboard Repeat

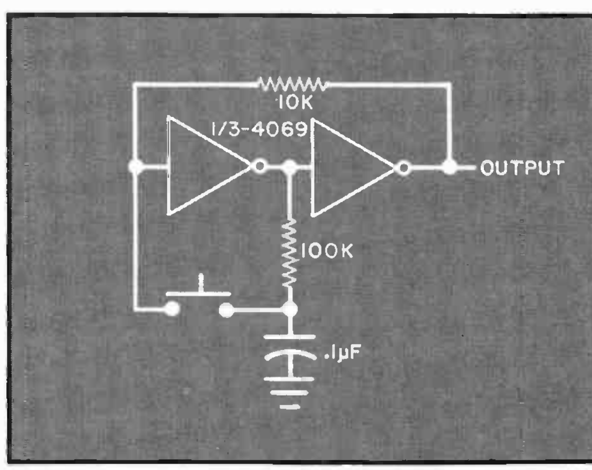
1 This circuit can be added to almost any ASCII keyboard and encoder to create a simple, low-cost repeat function. The circuit shown uses the positive output of a 2376 keyboard encoder IC to drive the negative-going input required by many UART's and TVT's.

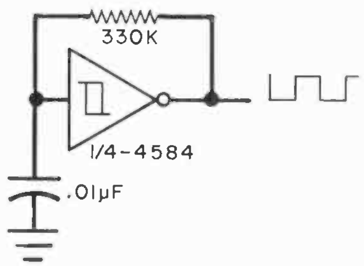
The signal from the keyboard encoder is normally low, thus this circuit has a high output. When a key is depressed, the positive-going pulse from the encoder drives this circuit output low for as long as the key is depressed. However, if the key is held down, the circuit will deliver outputs that repeat as long as you want. This is handy for cursor motions, adding spaces, etc. A one-second delay is provided between the first and second output pulses, and after that, the pulses will be repeated at a three-per-second rate. This built-in delay is created by the longer initial charging time of the capacitor, followed by the faster motion between the Schmitt trigger upper and lower trip points. You can use the other NAND triggers in the package to shorten pulses, or invert input or output.



Contact Debouncer

2 Pushbuttons and switch contacts must be debounced when used with clocked logic. Otherwise, contact noise and bounce will produce multiple "hits". The feedback resistor in this noninverting buffer circuit will hold the output in either the high or low state. The spdt pushbutton forces the circuit into one state or the other, while the latching holds the circuit in that state, during the debounce interval. Actually, the resistor can be eliminated and replaced with a short between the input and output, but this may add some current "glitches" to the power supply line. Six switches may be conditioned using the six buffers in the IC package.





Square-Wave Generator

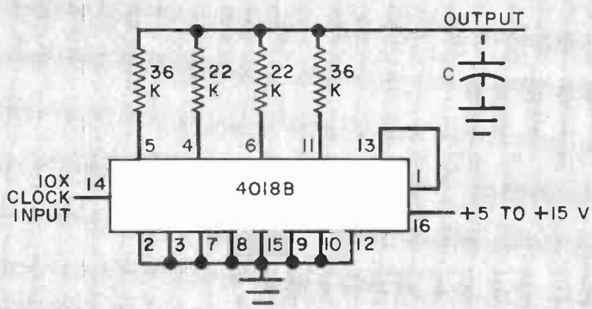
3 With the values shown, this circuit generates approximate 1-kHz square waves. When the Schmitt trigger output is high, the capacitor charges to the supply voltage through the resistor. When the voltage across the capacitor reaches the upper trip point of the Schmitt, the output drops low. The capacitor then discharges through the resistor, and when the capacitor voltage reaches the lower trip point, the Schmitt output snaps high and the cycle repeats.

The circuit is sure starting, and the output swings the full power supply level which can be anything between 5 and 15 volts. Supply current is typically 10 microamperes. Since the capacitor voltage always remains between the two trip points, no input protection is required. The frequency can be altered by selection of the resistor and/or capacitor value.

Alternate Action Pushbutton

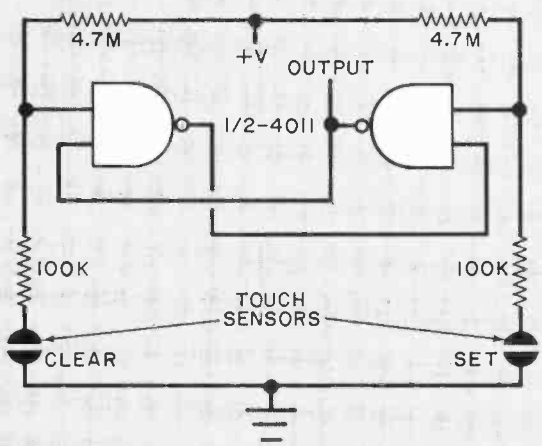
4 Each time the pushbutton switch is operated, the circuit shown here changes its output state. On one depression, the output is high; and on the next depression, the output is low. Operation is reliable and the pushbutton is fully debounced.

Despite its apparent simplicity, this is a full-fledged master-slave flip-flop with the RC network being the "master" that remembers where the output is to go. The two inverters form the "slave" latch.



Digital Sine-Wave Generator

5 This circuit uses a clock frequency 10 times the required output frequency. The walking-ring counter and resistor summing network will produce a "chunky" waveform at the output. However, you can filter this waveform since it is basically a sine wave with a little of the 9th and 11th harmonics present. You can either ignore the harmonics or use a capacitor (shown dotted on the schematic) as a filter. If desired, an active filter can be used. The unfiltered output swings the full supply voltage which can range from 3 to 15 volts.



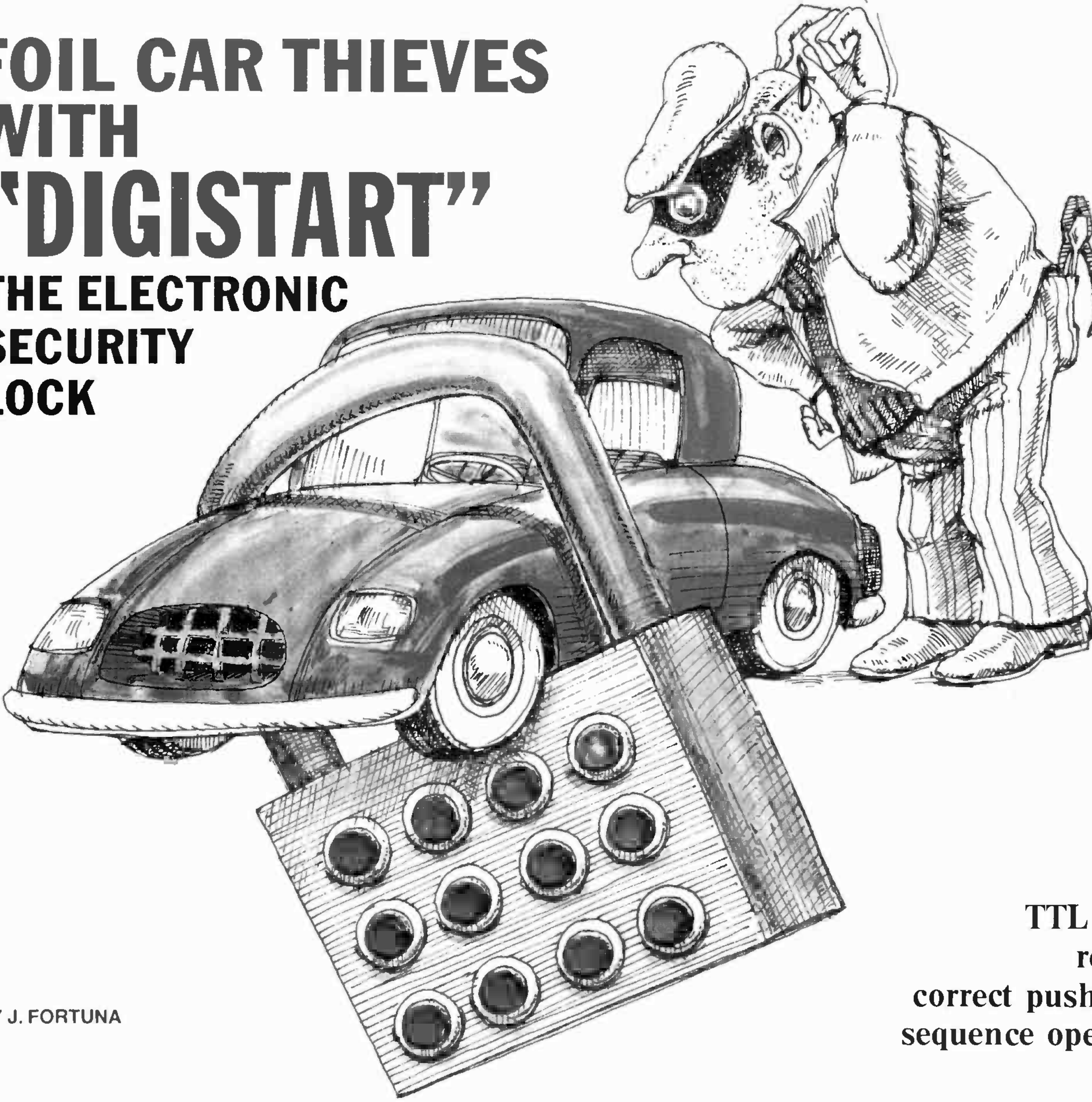
Touch-Controlled Latch

6 Short the SET contacts with your fingertip and the output goes high. Later on, if you touch the CLEAR contacts, the output goes low. In this simple set-reset flip-flop, the 4.7-megohm resistors hold the NAND gates inputs high, and are disabled when the 200,000 ohms or so of finger resistance provides the "low impedance" path to ground, to force the circuit to change states.

The touch sensors may be any type of conductive material with a slight gap between the two elements.

FOIL CAR THIEVES WITH "DIGISTART"

THE ELECTRONIC SECURITY LOCK



BY J. FORTUNA

TTL circuit requires correct pushbutton sequence operation.

DIGISTART can be used as a "keyless" security system for a vehicle or boat starter system, an electrically operated door, or any system that requires an electrical signal to activate.

This new digital security system uses a series of pushbutton switches that must be operated in a particular sequence, otherwise it will not operate. Even when the correct combination is inserted, the user must operate still another switch, and then he gets only between 5 and 6 seconds (adjustable by the installer) to activate the circuit.

Although this article uses a vehicle starter solenoid as the external electrical system being controlled, any type of 6-volt door solenoid can be activated. It can even be used to control a garage-door lifting motor, if the low-power contact relay within this circuit is used to operate a power relay whose contacts can take the current requirements of the door lifting motor.

How It Works. As shown in Fig. 1, the Digistart consists of five conventional JK flip-flops (*IC1,IC2,IC3*), whose Q-outputs are fed to 8-input NAND gate *IC4* with the three unused inputs connected in parallel with one of the used inputs. (This allows for further expansion if desired.) The output of *IC4* triggers a one-shot (*IC5*) whose on time is determined by *R6-C1.* The positive-going output from *IC5* turns on transistor *Q1* to energize *K1* in its collector circuit. When relay *K1* is energized, it completes the circuit between the system 12-volt bus, and the vehicle ignition key so that the starter solenoid can be operated.

However, for the Digistart to operate, each of the flip-flops must be "clocked" in order—left to right in the schematic, and this is done by operating the normally open pushbutton switches *S1* through *S5.* Each of these switches is connected to the clock (C) input of its associated flip-flop, and governs the flip-flop operation in accordance with the 74107 truth table shown in Fig. 2.

Initially, the system must be manually cleared by depressing one of the *S6* through *S11* "clear" pushbuttons. Once this is done, the Digistart will clear itself after each operation since the clear line is connected to the output of *IC5,* not-Q, which goes to ground after each operation. Once cleared, all the not-Q outputs will be high, and all the Q outputs will be low.

A clock pulse applied to the C input of *IC1A* (via *S1* closure and release) will cause its Q-output to go high since its unterminated J-input is high. Since the *IC1A* Q-output is connected to the *IC1B* J-input, the *IC1B* Q-output will go high when its C-input is clocked. This sequence continues down the line to *IC3.*

When all the Q-outputs are high, NAND gate *IC4* is enabled. When *IC5* gets toggled, the Q-output goes high, and the not-Q output low. This clears the

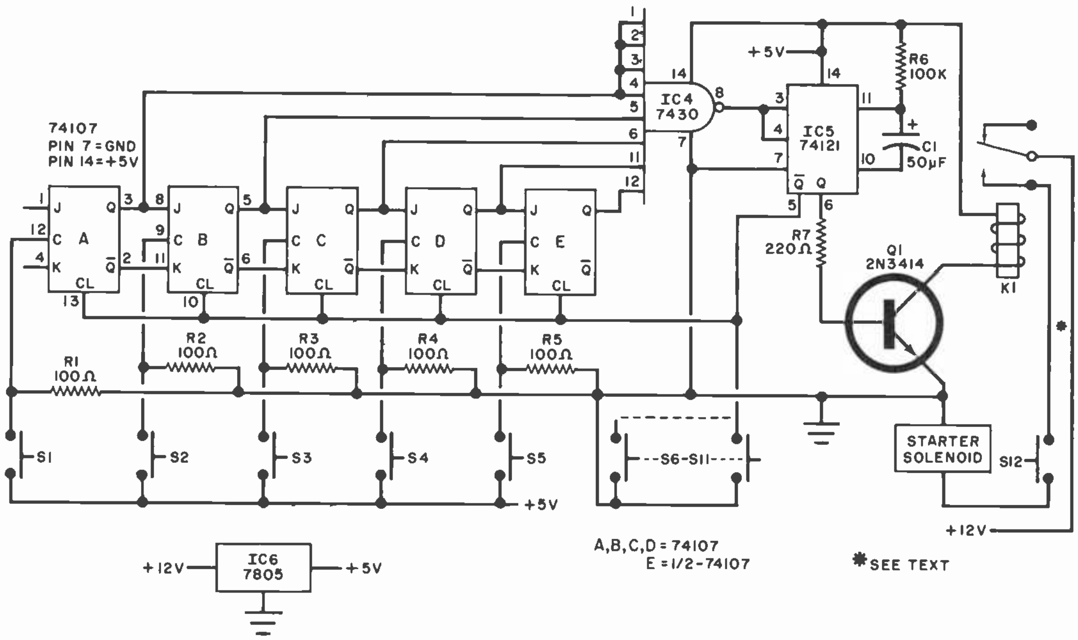


Fig. 1. Switches S1 through S5 sequentially "clock" the flip-flops and operation of S6 through S11 will shut the system down. Once activated, 5 seconds remain to start the controlled system.

PARTS LIST

C1—50-µF, 20-V electrolytic capacitor (see text)
IC1,IC2,IC3—74107 dual JK flip-flop
IC4—7430 8-input NAND gate
IC5—74121 one-shot multivibrator
IC6—5-volt regulator (7805 or similar).
K1—5-volt dc relay, spst (see text)
Q1—2N3414 transistor
R1 through R5—100-ohm, ¼-W resistor
R6—100,000-ohm, ¼-W resistor
R7—220-ohm, ¼-W resistor
S1 through S11—Normally open, momentary-contact pushbutton switch (Grayhill miniature, or similar)
S12—Spst slide or toggle switch
Misc.—Suitable enclosure, panel for switches, mounting hardware, etc.

flip-flops by the clear bus. The Q-output of *IC5* remains high for the duration of the time constant determined by *R6-C1* (which can be altered as desired). In the schematic, the time interval will be about 5 seconds. During this time interval, transistor *Q1* is saturated, and energizes *K1*. This completes the circuit to the starter solenoid—and if *S12* is held closed—the starter can be operated. When the timing interval has elapsed, the Q-output of *IC5* goes low, transistor

INPUTS				OUTPUTS	
CLEAR	CLOCK	J	K	Q	$\bar{Q}$
L	*	*	*	L	H
H	⎍	L	L	Q_0	$\bar{Q}_0$
H	⎍	H	L	H	L
H	⎍	L	H	L	H
H	⎍	H	H	TOGGLE	

*DON'T CARE

Fig. 2. Truth table for the 74107 flip-flop.

Q1 cuts off, the relay opens, and the circuit to the starter solenoid is open, thus the starter will not operate.

Note that besides the five "clock" pushbutton switches, there are six (more or less as desired) pushbutton switches that when operated, only serve to reset the Digistart and thus disable it. If all 11 switches (unmarked of course) are mounted on a small panel, the user must know which switch to operate, in what order, and if he "misses" any part of the sequence, or hits a reset switch, the Digistart will shut down.

Construction. The circuit can be assembled on a small piece of perforated board using sockets for the IC's and transistor, and small pins to support the six resistors and one capacitor.

Relay *K1* should be selected so that its contacts can handle the vehicle starter solenoid current. The wiring between the relay contacts and the starter solenoid should also be capable of handling this current. The five-volt regulator can be attached to the metal chassis for use as a heat sink.

The pushbuttons are mounted as a group on a small panel using any arrangement desired (such as that used for the prototype as shown is Fig. 3).

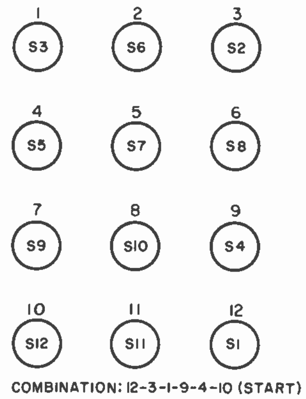
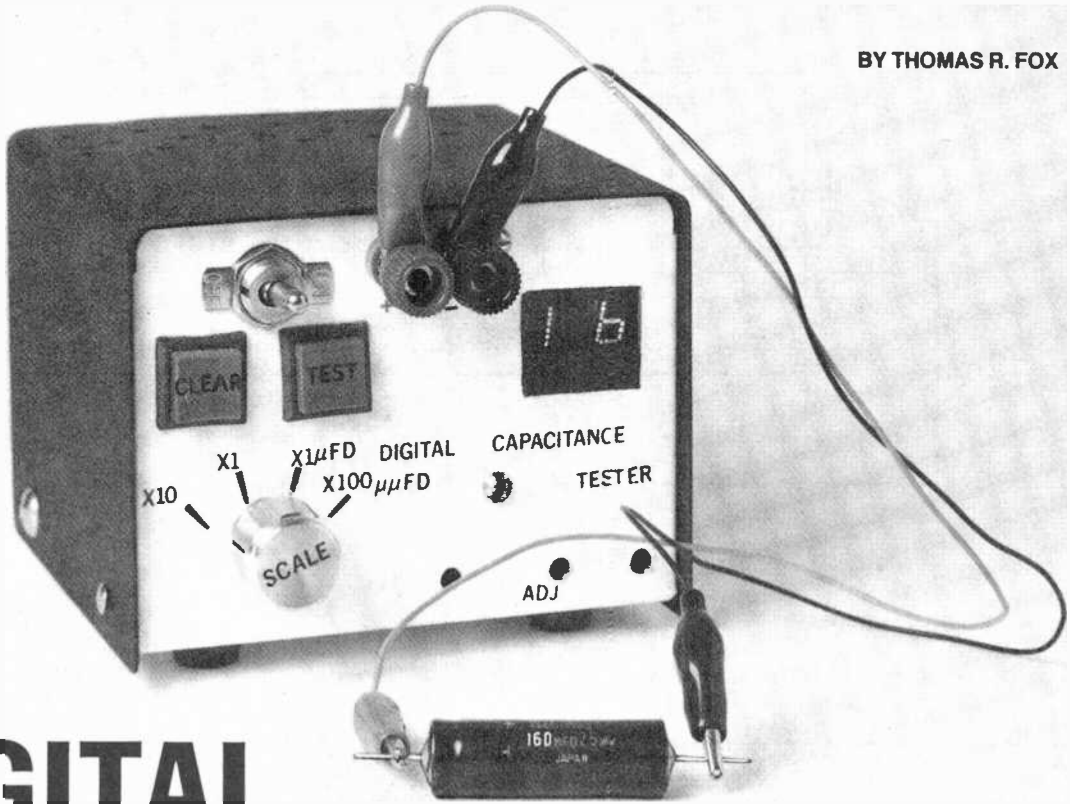


Fig. 3. Typical layout for a Digistart switch panel.

If desired, up to three more flip-flops can be added (along with their "clock" pushbuttons, 100-ohm clear resistors, using the extra inputs of *IC4*), and *S12* can be omitted. You can also elect to use two pushbuttons in series for *S12*. If you want to change the timing interval, select values for *R6-C1* in accordance with T=*RC* where T is in seconds, *R* is in ohms, and *C* is in microfarads. ◇

BY THOMAS R. FOX



DIGITAL CAPACITANCE METER

Provides digital display of capacitance from 100 pF to 1000 μF.

CAPACITORS are almost as numerous as resistors in many electronic circuits. Yet, while most of us have ohmmeters we can use to check resistor values readily, very few have instruments that check capacitor values. Although, in most cases, the actual capacitance value is not important, there are some circuits– time bases, oscillators, etc.—where the actual value of a capacitor can be very important.

The Digital Capacitance Meter described here is a simple, low-cost instrument that can be used in much the same manner as an ohmmeter to check the values of capacitors. It has a two-digit display and a measurement range from 100 pF to 1000 μF. To use it, you simply connect the capacitor to be measured between a pair of binding posts and press a button. The value of the capacitor is then indicated in the display. All test potentials are less than 2 volts. The instrument even has a low-battery alert (if it is battery powered); when the potential supplied by the battery falls below 4.5 volts, the display indicates 00.

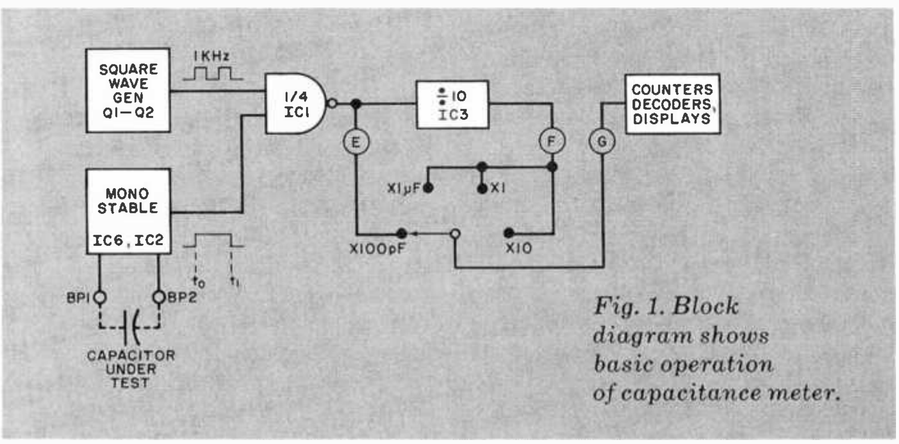


Fig. 1. Block diagram shows basic operation of capacitance meter.

Circuit Operation. The basic operation is illustrated by the block diagram shown in Fig. 1, while the complete schematic diagram is shown in Fig. 2.

Transistors *Q1* and *Q2* are arranged to form a free-running multivibrator square-wave generator that operates at about 1 kHz. The square-wave output forms one input for a two-input NAND gate (part of *IC1*), while the other gate input comes from a timer circuit consisting of *IC6* and two gates of *IC2*. The length of time that the *IC6* output is at "1" is determined by the value of the unknown capacitor connected between binding posts *BP1* and *BP2*, and the timing (range) resistor selected by one section of *S3*. With the timing resistor fixed, the time period is then proportional to the unknown capacitor value. The output of the NAND gate drops to zero only when both inputs are positive. Because the 1-kHz square waves are now gated by the timer duration, only the amount of

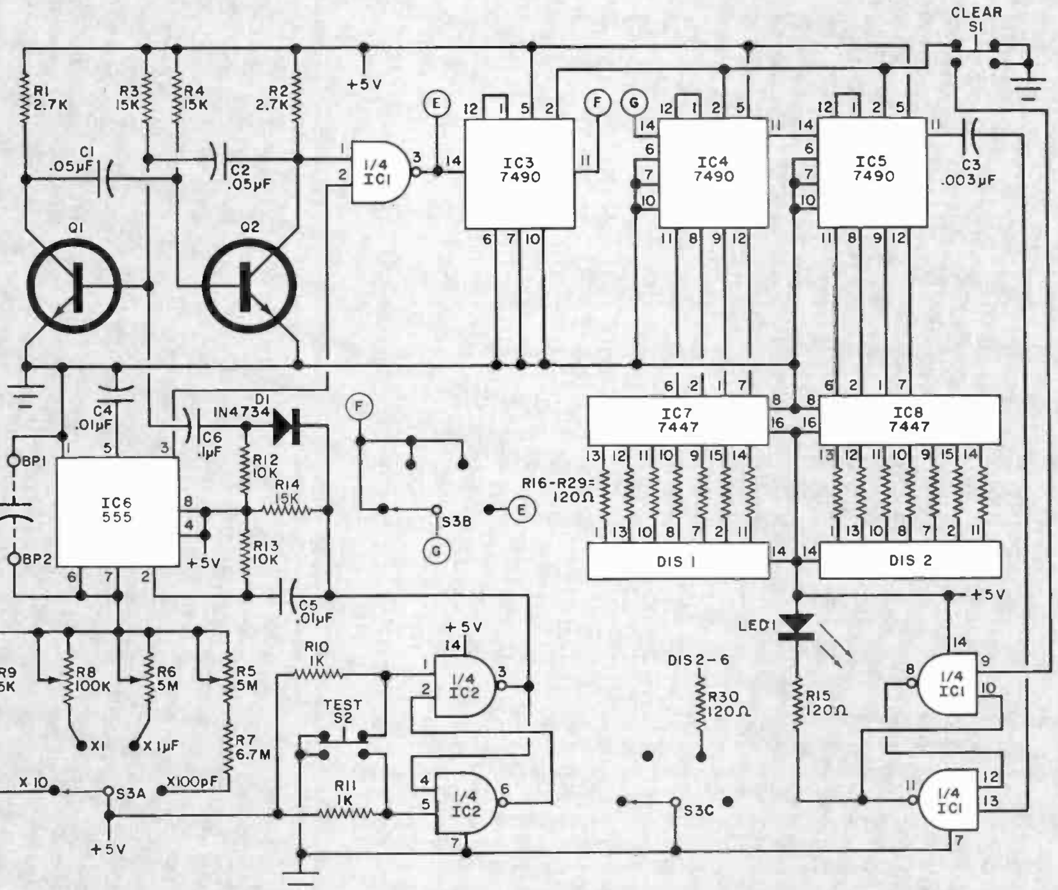


Fig. 2. Transistors Q1 and Q2 generate the 1-kHz square-wave input to IC1. The other input comes from IC6 and two gates of IC2. The output of decade counter IC3 is determined by the length of the second input.

PARTS LIST

BP1,BP2—5-way binding posts, one red, one black
C1,C2—0.05-µF Mylar or polystyrene capacitor
C3—0.003-µF capacitor
C4,C5—0.01-µF capacitor
C6—0.1-µF capacitor
D1—1N4734 diode or similar
DIS1,DIS2—Common-anode 7-segment LED (SLA-7 or similar)
IC1,IC2—7400 quad two-input NAND gate (TTL)
IC3,IC4,IC5—7490 decade counter (TTL)
IC6—555 timer
IC7,IC8—7447 BCD to 7-segment decoder (TTL)
LED1—Red LED
Q1,Q2—2N388 transistor or similar
R1,R2—2700-ohm, ¼-W resistor
R3,R4—15,000-ohm, ¼-W, 5% resistor
R5,R6—5-megohm trimmer potentiometer
R7—6.7-megohm, ¼-W resistor
R8—100,000-ohm trimmer potentiometer
R9—5000-ohm trimmer potentiometer
R10,R11—1000-ohm, ¼-W resistor
R12,R13—10,000-ohm, ¼-W resistor
R14—15,000-ohm, ¼-W resistor
R15 through R30—120-ohm, ¼-W resistor
S1,S2—spdt pushbutton switch
S3—3p4t rotary switch
Misc.—Suitable enclosure, knob (1), rubber feet (4), battery holder (if used), line cord (if used), mounting hardware, etc.

gated pulses can be counted by the following decade counter *IC3*. The output of this counter is a gated 100-Hz signal. Selector switch *S3* allows the choice of bypassing this decade counter when *S3* is in the 100-pF position.

The selected gated pulses are fed to a pair of conventional decade counter/seven-segment LED drivers, and their associated readouts. The two-digit display can handle a count up to "99", and if the 100th count is reached, the output pulse from *IC5* is coupled via *C3* to a flip-flop consisting of two gates of *IC1*. When this flip-flop operates, it turns on the OVER indicator LED. If desired, this discrete LED can be replaced by one of the colon points in the second decade

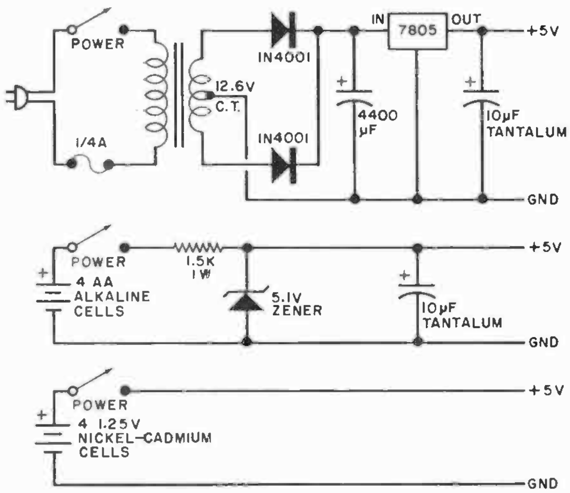


Fig. 3. Shown are three possible designs for the meter power supply.

counter. The system is reset to zero by pushbutton switch *S1*.

Construction. The basic circuit can be assembled on a small piece of perforated board using sockets for the IC's and transistors, and point-to-point wiring. Arrange the board layout so that the leads to pins 1, 6, and 7 of *IC6* are as short as possible between the IC and the front-panel binding posts *BP1* and *BP2*.

The two LED readouts, and their associated segment drivers (*IC7,IC8*) may be mounted on a separate small perforated board so that they can be positioned behind a "window" cut out of the selected chassis front panel.

Select a metal enclosure large enough to accommodate the two electronics boards, plus the power source. The power source can either be a battery set in a plastic holder, or an ac line-powered regulated 5-volt supply as shown in Fig. 3.

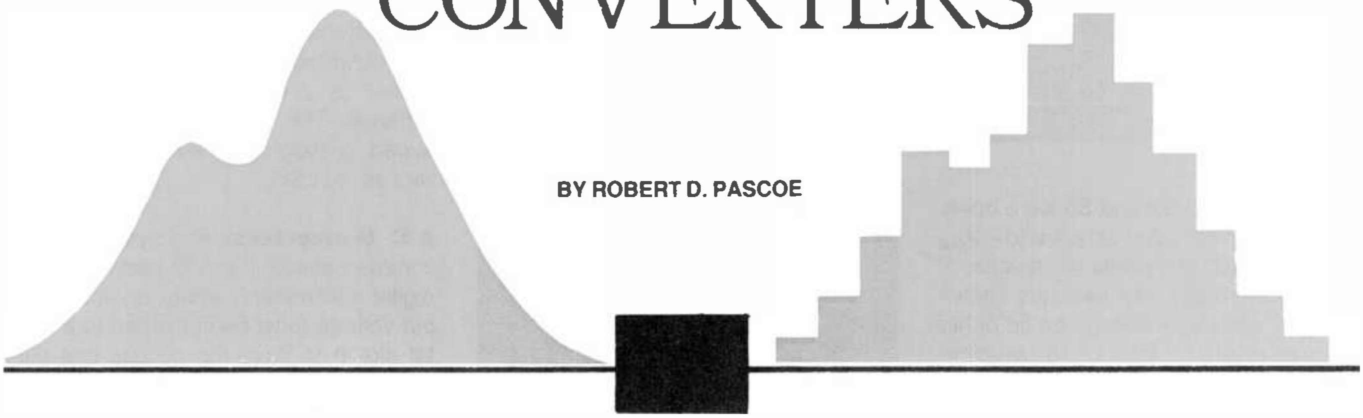
The CLEAR pushbutton (*S1*) and TEST pushbutton (*S2*) switches, along with the range selector switch (*S3*), power on/off switch, and the two five-way binding posts (with *BP1* being black and *BP2* red) can be mounted on the front panel along with the readout "window". The power line cord (if used) can exit via a grommetted hole on the rear.

Calibration. The ranges are 10,000 pF, 1 μF, 100 μF, and 1000 μF all full scale. For most purposes, 5% dipped silver-mica capacitors may be used for calibrating the two lower valued ranges, and 10% capacitors will suffice for the two higher ranges.

To calibrate a range, select a capacitor whose nominal value is near the middle of that range. For example, use a 5000-pF unit for the 10,000-pF range, and connect this capacitor between *BP1* and *BP2*. Turn on the tester power and note that the two displays illuminate. Depress the CLEAR pushbutton and the two readouts should indicate "00". Keep the TEST pushbutton depressed until the display comes to a rest, then adjust *R5* for the correct displayed value. The OVER indicator comes on when the unknown capacitor has a value that is larger than that selected by *S3*, so use the next higher range if this occurs.

An open capacitor will produce a "00" indication, while a "leaky" capacitor will indicate a much larger value than that marked on its case and a shorted capacitor will cause the display to keep counting without a reading even though the range switch is correct. ◇

The HOW's & WHY's of D/A and A/D CONVERTERS



BY ROBERT D. PASCOE

New devices and circuits reduce complexity and lower cost in interfacing analog and digital signals.

THE DIFFERENT worlds of analog and digital electronics must frequently be interfaced. In the past, the means for accomplishing this was extremely complex and quite expensive. During the last few years, however, new devices and circuits for interfacing the two types of circuits have made it possible to reduce complexity and bring down cost considerably.

There are essentially two types of circuits or devices that can be used to interface analog and digital circuits. One is for converting analog signals into digital signals and is known as an analog-to-digital (A/D) converter. The other converts digital signals into analog signals and is called a digital-to-analog (D/A) converter. Here is how both types of circuits operate.

D/A and A/D. The diagram shown in Fig. 1A illustrates a D/A converter. This circuit can accept a number of input lines whose signal voltages are a combination of 1's (high) and 0's (low) and transforms them into equivalent analog voltages at the output. As an example, a digital value of 1111 (15 in decimal) might represent an analog output of 15 volts, while 0000 might represent 0 volt. Any digital value between 0000 and 1111 can, hence, be used to generate between 0 and 15 volts at the output in 1-volt steps. In this example, the resolution of our four-bit D/A converter would be 1 volt.

The A/D converter shown in Fig. 1B transforms an analog voltage to an equivalent digital value. Using our four-bit example from above, the A/D converter would change a 15-volt input into the digital value of 1111 (all highs on the output lines), down to 0 volt with a digital value of 0000 (all lows on the output lines).

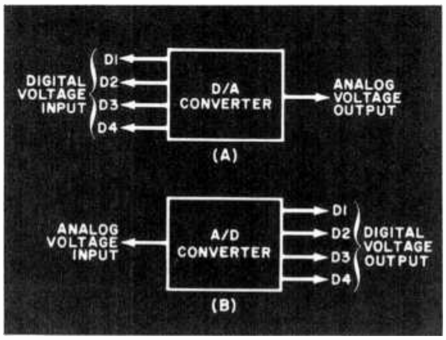


Fig. 1. Digital-to-analog (D/A) and analog-to-digital (A/D) converters are just opposites.

The two diagrams shown in Fig. 1 illustrate the basic principles of operation of the D/A and A/D converters. Now, let us take a look at how this conversion is actually accomplished.

D/A Converters. While there are a number of ways by which D/A conversion can be accomplished, we will limit our discussion to only the two most popular. The first approach is illustrated by the circuit in Fig. 2, where a resistor network and op-amp voltage amplifier are employed. In this circuit, the digital inputs are represented by switches *S1* through *S4*. If a switch is open, a logic 0 is generated; if it is closed, a logic 1 is generated. Note that in this case, a 1 is the value of V, while a 0 is represented by no voltage being applied (by the given switch) to the inverting (−) input of the op amp.

If we assume a value of 500,000 ohms for *R* and 5 volts for *V*, the following calculations can be made: 1) If *S1* is closed and *S2*, *S3*, and *S4* are open, I_{in} = 5 volts/500,000 ohms = 10 μA and $-V_{out}$ (don't forget that the op amp is operated as an inverter) = 10 μA × 100,000 ohms (the value of the feedback resistor, which is *R*/5 = 500,000 ohms/5 = 100,000 ohms) = −1 volt. 2) If *S4* is closed and *S1*, *S2*, and *S3* are open, I_{in} = 5 volts/62,500 ohms (500,000 ohms/8) = 80 μA and $-V_{out}$ = 80 μA × 100,000 ohms = −8 volts.

More than one switch can be closed at any given time, of course. If *S1* and *S4*

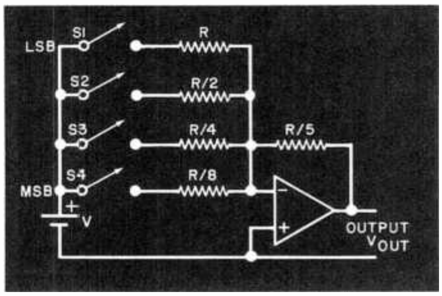
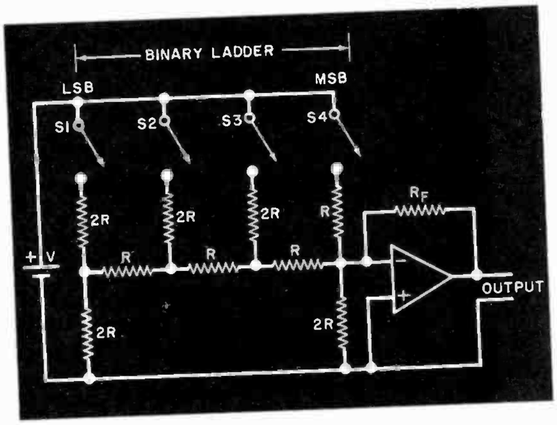


Fig. 2. This 4-bit D/A converter uses a resistor network and an op amp circuit.



were closed and *S2* and *S3* were open, I_{in} = 10 μA + 80 μA = 90 μA and $-V_{out}$ = 90 μA × 100,000 ohms = −9 volts.

Since there are four switches shown in Fig. 2 and each switch can be either open or closed, a total of 16 combinations exist. With this setup, the switches can be made to provide an output from the op amp of from 0 to −15 volts in 1-volt steps.

Instead of using mechanical switches, the input terminals, here the switch sides of the resistors in the network, can be connected to the outputs of binary bistable multivibrators or TTL decade counters. In the case of the 7490 decade counter, the A, B, C, and D outputs replace *S1* through *S4*, respectively. Since the 7490 counts to 9 and then resets to 0, the D/A converter circuit will generate 0 to −9 volts at its output. The logic-1 output of the 7490, or any other logic element tied to the D/A converter's input, may not be exactly 5 volts, which means that the value of the feedback resistor will have to be changed to compensate for the lower input level to retain the 0-to-9 volt output.

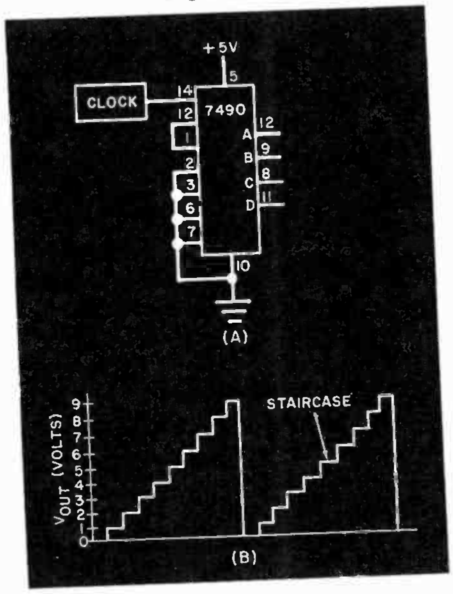
The advantage of the resistor-network approach is that the network uses only one resistor for each bit of information. However, the digital bit that has the most "weight" (*S4*) would have to supply much more current than any of the other switches. To illustrate, if a 10-bit D/A converter were constructed, the most-significant bit (MSB) would have to supply 1024 times more current than the least-significant bit (LSB).

To summarize, the weighted resistor network is constructed with N number of resistors whose values are *R*, *R*/2, *R*/4 . . . $R/2^N$, with each device connected to the network "seeing" a different resistance value. The LSB device would supply a current of V/*R*, while the MSB device would supply a current of N(V/*R*). Each digital input, however, requires only one resistor.

Another type of D/A converter, shown

Fig. 3. In this D/A binary ladder only two different values of resistors are used.

Fig. 4. Using a 7490 TTL decade counter to replace mechanical switches to get staircase output.



in Fig. 3, is commonly referred to as a "binary resistance ladder." In this converter, each digital bit supplies the same amount of current. It can be determined mathematically that the resistance "seen" by each digital bit is 3*R*. Hence, each digital bit supplies the same magnitude of current. The ladder is made up of only two resistance values—*R* and 2*R*.

If the voltage output of the op amp in Fig. 3 is the same as in Fig. 2, the value of feedback resistor R_f must be selected so that, in conjunction with the *R* and 2*R* combinations, it causes the op amp to have a gain of 24/5. Thus, if V were 5 volts, the combination of digital inputs would produce the same output range as in Fig. 2.

Switches *S1* through *S4* in Fig. 3 can be replaced with solid-state devices, as in the previous circuit. For example, if the outputs of a 7490 were connected to the inputs of the binary ladder and the 7490 were clocked, the circuit shown in Fig. 4A would produce the ladder output shown in Fig. 4B.

Two important terms used to describe the behavior of a D/A converter are *monotonicity* and *linearity*. Monotonicity is simply a continuously increasing output voltage for an increasing digital value up to the maximum for the ladder or resistor network. Linearity is the linear change in output voltage for increasing values of digital inputs. (The ladder steps should be equal.)

To sum up, the binary ladder is constructed using only two different values of resistance—*R* and 2*R*. Each device connected to the inputs of the ladder "sees" a constant 3*R* value of resistance. The Nth bit, or MSB, is required to supply the same level of current as the LSB.

A/D Converters. Perhaps the most common use of the A/D converter is in digital multimeters, where an analog input voltage must be converted to a digital signal to drive the circuits that ultimately provide the numeric display. There are many methods for making this conversion, four of which will be discussed here.

A simple four-bit, 0-to-9-volt DMM concept is illustrated in Fig. 5. The circuit employs a binary ladder, four-bit decade counter, decoder, seven-segment LED numeric display, and an op amp as a comparator. In the following discussion, we will assume that the reset clock generates a short pulse every 20 ms, while the clock generates a count pulse every 0.01 ms (10 μs). The binary ladder is

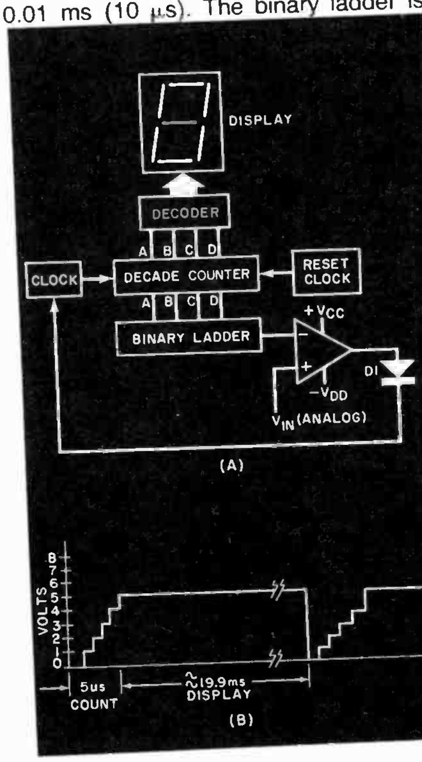


Fig. 5. At (A) is simple 0-9-volt digital voltmeter with its output waveform shown below at (B).

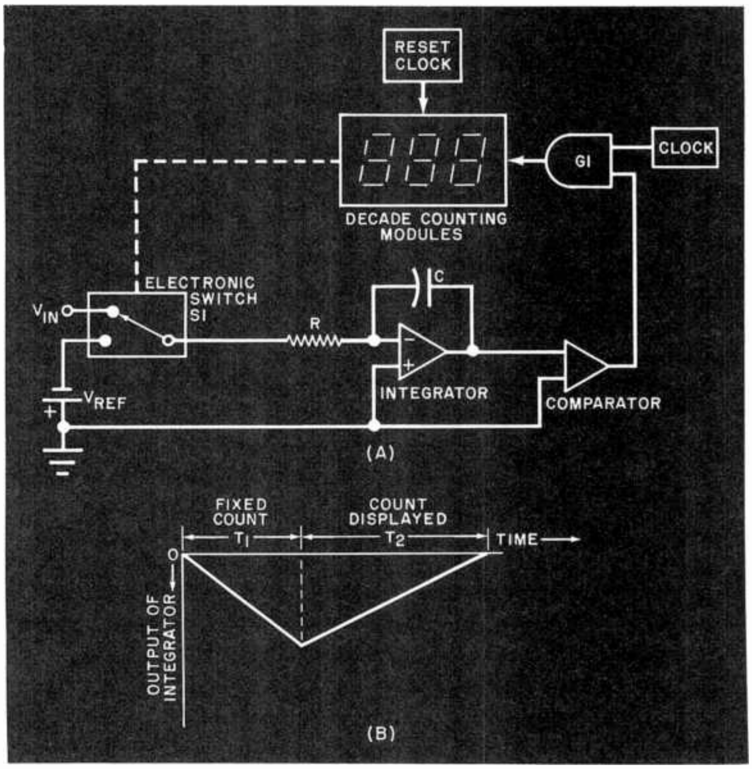


Fig. 6. The dual-slope converter integrates in both directions. An integrator (op amp with capacitor in feedback) is used as input to op amp comparator.

similar to that shown in Fig. 3 so that the output voltage from it is incremented by 1 volt for increasing digital values with a range of 0 to 9 volts.

Because the counter is clocked through all 10 states in 100 ms, it can count in a maximum time of 100 μs and the analog value is displayed for 19.9 ms (20 ms − 0.1 ms). For this particular circuit, the maximum time for conversion, or the time the counter takes to convert the maximum analog value and display it, is 100 μs. The average time for conversion is 100 μs/2 = 50 μs, while the update, or display time, is approximately 19.9 ms. This means that every 19.9 ms, a new conversion occurs.

In Fig. 5A, let us assume that an analog potential of 5 volts is applied to the noninverting (+) input of the op amp and that a reset pulse has been generated. At this instant, the output of the D/A converter is 0 volt (see Fig. 5B). The output from the op amp is maximum positive (supply voltage) and is passed through the forward-biased *D1* diode to activate the clock generator. The clock begins operating and supplies count pulses to the decade counter. The ABCD outputs of the decade counter start "piling" up a voltage in the binary ladder until at the count of 0101 (5 decimal), the binary ladder potential to the inverting input of the op amp very slightly exceeds, by a few millivolts, that of the reference voltage on the noninverting input. At this instant, the op amp slews very rapidly to a maximum negative output and forces the clock to stop working. The counter remains at the 0101 count until a reset pulse is generated, at which time, the counter stops and the cycle repeats. This process is illustrated in Fig. 5B. Because the display time is far longer than the count time, the display on the readout does not flicker.

For the device shown in Fig. 5, it is important to understand that the accuracy of the system is 10%, or 1 volt. This is because the D/A ladder is a four-bit system that has a least-significant value of 1 volt. For greater resolution and, hence, greater accuracy, more bits can be added to the system. The greater the number of bits, therefore, the better the resolution and the higher the accuracy.

As a point of interest, the Fig. 5 circuit has a display for one full digit. It can be converted to provide a three-digit display by "weighting" the outputs of a number of counters. Then, the three full digits would display values from 000 to 999.

The circuit shown in Fig. 6 is a dual-slope converter. It employs an integrator (an op amp with a capacitor in the feedback loop) as the input device to an op-amp comparator. If we assume that the analog input potential is 5 volts and that the counter has just been reset, the output of the circuit is at point 0 in Fig. 6B.

In this circuit, the decade counter has 1000 possible states. Electronic switch *S1* normally connects the input analog voltage to the integrator, which starts to charge the feedback capacitor in a linear fashion until the decade counter has cycled through its 1000 counts. At this instant, the MSB changes from a 9 to a 0, causing *S1* to change the integrator input from the analog voltage being measured to a reference voltage, V_{ref}. This is time T1 in Fig. 6B.

The integrator now integrates the negative reference voltage until it reaches 0 volt. At this time, T2, the comparator switches states and turns off the clock via AND gate *G1* to prevent any further change in state in the decade counters. The counter then remains at this particular count until the next reset pulse is generated to start a new cycle. The total conversion time is the sum of T1 and T2, hence the reason for calling this system "dual slope."

The analog input voltage is $V_{in} = (N/1000)V_{ref}$, where N is the display count. If N were 185 and V_{ref} were 10 volts, $V_{in} = (185/1000) \times 10 = 1.85$ volts.

The great advantage of dual-slope conversion is its simplicity. Needless to say, dual-slope conversion is very popular in the design of many types of digital multimeters.

The A/D converters discussed so far must be clocked through their states, which could possibly be 2^N states, where N is the number of bits. If a counter like that shown in Fig. 5 used 10 bits, the total number of states would be 2^{10}, or 1024. If the clock pulses occurred every 1 μs, the maximum conversion time would be $2^{10} \times 1$ μs, or approximately 1 ms. While 1 ms does not appear to be a very long time, in some applications it could prove excessive.

One method of reducing the conversion time is to use a circuit called a "successive approximation counter," the logic for which is shown in Fig. 7. This system has a conversion time equal to the clock-pulse time times the number of bits. Using the example above, the conversion time for this circuit would be 10×1 μs = 10 μs. Comparing this to 1 ms, you can see that the successive approximation counter's conversion time is considerably shorter than for other types of A/D converters.

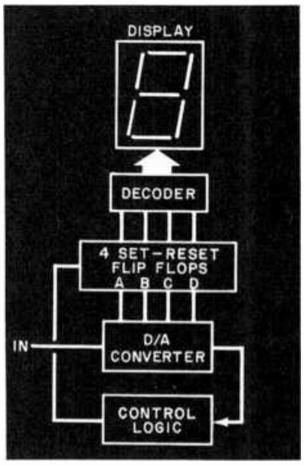


Fig. 7. Successive approximation converter uses bit-comparison technique and is faster than ladder.

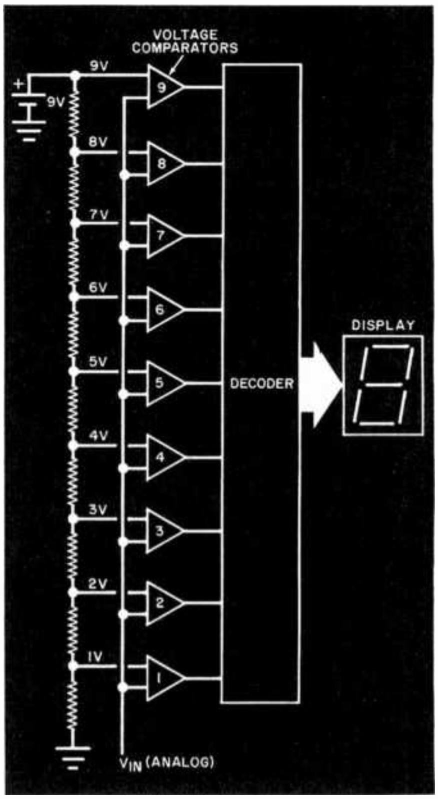


Fig. 8. Simultaneous A/D converter is fast but requires several comparators and resistors.

In the Fig. 7 circuit, the analog voltage at the input is transformed by the D/A converter by comparing the input voltage to the voltage generated by the binary ladder at a rate of one bit at a time. The MSB is compared first, followed by each successively lower significant bit, until the LSB is compared. As an example, assume that a four-bit successive approximation counter is used. The four flip-flops (8,4,2,1) would be turned on and off, starting with the MSB and ending with the LSB. Now, let us assume a 5-volt analog input. The MSB is turned on, which causes the output of the ladder to be 8 volts. Because 8 volts is greater than 5 volts, this flip-flop turns off. This starts the cycle.

The cycle continues with the next significant bit's flip-flop being turned on. Since this flip-flop generates a 4-volt output, which is less than 5 volts, this flip-flop remains on. The next lower bit, 2, is turned on, causing the output of the ladder to be 6 volts (4 volts + 2 volts). Because 6 volts is greater than 5 volts, the 2 flip-flop is turned off. Finally, the LSB flip-flop, 1, turns on, making the ladder output 5 volts (4 volts + 1 volt). Since the 5-volt output of the ladder is the same as the 5-volt input to the system, this last bit is left on. The output states of the four flip-flops are 0101, which represents 5 volts. Note here that the converter used a comparison of only four bits to convert the input voltage.

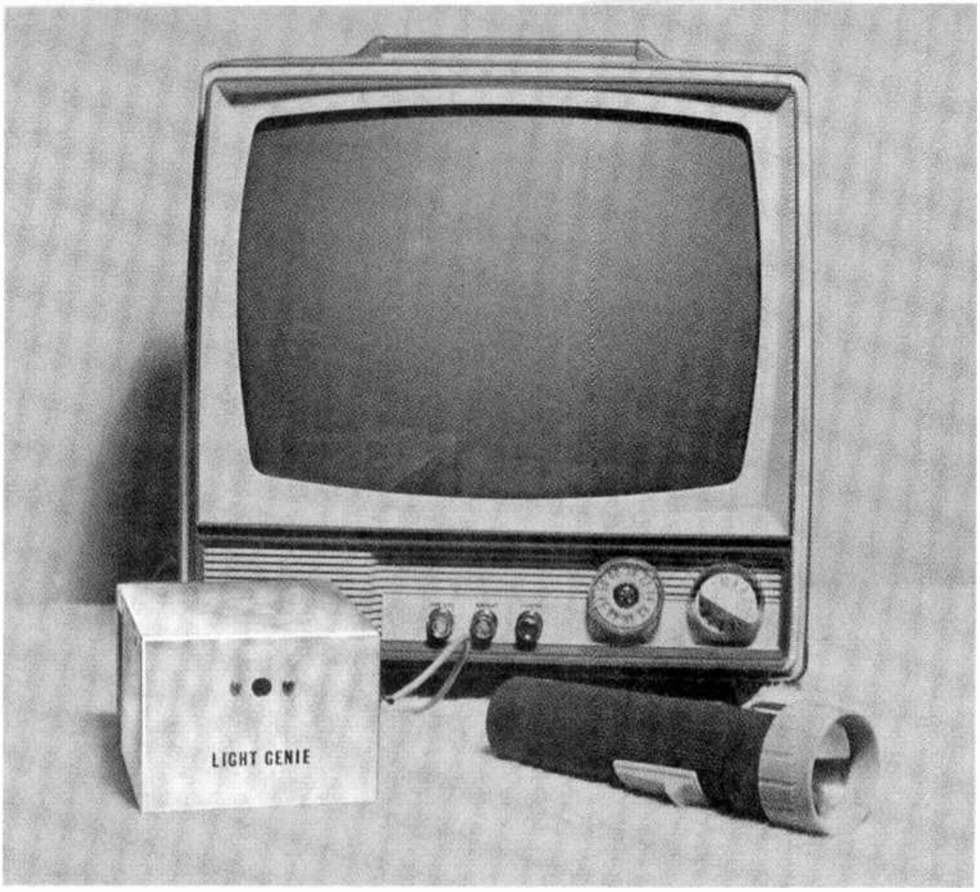
The circuitry for the successive approximation counter is more complex than for other types of A/D converters.

Simultaneous A/D conversion, shown in Fig. 8, falls into the "big-bang" school because everything happens simultaneously. Note that this circuit uses a number of op-amp comparators with one input of each comparator tied to decreasing dc voltages on a resistor network. The upper comparator here is referenced to 9 volts and the resistors are selected so that each comparator going down the line is referenced 1 volt lower. The outputs of all comparators are fed to a decoder that drives a 0-to-9 display.

If the analog input is 5 volts, comparators 1 through 5 would have a positive output, while the other comparators would have a 0 (or negative) output. The decoder converts this combination of 1's and 0's as required to display on the readout a numeral 5.

The disadvantage of using simultaneous A/D conversion is the large number of comparators and the associated resister network and decoder required.

In Conclusion. In this article, we have discussed a number of methods commonly used to interface the analog and digital worlds of electronics. Needless to say, we have only scratched the surface of A/D and D/A conversion techniques. However, the circuits and systems we have discussed should give you a basic understanding of how A/D and D/A converters in general work. ◇



BY MAYNARD GRADEN

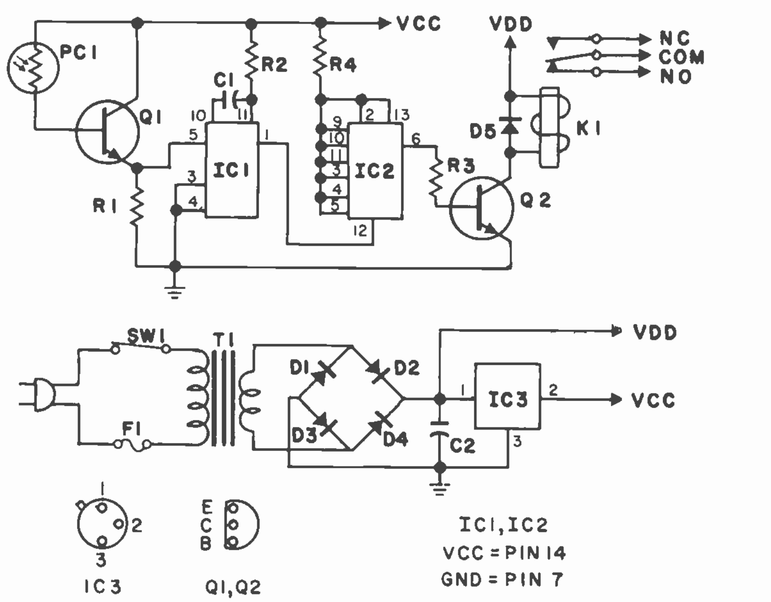
Handheld photoelectric system turns electrical equipment on or off.

BUILD THE "LIGHT GENIE"

ALADDIN was a lucky fellow. When he wanted a job done, all he had to do was rub his magic lamp and a genie would do his bidding. With the "Light Genie," you can do almost the same thing. You can use it to silence annoying TV commercials or change your stereo system from tuner to tape deck. In fact, the Genie will control just about anything that has a switch.

A small penlight will operate the Genie at distances up to 12 feet (3.6 m), while a regular flashlight extends the range to greater than 30 ft (9.1 m). High ambient room light will not interfere with the Genie's operation.

Circuit Operation. The schematic diagram of the Genie is shown in Fig. 1. A light shield is used to prevent random ambient light from striking the photocell, *PC1*. The latter provides base bias for emitter follower *Q1*. Small, relatively constant amounts of light only vary the quiescent operating point of the circuit.



PARTS LIST

C1—10-μF, 10-volt electrolytic capacitor
C2—500-μF, 15-volt electrolytic capacitor
D1 through D5—1N4001 rectifier diode
F1—¼-ampere fuse (see text)
IC1—74121 integrated circuit
IC2—7472 integrated circuit
IC3—LM309H 5-volt regulator IC
K1—6-volt dc relay with spdt contacts (Sigma No. 65F1A-6DC or similar—see text)
PC1—Clairex CL702L photoresistive cell
Q1,Q2—2N3704 transistor
The following resistors are ¼-watt, 10%:
R1—470 ohms
R2—39,000 ohms
R3—220 ohms
R4—1000 ohms
SW1—Spst toggle or slide switch
T1—6.3-volt, 1.2-ampere transformer (see text)
Misc.—Metal utility box; fuse holder; line cord with plug; 9-pin shielded tube socket; ¾" flat washers (2); matte black construction paper; tape; glue; hookup wire; solder; machine hardware; etc.

Fig. 1. Circuit is activated to energize K1 when light beam strikes PC1 directly.

However, when a beam of light is directed at the Genie so that it falls directly on the photocell, the resistance of *PC1* rapidly decreases and sends *Q1* into conduction.

Integrated circuit *IC1* is a monostable multivibrator. A time constant of 250 ms, which prevents multiple triggering from a slowly changing light source, is provided by *C1* and *R2*. The output from *IC1* is a clean square pulse that is used to clock *IC2*. As flip-flop *IC2* toggles, transistor *Q2* is either driven into saturation or cut off to energize or de-energize relay *K1*, respectively.

The power supply is also shown in Fig. 1. It provides power for the relay and regulated 5 volts, through *IC3*, to operate the logic.

Construction. To construct the light shield, use a piece of 8" × 4" (20.3 × 10.1 cm) matte black construction paper. Form a tube by rolling it around two ¾" flat washers. Insert a washer inside the paper tube at the halfway point and perpendicular to the central axis. Drop in a small amount of glue to secure it in place. Use tape to hold the tube together, as shown in Fig. 2.

Remove the Bakelite base from the frame of a nine-pin shielded tube socket. (The two pieces are usually held together by small metal tabs that can be bent to separate the two parts.) Using the frame as a template, mark and drill mounting holes on the front of the box. Locate the center of the frame and drill a third ¼" (6.35 mm) hole at this point. Attach the frame to one end of the paper tube. This will be the mounting bracket for the light shield.

Mount the photocell and two 12" (30.5 cm) lengths of wire on the tube base using two of the pins as tie points. Adjust the photocell so that it is parallel to the base of the tube. Complete the light shield by cementing the photocell assembly to the other end of the paper tube.

The circuit can be assembled using perforated board and point-to-point wiring or a printed circuit board that can be made using Fig. 3. In either case, the board should be mounted vertically on one side of the box so that ample space remains for installing any additional parts that may be required for various switching applications.

Uses. The Light Genie can be used to silence television commercials as shown in Fig. 4. The value of *RL* should be equal to the impedance and wattage of the speaker. If there is enough room

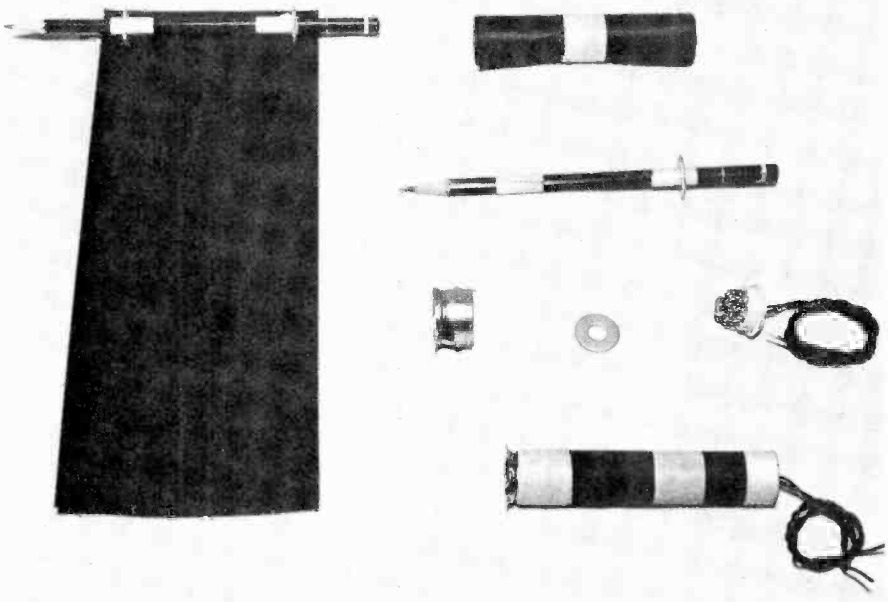


Fig. 2. Photo shows how to make light shield out of black construction paper. Base from a 9-pin shielded tube socket is used as a mounting bracket.

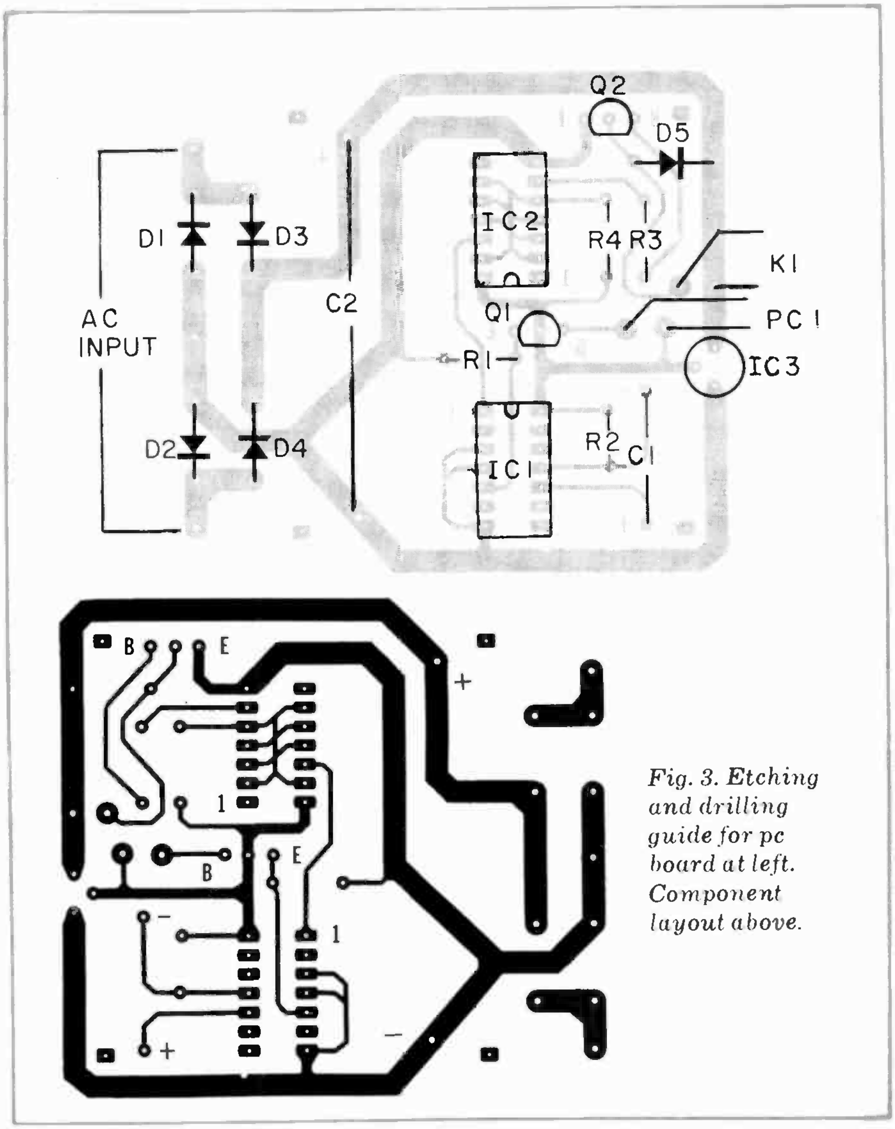


Fig. 3. Etching and drilling guide for pc board at left. Component layout above.

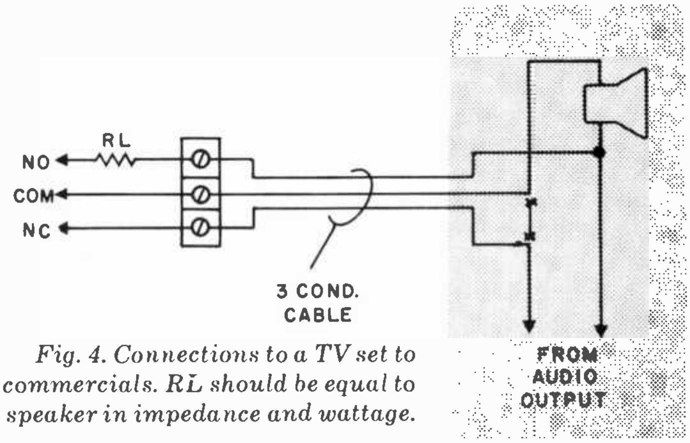


Fig. 4. Connections to a TV set to kill commercials. RL should be equal to speaker in impedance and wattage.

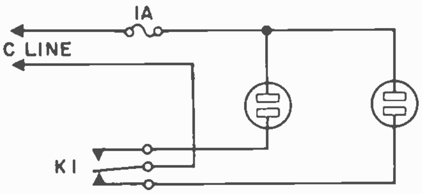


Fig. 5. Using two chassis-mounted ac receptacles to switch power. Fuse shown is separate from the one in Genie power supply.

inside the TV receiver, the entire circuit can be placed inside the cabinet behind a small hole that allows unobstructed access to *PC1* for the light beam. If the Genie is to be an outboard unit, mount a terminal block on the outside of the box and use a length of three-conductor wire to make the interconnections.

An application using two chassis-mounted ac receptacles to switch power is shown in Fig. 5. The relay specified in the Parts List will handle a 1-ampere resistive load. If a heavier load is to be controlled, substitute a relay with a higher contact rating, or have the specified relay drive a 117-volt ac relay with sufficiently heavy contacts. The fuse is separate from the power supply fuse and should be equal to the current capacity of the relay contacts.

It is possible to perform complex switching functions by using one relay to control several other relays as shown in Fig. 6. Here, relay *K1* is used to control two other relays, which choose between two components in a stereo system with the same output level, impedance, and required equalization characteristics.

The preceding examples begin to demonstrate the versatility of the Light Genie in two-state switching applications. Sequential switching functions can just as easily be implemented using stepping relays. ◇

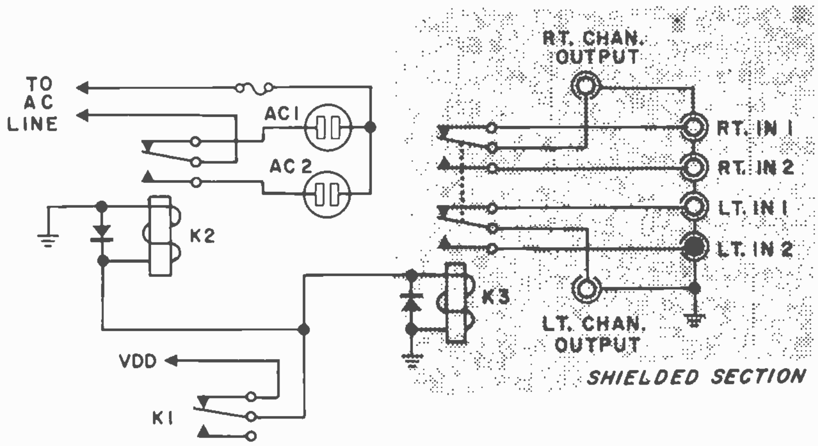


Fig. 6. Performing complex switching functions by using one relay to control several others.

SWITCHING REGULATORS REDUCE POWER SUPPLY COST

How switching regulators can be used in power supplies to lower heat loss and, thereby, keep costs down.

BY DON RAUDENBUSH

DC POWER supplies that use pass transistors or IC regulators must be capable of dissipating a great deal of heat. This can add to the cost of the supplies because of the need for large heat sinks and/or cooling fans. In addition, because the heat losses must be made up for by the power transformer, the transformer itself must have a fairly high current rating. This also adds to the expense. You can minimize the heat loss problem and reduce cost by using a switching regulator in your power supply designs.

The switching regulator acts as an ideal lossless switch. It applies power to the load only when necessary to prevent the load voltage from falling below some preset limit. Conventional power supplies use the pass transistors or IC's to absorb and dissipate the excess input power when the load voltage rises above some preset limit.

Operating as a saturated transistor switch, the switching regulator dissipates only the power lost during each switching cycle, plus the loss due to the residual collector-to-emitter saturation voltage of the switching transistor in the on condition. Depending on the output power demands of the power supply, the low level of these losses eliminates the need for fans, minimizes the size of the heat sink required, and cuts down on the size as well as the weight of the power transformer.

Basic Circuit Operation. The operation of the basic free-running switching regulator circuit shown in Fig. 1 is fairly simple. Transistor *Q1* serves as the saturated switch that connects the unregulated dc input voltage to the load through inductor *L1*. The switching causes the input end of *L1* to instantly assume the value of the input voltage, but the voltage at the output end of *L1* cannot change instantly because of the presence of *C1*. Therefore, current flows through *L1* to charge *C1* and to supply the load.

When the potential on *C1* builds up to slightly greater than the level of reference voltage V_R, the error amplifier shuts off *Q1*. The voltage at the input of *L1* now attempts to reverse polarity but is prevented from doing so by *D1*. However, the energy stored in *L1* causes a decreasing current to continue to flow in *L1* through *D1* toward *C1* and the load.

When the current falls to the point where *C1* is no longer receiving current, the voltage across the capacitor and load begins to decrease. When it falls slightly below V_R, the error amplifier turns on *Q1* to repeat the cycle. Resistor *R2* feeds back a small portion of the input voltage when *Q1* is conducting to insure positive switching action by the error amplifier.

The output ripple voltage at the switching frequency, represented by the rising and falling voltage across *C1* and the load, is typically about 0.3% rms with the input and output voltages normally used in solid-state circuits. The amplitude of the ripple is greatly affected by the type of capacitor used for *C1*.

As a result of the heavy current surges caused by the switching action of *Q1* in power supplies that deliver 1 or more amperes to the load, noise voltage spikes with frequency components in the multi-megahertz range can be generated by the regulator. With proper construction precautions, however, the amplitude of this noise can be held down to the levels of the switching frequency's ripple.

Regulator efficiencies of up to 85% or 90% can be realized with load regulation of 1% and line regulation of 0.2%. The switching frequency should be just above the audible range to prevent the regulator from "singing" without introducing unnecessary inductor and capacitor losses.

Circuit Description. A more detailed circuit of the switching regulator is shown in Fig. 2. The error amplifier is a standard 723 regulator IC. It is convenient to use because it has an internal reference source and an output power stage. Its frequency response is more than adequate for the switching frequencies required.

The voltage divider made up of *R1* and *R2* is selected to produce a potential equal to the desired output voltage, keeping in mind the reference current source capabilities of the 723 of 15 mA and the reference potential of 7.15 V.

The basic equation for determining

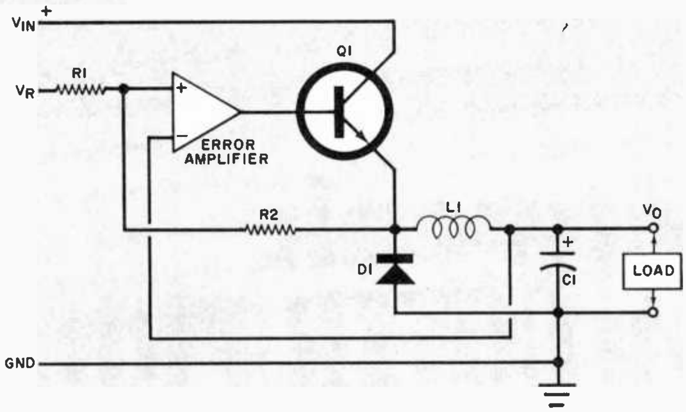


Fig. 1. Basic free-running switching regulator circuit. When ouptut is too high, error amplifier cuts off Q1.

the values of *C1* and *L1* in the Fig. 2 circuit is

$$C1L1 = \frac{V_O(V_{IN} - V_O)}{8f^2V_{IN}(V_{OR} - V_{FB})} \times 10^9$$

Presented in this form, this equation emphasizes the relationship between *C1* and *L1* and the tradeoff possibilities of the values of these components. The value of *L1*, for example, can be decreased simply by increasing the value of *C1*.

In the above equation, *L1* is in millihenries, *C1* is in microfarads, f is in hertz, and all potentials are in volts. The unregulated dc input voltage to the regulator is represented by V_{IN}, while V_O is the regulated output voltage. For best operation, V_{IN} should be three to five times V_O. The f in the equation is the switching frequency, which should be about 20,000 Hz. The tolerable peak-to-peak output ripple voltage, usually between 50 and 75 mV, is represented by V_{OR}, while V_{FB} is the fraction of the input voltage (neglecting the $V_{CE\ SAT}$ of switching transistor *Q1*) this is fed back to the error amplifier. With *R4* much greater in value than *R3*, $V_{FB} = (V_{IN}\ R3)/R4$. Resistor *R3*'s value should be about 1000 ohms so that with *R4*'s value set at 1 megohm, V_{FB} is kept small with respect to V_{OR}.

With a value on the order of 51 ohms, *R5* limits the base drive current to *Q2* through *IC1*. In the event of a short circuit at the output of the regulator, *R5* also prevents damage to *IC1*, *Q1*, and *Q2*. Resistors *R6* and *R7* are included in the circuit to insure fast turn-off of *Q1* and *Q2*. The value of *R6* should be about 100 ohms, while the value of *R7* should be several thousand ohms. Capacitor *C3* provides a bypass to ground for voltage divider *R3-R4*.

As an exercise in using the equation, let us determine the value of *L1* that will be required for a regulator whose output is 5 volts at 2 amperes. Assume that the unregulated V_{IN} is 24 volts, that at this voltage the average current capability is 0.5 ampere, and that an output ripple voltage, V_{OR}, of 50 mV peak-to-peak can be tolerated.

Assuming switching frequency f is to be 20,000 Hz, we have all the information needed in the basic equation except the feedback voltage, which can be calculated as follows: $V_{FB} = (24 \times 1000)/10^6 = 0.024$ volts, or 24 mV. Now let us also assume that the value of *C1* is 250 μF. Plugging these values into the basic equation, we calculate the value of *L1* to be 0.19 mH.

The Magnetics Components Division of Spang Industries, Inc., Butler, PA 16001, offers a line of molypermalloy powder cores for winding inductors and an excellent catalog and applications manual (No. MPP-303S). Using the Core Selector Chart in the manual, we would choose a core with a 1.06" (26.92-mm) outer diameter, 0.58" (14.73-mm) inner diameter, and permeability of 125. Calculations detailed in the manual indicate that 37 turns of 18-gauge wire will have to be wound on this core to handle the 2-ampere output current from the regulator.

It is interesting to compare the performance of the switching regulator to a conventional regulator that uses pass transistors to produce a 5-volt, 2-ampere output when the unregulated source is 24 volts. The pass transistor must drop the potential from 24 to 5 volts at 2 amperes, generating a heat loss of an equivalent 38 watts. The switching regulator, on the other hand, accomplishes the same thing with a heat loss of only 2 watts.

Selecting Components. When the output current of the regulator circuit is to be 1 or more amperes, the size of the wire used for the windings of *L1* must be quite large, as illustrated in the above example. Therefore, *L1* should have as small an inductance value as possible to save size, weight, cost, and winding time. If you do not wish to wind your own inductors, you can use an appropriate ET Series high-current inductor suitable for operation at switching frequencies made by Triad-Utrad Division of Litton Industries, 305 N. Briant St., Huntington, IN 46750.

The selection of output capacitor *C1* is extremely important in minimizing the output ripple. Usually an aluminum elec-

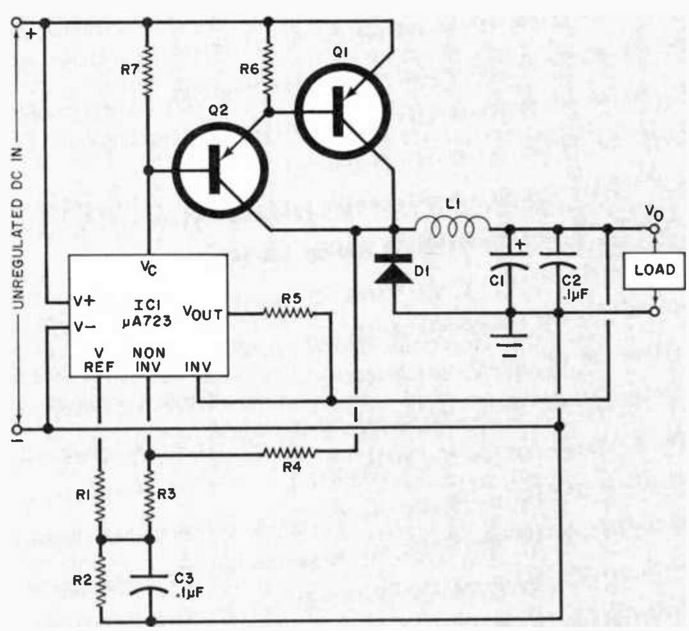


Fig. 2. Schematic diagram for a more sophisticated switching regulator using a 723 IC as the error amplifier.

trolytic, this capacitor must have low stray inductance for optimum performance. Good results have been obtained using the Type BR "Blue Beaver" electrolytic capacitors made by Cornell-Dubilier. The company also offers a line of four-terminal electrolytics made specifically for switching regulator applications. Sprague Electric offers a similar line of capacitors.

Capacitor *C2* helps to minimize ripple and noise in the output voltage. Use a ceramic disc capacitor here.

For best efficiency, *D1* should be a fast switching silicon power diode with a rating in excess of the expected maximum load current. Not all silicon diodes fill the bill in this application. A line of diodes for use in switching regulators is made by Semtech Corp., 625 Mitchell Rd., Newbury Park, CA 91320.

Transistor *Q1* conducts the load current as pulses of a peak value equal to the output current. The losses that occur during switching because of the finite time taken by *Q1* to go from full cutoff to full saturation and vice-versa contribute significantly to the total power loss and cause the transistor to heat up. For this reason, *Q1* must be a fast silicon power switching transistor with an f_T of at least 4 MHz. Similarly, *Q2* should have a 4-MHz or greater f_T, but since it only drives the base of *Q1*, its current rating need be only 10% of that of *Q1*.

Proper Construction. In all but low-power supplies, *Q1* should be mounted with mica insulators on the metal chassis of the supply or to the chassis via a heat sink assembly.

The ground system of the power supply is perhaps the most important construction detail involved in minimizing switching noise. Ideally, a single-point ground system should be used, and particular attention should be given to using short leads to connect the unregulated input supply to the input of the voltage regulator circuit and the single-point ground. The chassis of the power supply should be connected to the regulator at only this point. The network made up of *C1*, *C2*, *D1*, and *L1* should be connected as physically close together as possible. The amount of care taken in building a power supply with a switching regulator will pay off in better operation and the less likelihood to generate noise. ◇

Note: *Diagrams courtesy Fairchild Semiconductor Components group, which assumes no responsibility for circuits described other than entirely embodied in a Fairchild product. No other circuit patent licenses are implied.*

Solid State

By Lou Garner

BETTER THAN MOS

COMPARED to bipolar types, metal-oxide semiconductor (MOS) devices offer the advantages of low power requirements, high input impedances, high gain, and comparative ease of manufacture, but these advantages are offset for many applications by a limited power capability and a susceptibility to damage from voltage transients and momentary overloads. Bipolar devices, on the other hand, while offering higher voltage and current handling capabilities and greater resistance to damage from transients and overloads, also have relatively low input impedances. The "ideal" design, in the opinion of many engineers, would be one combining the capabilities of both bipolar and MOS technologies in a single device . . . and that is exactly what RCA's Solid State Division (Box 3200, Somerville, NJ 08876) has done in its CA3140 family of operational amplifiers. Dubbed *BiMOS* (for *Bi*polar—*MOS*) devices, these monolithic silicon op amps feature the high impedances and low input current requirements of a MOS/FET input stage with the high voltage capabilities and ruggedness of a bipolar output amplifier.

Suitable for use in sample-and-hold amplifiers, power supplies, function generators, tone controls, portable instruments, intrusion alarm systems, peak detectors, active filters, photocontrol amplifiers, timers, multivibrators, and other familiar op amp circuits, as well as TTL interface applications, the CA3140 family comprises six devices supplied in two series, with three versions in each. All six devices are furnished in standard TO-5 metal cases. Identified by a "T" suffix, one series offers the devices with 8 leads arranged in a familiar circular pattern, while the second series, identified by an "S" suffix, has leads preformed in a dual-inline (DIP) configuration.

Except for the lower input offset voltage characteristics of the "A" and "B" version, all members of the CA3140 family have similar maximum ratings and electrical characteristics. The CA3140 and CA3140A have a maximum dc supply voltage rating of 36 V, the CA3140B of 44 V. With a 5-volt dc source, the CA3140 has a typical input offset voltage requirement of 5 mV; the CA3140A, 2 mV; and the CA3140B, 0.8 mV. All of the devices have a maximum power dissipation rating of 630 mW at temperatures up to 55°C without a heat sink, or up to 1 W at the same temperature with a suitable heat sink. In typical applications, all versions offer an input resistance of 1.5 × 10^6 megohms, a slew rate of 9 V/μs, a gain-bandwidth product of 4.5 MHz, a CMRR of about 90 dB, large signal voltage gains of up to 100k (100 dB), and the capability of operating from either single-ended or dual power supplies. Characterized for both ±15-V and 5-V TTL system operation, the CA3140 family will operate effectively on dc sources as low as 4 V.

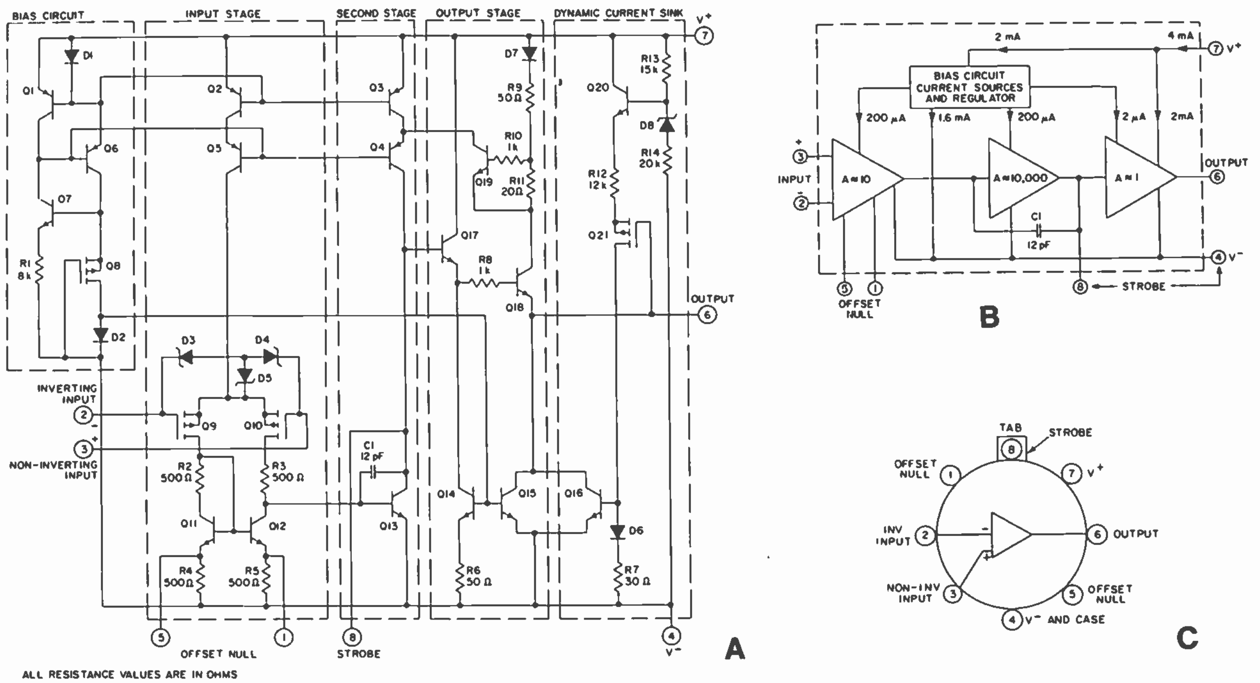


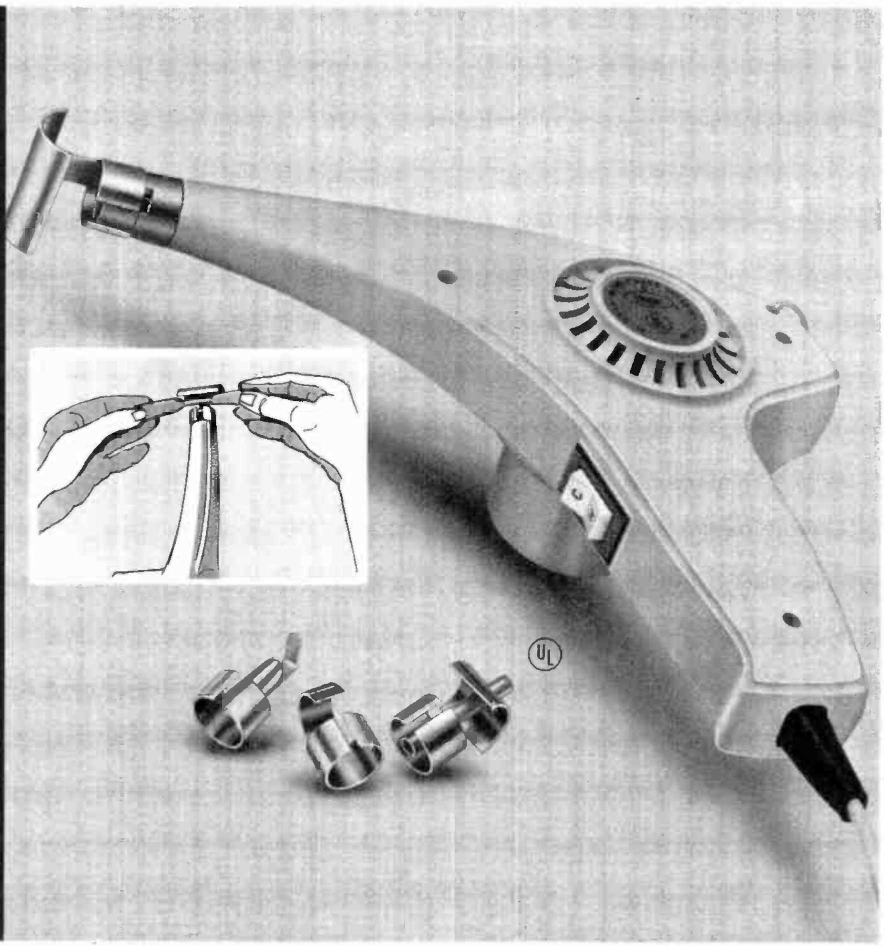
Fig. 1. The equivalent schematic diagram for RCA's BiMos operational amplifier is shown at (A); functional block diagram (B); and basing diagram (C).

The equivalent schematic, functional block and basing diagrams for the CA3140 BiMOS op amps are given in Figs. 1A, 1B and 1C, respectively. Each device comprises four functional sections: a high input impedance, moderate gain, class-A input stage; a second high-gain class-A amplifier; a special unity (voltage) gain, class-AB output stage to provide the current gain required to drive low-impedance loads; a regulated biasing circuit which controls the constant-current sources for the first and second stages. In addition, the devices include an on-chip capacitor, *C1*, across the high-gain second amplifier stage which provides adequate phase compensation for most practical circuit applications. The family's terminal connections are identical to those of the familiar "741" and other industry-standard op amps except for the addition of a strobe control terminal (pin 8).

Referring to Fig. 1A, the input section consists of a differential amplifier using PMOS FET's *Q9* and *Q10* in conjunction with a mirror pair of npn bipolar transistors, *Q11* and *Q12*, which, together with resistors *R2* through *R5*, serve as output loads for the stage. Input protection against high voltage (static) transients is supplied by bipolar zeners *D3, D4* and *D5*. The constant-current source required for differential amplifier operation is provided through cascoded pnp bipolar transistors *Q2* and *Q5*, which obtain their base bias from the regulated biasing network made up of *D1, D2, Q1, Q6, Q7, R1* and PMOS FET *Q8*. In addition to acting as part of the first stage output load, *Q11* and *Q12* also serve as a differential-to-single-ended converter, furnishing base drive to the high-gain second stage npn bipolar transistor, *Q13*. Cascoded pnp transistors *Q3* and *Q4*, stabilized by the regulated base bias source, serve as the collector load for *Q13*.

Driven by *Q13*, the final stage is designed to operate either as a current source from the positive dc supply or as a current sink with respect to the negative dc supply. The basic output stage consists of cascaded npn emitter-followers *Q17* and *Q18*, with npn transistors *Q14* and *Q15* serving as emitter loads. The quiescent emitter-follower current is established by the base bias applied to *Q14* and *Q15* which, in turn, is determined by the current flow through diode *D2* in the regulated biasing network. When functioning as a source, load current is supplied from the positive supply by *Q18* through *D7, R9* and *R11*. The voltage drop across *R11* is sensed by *Q19*, which acts to divert current from *Q4* under heavy load conditions, thus reducing the base current drive to *Q17* and *Q18*, limiting the output current and providing short-circuit protection. When functioning as a current sink, npn transistor *Q16* serves as the active sinking element, controlled by an output voltage sensing network made up of *R7*, diode *D6*, PMOS FET *Q21, R12*, and series npn transistor *Q20*, which receives its base bias from a series array consisting of *R13*, zener *D8* and *R14*. In operation, *Q21* senses incremental changes in output voltage caused by *Q18* and, in turn, controls the base bias applied to *Q16* to achieve dynamic sinking. The sink current flows regardless of load, with any excess current internally supplied by *Q18*.

Although ideal for designs requiring extremely high input impedances, very low input currents, high slew rates, wide voltage ranges, high gain-bandwidth products, and the other performance characteristics made possible through BiMOS construction, the CA3140 family also may be used for virtually all standard op amp projects. Typical application circuits are illustrated in Fig. 2. These were abstracted from the 20-page



data brochure for the CA3140 family, file number 957, published by RCA.

Suitable for use in test instruments, control systems, computers, games, and similar projects, the simple sample-and-hold circuit shown in Fig. 2A effectively utilizes the high input impedance of the CA3140. Here, the BiMOS device serves as a readout amplifier for a 200-pF storage capacitor while a CA3080A operational transconductance amplifier is used as a combination input buffer amplifier and low feed-through transmission switch. Offset nulling is provided by a 100k potentiometer connected between pins 1 and 5 of the CA3140. In operation, the value of the storage capacitor determines both the system's effective "hold" period and its slew rate. A larger capacitor will increase the hold period but, at the same time, reduce the slew rate, and vice versa. With the component values given, for example, the slew rate is approximately 2.5

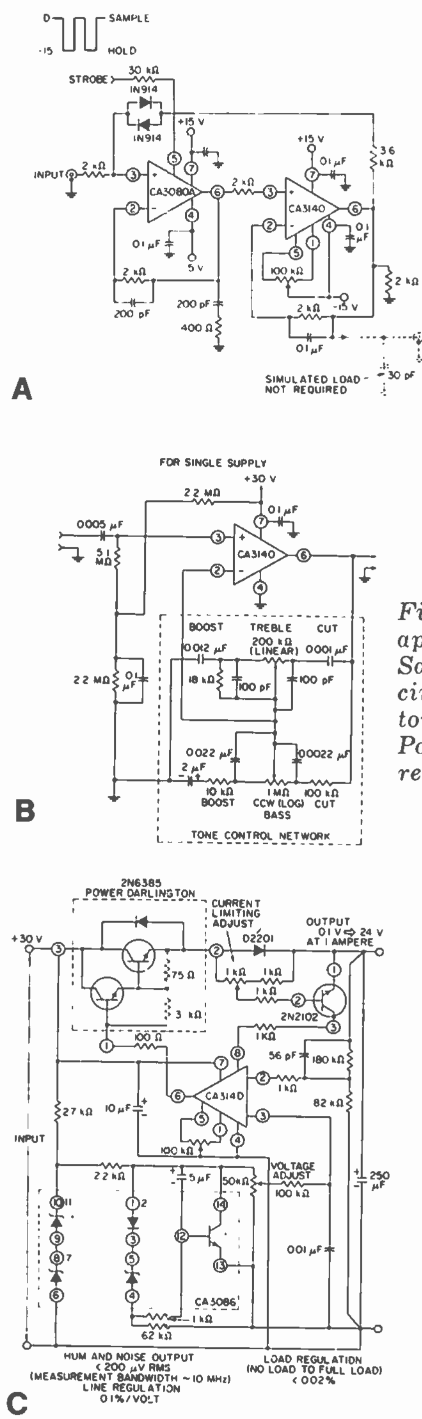


Fig. 2. BiMOS op amp applications: (A) Sample-and-hold circuit; (B) Audio tone control; (C) Power supply regulator circuit.

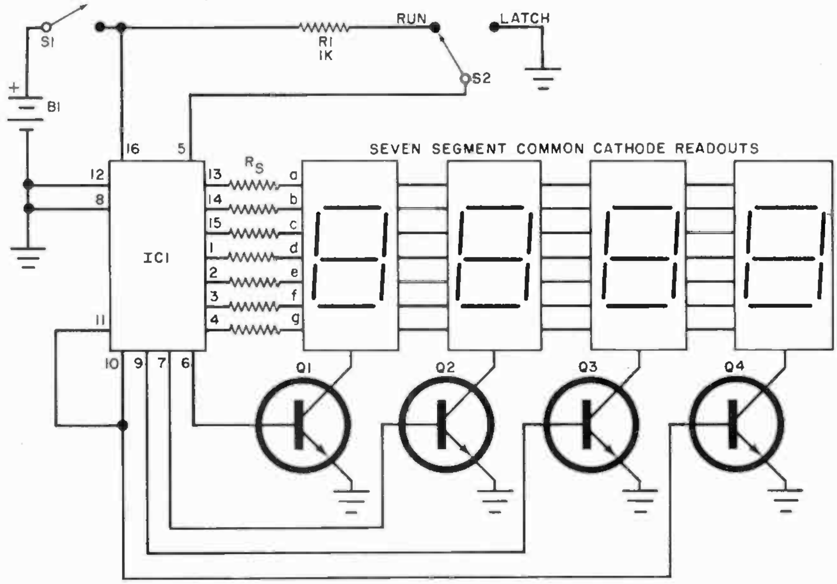


Fig. 3. Random number generator circuit uses the self-generated strobe signal available in the counter/driver IC instead of a separate pulse oscillator.

V/µs. If the storage capacitor value were increased to 2000 pF, the slew rate would be dropped to 0.25 V/µs.

An audio tone control circuit which exploits the special performance characteristics of the CA3140 is given in Fig. 2B. In operation, the amplifier's frequency response is modified by means of selective feed-back to its inverting input terminal. The circuit's input impedance is essentially the same as the resistance between pin 3 and ground. Furnishing 20 dB gain when its bass and treble controls are adjusted for a flat response characteristic, the circuit can provide up to ±15 dB bass and treble boost or cut at 100 Hz and 10 kHz, respectively. Depending on the input amplitude, output levels may be as high as 25 V p-p, typically, at 20 kHz.

A dc power supply regulator circuit featuring the CA3140 is illustrated in Fig. 2C. In addition to the BiMOS op amp, the circuit employs a 2N6385 power Darlington as the series-pass device, a D2201 diode as a current sensor, a 2N2102 npn transistor as the current sense amplifier, and a CA3086 transistor array, with the latter interconnected to utilize some of the transistor junctions as zener diodes. In operation, the CA3140 senses the output voltage and compares it to a controllable reference voltage, adjusting the base bias applied to

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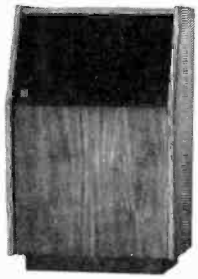

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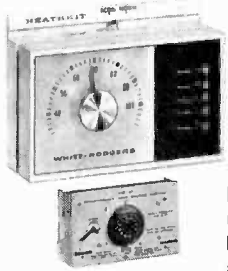

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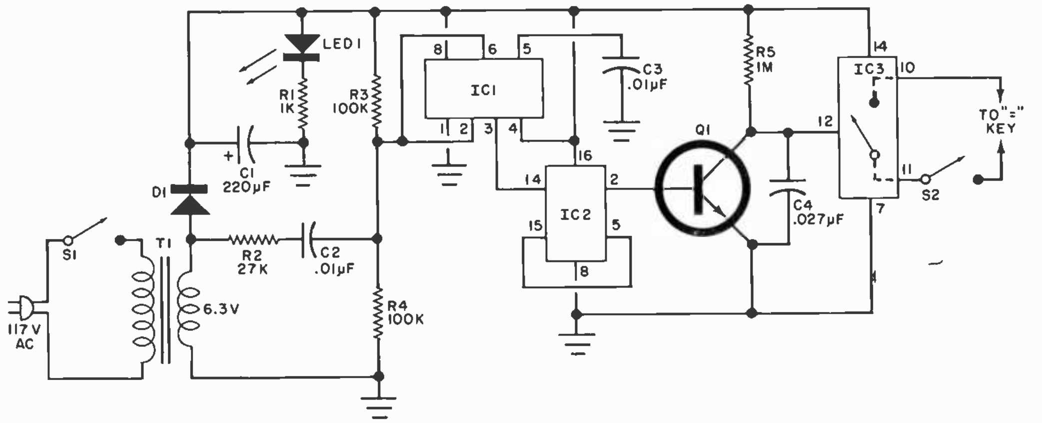


Fig. 4. Accessory for a pocket calculator to permit the latter's use as a simple stopwatch.

the series-pass Darlington automatically to maintain the preset output voltage despite changes in the line voltage or load current. At the same time, the load current is sampled by means of a series diode and amplified to serve as a limit control on the CA3140's operation. With the component values specified and a 30-volt dc source, the regulator's output voltage can be adjusted from approximately 0.1 V to 24.0 V at adjustable maximum current limits from 10 mA to 1 A. The design offers better than 0.02% load regulation (from zero to full output) and a line regulation of 0.1% per volt.

When using the CA3140 in practical circuits, reasonable care should be exercised to avoid damage. Although the device is comparatively rugged and includes diode gate protection, it should be handled as any other MOS device. Soldering iron tips and the metal parts of tools or fixtures should be grounded. The device should not be inserted into or removed from circuits while energized. Signals should not be applied to the input terminals when the device's power source is OFF. Finally, all maximum ratings must be observed, including storage and operating temperatures.

Readers' Circuits. Commenting on the random 4-digit number generator circuit contributed by Michael S. Pyska and featured in last September's column, Michael M. Lacefield (1008 Turnbull Drive, Metairie, LA 70001) suggests that the circuit can be simplified considerably by using the self-generated strobe signal available in the counter/driver IC instead of a separate pulse oscillator as the counting signal source. Mike Lacefield's modified circuit is illustrated in Fig. 3. As in the original design, the counter/driver (*IC1*) is a National Semiconductor type MM74C925, the readouts are 7-segment common-cathode types, the driver transistors, *Q1* through *Q4*, are type 2N2222 general-purpose npn devices, and the power supply, *B1*, consists of three or four series-connected penlight or flashlight cells. Power switch *S1* is a spst toggle, slide, or rotary unit, with the *latch* switch, *S2*, a spdt spring-return pushbutton or lever type. All resistors are one-quarter or one-half-watt types, with the series readout current limiters (*Rs*) 100-to-220-ohm units (the exact value is not critical). In operation, *IC1* counts at its strobe rate (approximately 1 kHz) continuously while *S2* is in the RUN position. When *S2* is depressed, the instantaneous count in *IC1*'s register, essentially a random number, is displayed on the readouts. As the original design, the random number generator can be assembled using any desired construction technique from perf board to a specially designed pc board, and can be used in games, ESP experiments and similar applications.

Submitted by Will Hobbs (656½ W. 22nd, Eugene, OR 97405), the circuit shown in Fig. 4 was developed as an accessory for a pocket calculator to permit the latter's use as a simple stopwatch. It is basically a repetitive switch operating at a 10-Hz rate. Easily duplicated in the home workshop using either perf board or pc wiring techniques, the design uses standard, readily available components. The active devices required for the project are a 555 type timer (*IC1*), a CD4022 counter/divider (*IC2*), a CD-4016 quad bilateral switch (*IC3*), a 2N2222 general-purpose npn transistor (*Q1*), and a 1N4001 general-purpose rectifier (*D1*). Diode *LED1* and associated current limiting resistor *R1* are optional. All resistors are one-quarter or one-half-watt units and, except for 12-volt electrolytic capacitor *C1*, all capacitors are small, low-voltage ceramic or plastic film types. Power switch *S1* is a spst toggle or slide type while *S2* is a spst alternate action (push on/push off) pushbutton switch. A small 6.3-volt filament transformer is used for T1.

In operation, a 60-Hz signal derived from *T1* through series limiting resistor *R2* and blocking capacitor *C2* is applied to *IC1*, connected as a modified Schmitt trigger. The 60-Hz trigger pulses from *IC1* are divided by 6 by *IC2* to deliver a 10-Hz signal through buffer amplifier *Q1* to one section of the quad bilateral switch, *IC3*. Driven by *T1*'s secondary, a simple half-wave rectifier (*D1*) and capacitive filter (*C1*), monitored by *LED1*, serves as the circuit's dc power supply.

Although Will developed the design primarily for use as a calculator stopwatch adaptor, the circuit can be used in virtually all applications requiring low-level repetitive switching at a reasonably accurate fixed rate. For stopwatch applications, the adaptor must be used with calculators capable of constant operations using the "equals" key. The circuit output leads are connected in parallel with the calculator "=" key terminals. Next, the decimal point, "1," and " + " keys are depressed to enter "0.1" and the addition function. Alternate action pushbutton *S2* is then pressed once to start the timing cycle, a second time to stop timing. The calculator display will indicate the number of seconds and tenths of seconds that have elapsed during the interval.

Device/Product News. A new single-chip CMOS IC that requires only two external resistors, two capacitors, and a single voltage reference to form a modified, dual-slope, analog-to-digital converter is now available from Motorola Semiconductor Products, Inc. (Integrated Circuit Division, 3501 Ed Bluestein Blvd, Austin, TX 78721). Designed for DVM/DMM, digital thermometer, digital scale, and μP applications, the 3½-digit circuit, designated type MC14433, has a multiplexed BCD output format and an intrinsic full scale range of ±199.9 mV (200 mV reference) or ±1.999V (2 V reference), with an input impedance of more than 1000 megohms. Dissipating very little power, the device can be used with both LED and LCD displays. Combining both linear and digital functions on one chip, the MC14433 is supplied in a 24-pin plastic ("P" suffix) or ceramic ("L" suffix) DIP. ◇

Experimenter's Corner

By Forrest M. Mims

ACTIVE FILTERS

ACTIVE filters provide one of the most important applications for operational amplifiers. Conventional "passive" filters use various combinations of resistors, capacitors, and sometimes inductors to block one range of frequencies while passing another range. Filters like this have been used for many years, but they have a major disadvantage in that their passive components can *absorb* much of the signal they are designed to *pass*! The active filter overcomes this major drawback by incorporating one or more op amps (or other active devices) to beef up the filtered signal. A suitably designed active filter can even have significant gain. And active filters can provide the desirable combination of high input impedance and low output impedance.

Like passive filters, active filters are designated by function—low-pass, high-pass, band-pass, or notch. As the name implies, a low-pass filter blocks high frequencies but passes low frequencies. A high-pass filter blocks low frequencies but passes high frequencies. A band-pass filter passes only a narrow band of frequencies. And a notch filter blocks a narrow band of frequencies. The operation of each of these types of filters is clearly demonstrated by the frequency response curves of Fig. 1.

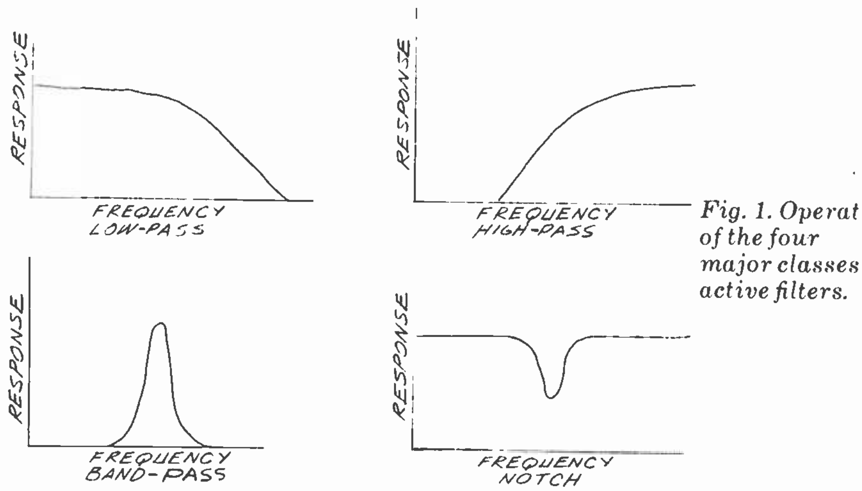
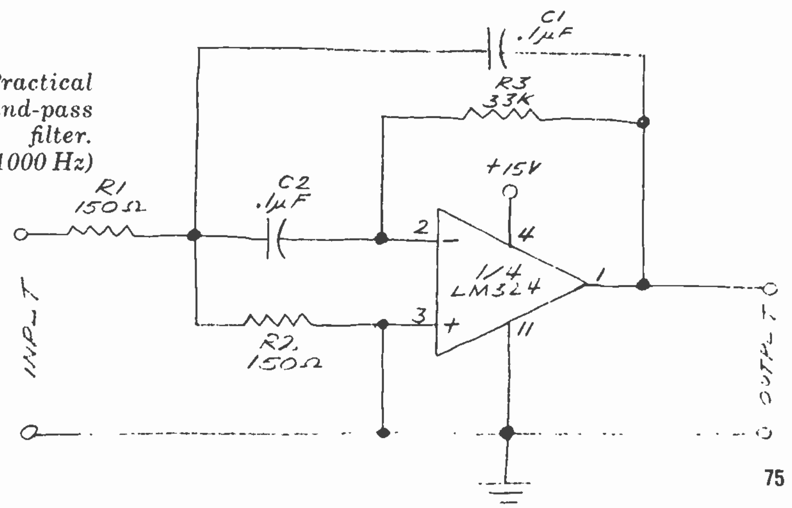


Fig. 1. Operation of the four major classes of active filters.

Active filters are often found in modern electronic circuits. For example, notch filters can be included in high-gain audio and instrumentation amplifiers to block unwanted signals such as 60-Hz hum. High-pass filters can also be used to block 60-Hz hum as well as low-frequency noise and interference in general. Similarly, low-pass filters can be used to block unwanted high-frequency noise and hiss. Both low- and high-pass filters can be used in various audio applications to emphasize certain frequency ranges. Band-pass filters can be used in tone-sensitive devices such as Touch-Tone decoders, LED intrusion alarms, secret locks activated by a tone-modulated LED, frequency indicators, and many others.

Fig. 2. Practical active band-pass filter. (f_0 = 1000 Hz)



A Practical Bandpass Circuit. There are many ways to design active filters using op amps. Figure 2 shows the circuit for a working band-pass filter which uses a total of only six components—including the op amp! A LED is included at the filter's output to let you know when a signal is being passed through the filter.

The circuit in Fig. 2 uses one of the four amplifiers in a LM324 quad op amp (Fig. 3). This chip was used because it can easily be operated from a single-ended power supply. Also, the LM324 allows you to make up to four separate active filters using a single chip. However, if you prefer, you can use a 741 or other standard op amp in place of the LM324 and a dual-polarity supply (if required).

You can assemble and test this circuit in a matter of minutes on one of the new IC breadboards. With a sine-wave input, the values shown in Fig. 2 will give a peak frequency response of about 1000 Hz. This means that, as the input frequency approaches 1000 Hz, the LED will begin to glow. The LED will glow brightest at about 1000 Hz and begin to dim as the frequency increases. If the LED doesn't glow, increase the amplitude of the sine wave to a volt or more.

If you don't have a sine-wave generator, you can test the circuit with the simple triangle generator shown in Fig. 4. This circuit uses a 566 function generator IC. The oscillation frequency of the 566 can be easily varied by adjusting potentiometer *R3*. Connect the output of the generator to *R1* of the filter.

Since the output of the 566 is a triangle wave riding on a dc level, the frequency response of the filter will be different than when a positive-negative symmetrical sine wave is fed into the filter. For example, when the oscillator of Fig. 4 is connected to the filter, the frequency of maximum response is shifted downward to about 250 Hz.

Bandpass Design Equations. In his book "Applications of Linear Integrated Circuits," (John Wiley and Sons, New York, pp. 170-185), E.R. Hnatek gives a set of design equations that can be used to tailor the filter of Fig. 2 to any desired frequency response. They are:

$R1 = 1/HC1\omega_0$

$R2 = R1R_{EQ}/(R1 - R_{EQ})$

$R_{EQ} = 1/Q(C1 + C2)\omega_0$

$R3 = A_0R1\,(1 + C1/C2)$

where,

$H = A_0Q$

A_0 = op amp gain

Q = filter quality factor

$\omega_0 = 2\pi f_0$

f_0 = detection frequency

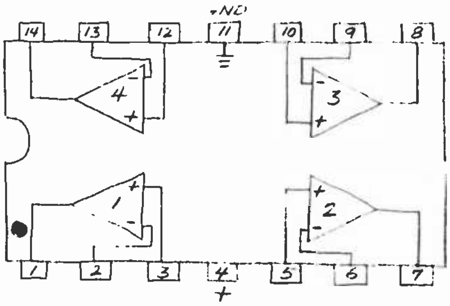


Fig. 3. LM324 pin diagram.

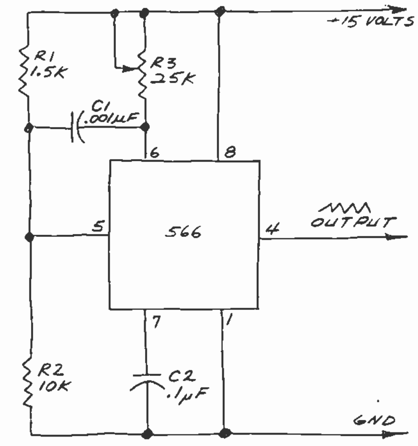


Fig. 4. Triangle-wave generator.

For best results, use identical values for both *C1* and *C2*. A good choice is 0.1µF. Also, try to keep A_0 down to 100 or less; and *Q* to 10 or less in initial experiments. After you have experimented with the actual circuit, you can try larger values for A_0 and *Q*. Incidentally, the larger the *Q*, the narrower the pass band.

A pocket calculator, particularly one with scientific notation, comes in very handy when solving these design equations. If you have a programmable calculator, you might even want to write a program which will automatically solve the equations. Remember that all R's are in ohms and all C's in farads. Frequencies are in hertz.

While these equations make it possible to design an active band-pass filter *on paper*, you can quickly see the effect that variations in only one component have on the filter by substituting a 250-ohm potentiometer for *R2*. The following table shows how the detected frequency *and* the total band of detected frequencies change as *R2* is varied:

R2	f_0	Passband*
25	439	380-504
50	260	192-317
75	255	147-459
100	231	119-787

*Measured at the 1.75-volt points

These measurements were made with the triangle wave source in Fig. 4 connected to the input of the filter. Both circuits were powered by a common 15-volt supply. Resistor *R2* and f_0 were measured with a digital multimeter and a digital frequency counter, respectively. The pass band was measured with an oscilloscope. As you might expect, a scope and frequency counter are *very* handy when designing practical active filter circuits. ◇

April Hobby Scene

By Marcia Swampfelder

STEREO SPEAKER POSITIONS

Q. ***Should car stereo speakers be pointed to the rear for more thrust, or up for more traction?***

A. That depends on your particular driving conditions. On long trips, the 20-to-30% improvement in gas mileage you get with speakers pointing to the rear is certainly worthwhile. On the other hand, if you drive on snow or ice, the extra traction of speakers pointing upward gives you added control. But be sure to watch the volume when you do this. Recent tests show that extra loud rock music can delaminate radial tires.

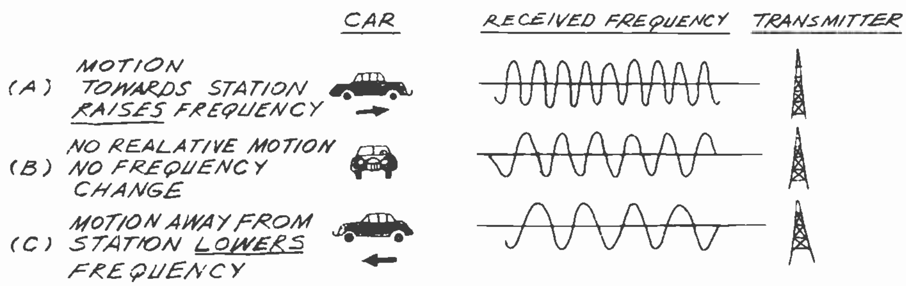
THE DOPPLER EFFECT

Q. ***As I drive around town, I have to keep fine-tuning my AM car radio. Why is this, and how can it be fixed?***

A. Your problem is caused by the Doppler effect. As shown in the diagram, as you drive toward a radio station, you intercept the r-f cycles progressively earlier in each cycle, and the apparent frequency goes up. As you sit still or drive at right angles to the station, you get the normal frequency. As you drive away from the station, you see each cycle later in time, and the frequency goes down. This is why constant retuning may be needed.

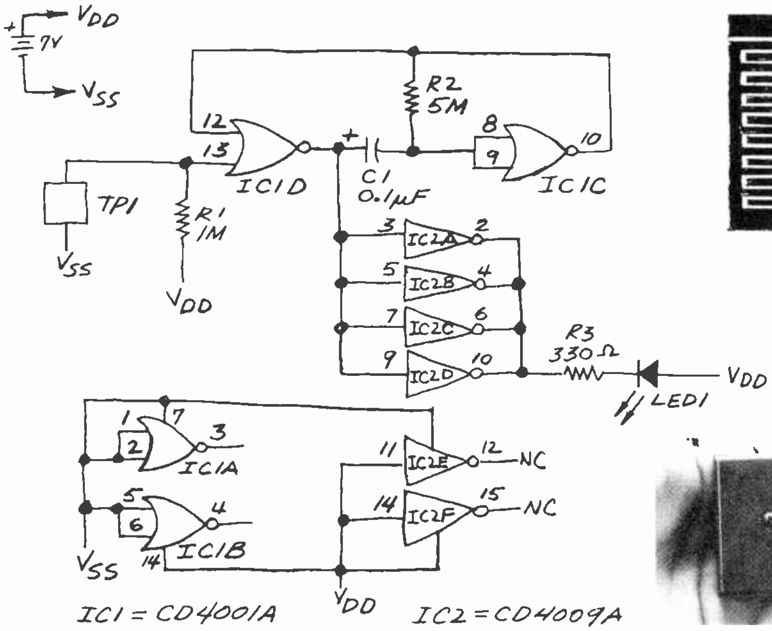
To get around this problem, you can go to a rather expensive phase-locked-loop tracking circuit; but it's far simpler to arrange your driving so that you are a constant distance (for example, in a circular path) from your favorite station.

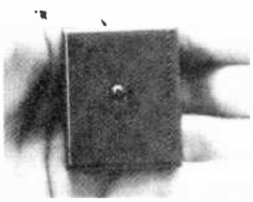
By the way, this is the real reason those loop thruways were built around many cities, and also explains why traffic on them is heaviest during the most popular programs.



STATE-OF-THE-ART DO-NOTHING BOX

Q. ***We've all built old-fashioned do-nothing boxes using neon lamps and 90-volt batteries. How about an updated design using low voltages, IC's, and a LED?***





A. A schematic and foil pattern for an advanced technology, 100%-IC design do-nothing box is shown here, courtesy of Joel Grodstein, Highland Park, N.J. A 0.7-Hz multivibrator is composed of *IC1*, *R2*, and *C1*. When nothing touches *TP1*, an etched pc touch plate, voltage applied to *IC1D* through *R1* keeps the oscillator turned off. When the plate is touched, skin resistance provides the other half of a voltage divider, and the oscillator free-runs. Its output drives *IC2*, which sinks current from *LED1* and *R3*. Quiescent current demand is 0.04 μA, so the battery will last a long time. Do-nothing boxes should be very compact. The prototype uses a Pomona 3720-2 enclosure measuring a scant 1.75" × 1.44" × 0.69" (4.45 × 3.66 × 1.75 cm). An Eveready E175 7-volt mercury cell and a subminiature tantalum capacitor (Sprague SD35-104 or similar) should be used. The circuit can be assembled on a 1-3/16" × 25/32" (3.02 × 1.98 cm) circuit board using pc, point-to-point, or Wire-Wrap techniques. Touch plate *TP1* is a 1-19/32" × 1-9/32" (4.05 × 3.25 cm) etched pc board which should be mounted in place of the panel supplied with the box. This forms the bottom of the box. The LED (a standard subminiature red—to match the box—diode) mounts on the top of the box after a small hole has been drilled for it. When you pick up the box, your fingers will invariably touch *TP1* and activate the do-nothing circuit, causing the LED to blink.

NEW SOLAR CELLS

Q. *What is the* in situ *solar cell process?*

A. That's the big breakthrough in solar cell design that drops the cost of solar power to $90 per kilowatt. Actually, the *in situ* (Latin for "in place") technique is stunningly simple. Instead of refining the silicon and then building cells, you build the cells first and then refine the silicon.

The process generates a cell from ordinary beach sand (silicon dioxide). After cell fabrication, the sand is chemically treated. The reaction drives off the oxygen, leaving an almost pure polycrystalline silicon. Most conveniently, any remaining impurities rearrange themselves to form uniformly doped series connected pn junctions through a process called Barfoot Layering. For each centimeter of cell thickness, you typically get several hundred series pn junctions or about 120 volts dc under normal sunlight. The thickness of the panel determines the voltage and the area the current. Typical current densities are four amperes per square meter of panel!

You can easily build a 100-watt cell. Simply take an ordinary metal cookie sheet, cover it uniformly with a 1-centimeter thick layer of beach sand, cover that with a piece of screening for the front collector, add a protective glass cover, and clamp everything together with large rubber bands, bungee cords, or something similar.

To do your final chemical refinement, carefully remove the glass cover and spray the sand with two liters of 3,7 Dimethylpentadecon-2-ol Propionate (available from larger organic chemical supply houses). An ordinary window cleaner bottle makes a handy spray source. Reaction time is four hours. Since the reaction is photoisentropic, it should be done under magenta safelight, such as that from a Portal Industries JJ-668 source.

The front terminal is positive and the greatest output will be obtained when the panel is pointed due south at an elevation of your latitude plus ten degrees. A group of panels can, of course, be wired in parallel for independent, on-site power.

INTERFACING COMPUTERS

Q. *What is a MacDonald computer interface?*

A. Dr. Jerome F. MacDonald is the senior member of a design team that has long been working in the Dairy Science Division of the U.S. Department of Agriculture. They have come up with a communications input/output (I/O) and interchange code for computers, terminals, and real-world inputs. The coding is simple, effective, and easy to use. It's spreading rapidly to other government agencies and now is becoming an industry-wide standard. In fact, the code already has an Electronic Industries Evaluationary (EIE) status. Thus, the old MacDonald farm interface is now an EIE I/O.

DE-HEXING CIRCUITS

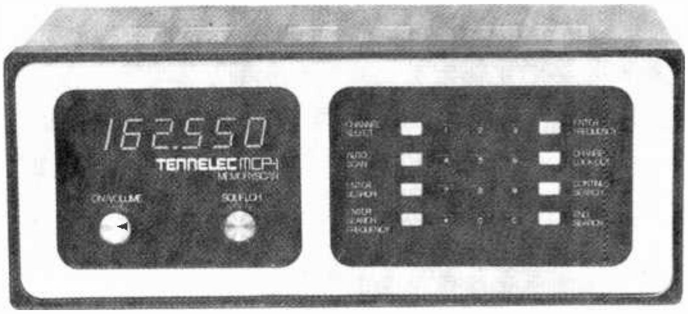
Q. *After seeing a not-so-recent horror movie, my kid brother claims he is possessed by demons. Is there any electronic cure I can try?*

A. Your brother's cure is simple. Virtually any hex inverter will work. Try the 7404 (TTL), the MC789 (RTL), or the 4049 (CMOS).

Product Test Reports

TENNELEC MODEL MPC-1 MEMORYSCAN MONITOR RECEIVER

Microprocessor-controlled scanner expands operating functions.



THE Tennelec Model MPC-1 "Memoryscan" 16-channel receiver can search the entire uhf, vhf-low, and vhf-high bands to detect active frequencies and store them in a random-access memory. These frequencies can later be recalled automatically or manually by pressing a button. The heart of the system is a microprocessor, which provides control of frequencies through a phase-locked-loop frequency synthesizer that eliminates the need for channel crystals. The monitor provides frequency coverage of the Public Service bands in 5-kHz increments over the ranges of 31.180 to 51.655 MHz on low vhf, 151.180 to 171.655 MHz on high vhf, and 451.180 to 471.655 MHz on uhf.

The monitor receiver differs from other digitally synthesized scanners. Whereas others require use of a code book to set up new frequencies, here frequencies for each channel are set by a keyboard. Both channel selected and frequency are indicated by a LED numerical display.

A special provision built into the receiver is a "search" feature that automatically scans a spectrum to locate and identify the frequencies of signals at any given time anywhere within a given range. It is not necessary, therefore, to know in advance what frequencies are active in your reception area. The frequencies that have been searched out can then immediately be stored in the RAM for subsequent use.

The receiver features: squelch, volume control, manual/automatic scan, 10-channel/second scan rate, channel bypass, plug-in whip antenna, built-in loudspeaker. and 117-volt, 60-Hz ac power supply. There is no scan delay or priority channel.

Separate front ends are provided for each range. The front ends are automatically selected according to the programmed frequency. The inputs are matched for optimum performance with the 18" (45.7-cm) whip antenna supplied with the scanner. Selectivity is obtained by filtering at a 10.7-MHz i-f.

Heterodyning signals are obtained from the digital synthesizer, which employs the PLL. The microprocessor that controls the synthesizer operates as a computer that calculates the code for the frequency and stores this code in the RAM and sets up the numerical channel/frequency display and initiates other functions.

The receiver measures 10¾"W × 9¾"D × 4½"H (27.3 × 24.8 × 11.4 cm). $399.95.

Test Results. The receiver's sensitivity for a 10-dB (S + N)/N ratio with a 3000-Hz deviation at 400 Hz is rated at 0.5 μV over the ranges of 33.100 to 45.000, 151.180 to 163.000, and 453 to 460 MHz. Somewhat lower sensitivity can be expected toward the ends of the normal ranges. With respect to the uhf range, full sensitivity is specified to be obtainable over any 7-MHz segment of the band when the associated r-f circuits are tuned as indicated in separately obtained service instructions.

The input impedance was found to be quite reactive and the manufacturer's method of measurement under this condition was not known (probably being based on the characteristics of the whip antenna).

Our measurements were based on a 50-ohm source and indicated sensitivities in the range of 0.5 to 1 μV. In addition, on-the-air tests with weak or distant signals provided just as good reception as that obtained with other scanners of a known sensitivity of 0.5 μV.

Slight asymmetry in selectivity was evident by an adjacent-signal rejection of 40 to 45 dB (at ±15 kHz), depending on which side of the desired frequency the signal was present.

Maximum squelch threshold sensitivity also was 0.5 to 1 μV. There is no external-speaker jack to allow use of a resistive test load, so our audio output measurement was made across the speaker terminals located within a shielded enclosure. Assuming the speaker to have an 8-ohm impedance, we measured 1.5 watts of power at 5% THD at 1000 Hz at start of limiting.

User Comment. The frequencies are set up by selecting the channel with a MANUAL pushbutton until the LED's display the desired channel. (Channel numbers start at 00 and go progressively up to 15.) You then press a CLEAR button that extinguishes all but a decimal point in the numeric display. The frequency is then programmed by depressing the numeric buttons in proper sequence, at which time the LED's indicate the selected numerals (as with a calculator) until the complete frequency is displayed. Storing the information in the memory is accomplished by depressing an ENTER FREQUENCY button. After the frequencies are set up, manual or automatic scanning can be chosen with appropriate buttons.

The channel and the frequency are alternately displayed, each for about one second at a time. Channels are bypassed by operating a CHANGE LOCKOUT button when the undesired channel is displayed. The display also shows a 0 or a 1, indicating if the channel is out-of or in operation.

Correction. In the description of the Ballantine 1010A Oscilloscope (March, p 101), the input sensitivity was incorrectly given as 20 mV/cm. It should have been 2 mV/cm.

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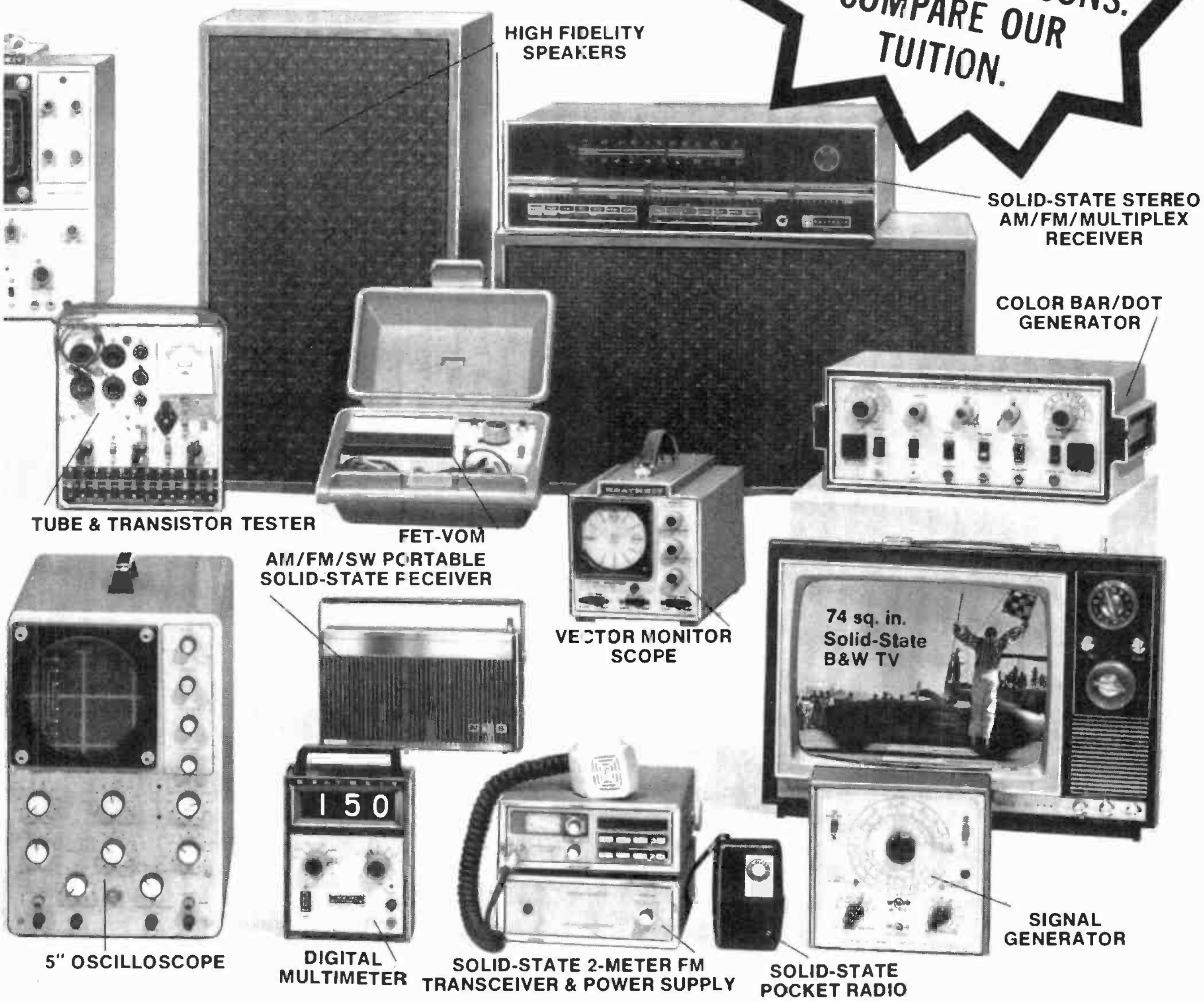

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Four other buttons are provided for the SEARCH operations. A search in 5-kHz increments over only a 1.2-MHz spread can be obtained, starting at the lowest frequency for which the channel used has been set up for this purpose. Other similar segments can be searched by reprogramming the starting frequency. When a signal has been located, searching stops to enable monitoring of the signal. When the signal ceases, the search continues.

The memories must constantly receive power to retain the stored information. Any interruption of power causes a loss of the stored data. There is no back-up battery or other means to prevent this in the event of a power failure. However, as long as the power cord is plugged into a live a-c outlet, power is still applied to the memories even when the receiver's ON/OFF switch is set to OFF. Any time the power plug is removed or due to other power-line interruptions, the scanner must be reprogrammed.

The input power drain for the memories alone is about 35 watts. Full operation requires 50 watts (continuous).

The selectivity and FM modulation acceptance result in a 5-kHz resolution. Signals 5 kHz from the programmed frequency can, therefore, be copied. Strong signals 10 kHz away can often be heard after a fashion.

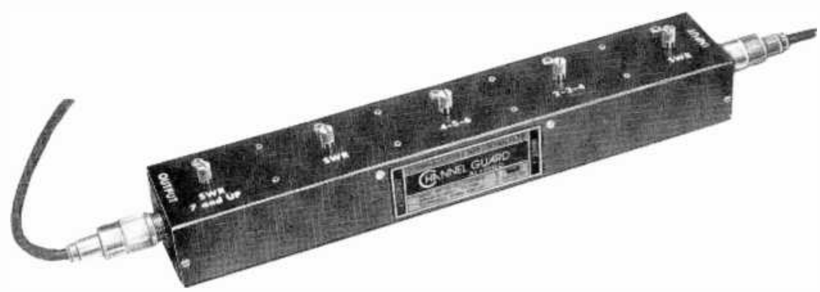
We discovered some unwanted responses on the high vhf band from signals about 7 kHz below the desired frequency. Similar situations also have been noted with other scanners using digital frequency synthesis.) For example, while listening to the weather broadcast on 162.55 MHz, we picked up our local police transmissions on 155.415 MHz. However, such a coincidence is seldom likely to occur.

In other respects the scanner performed excellently, providing good audio quality. The SEARCH feature is handy for eliminating the need for a directory to find the frequencies of services receivable in your area. Operation is simple after one becomes accustomed to the method of setting up the frequencies and modes. Clearly, the MCP-1 is among those scanners in the forefront of the technology.

CIRCLE NO 103 ON FREE INFORMATION CARD

TELCO CHANNEL GUARD MODEL XL-1000 TVI FILTER

Adjustable filter with up to 100 dB attenuation above 40 MHz.



TELEVISION interference (commonly abbreviated TVI) caused by a CB transmitter can often be eliminated by a low-pass filter installed between transmitter and antenna. Such a TVI filter permits transmission of signal frequencies below about 40 MHz (allowing the CB channels to pass) while attenuating the higher frequencies that fall within the TV channel range. Hence, harmonics of the fundamental CB frequency of the spurious signals that might affect certain TV channels can be sufficiently held down to eliminate TVI.

There are, of course, a number of TVI filters on the market, most of which provide 40 to 50 dB of attenuation at frequencies higher than 40 MHz or so. The Telco Model XL-1000 TVI filter, on the other hand, is designed to provide attenuation up to 100 dB. User-adjustable circuits can be precisely set for maximum spurious-signal attenuation at several specific TV channel frequencies.

Although harmonically related CB TVI is likely to affect mostly TV channels 2, 5, 6, and 9, the filter is also suitable for amateur radio transmitters that might interfere with other TV channels. Therefore, the TVI filter is designed to handle up to 1000 watts of r-f power for amateur radio use.

The retail price of the Model XL-1000 TVI filter is $34.95.

General Details. The filter is sealed in a metal box, which precluded our being able to look inside to determine what type of circuitry it employs.

There are five controls on the filter's case. Two are used for setting up the reflected SWR and two others for "notching" (maximizing) attenuation on TV channels 2, 3, 4 and 4, 5, 6. The fifth control is for TV channels 7 through 13. This last control also affects the SWR indication.

An SWR indicator is required at the output of the transmitter for properly performing the filter adjustments. The SWR meter can be an external instrument, or it can be built into the transceiver itself. Adjustments are first made for the lowest obtainable SWR indication with the filter installed between the SWR meter and a 50-ohm nonreactive dummy load. Then, the antenna line is substituted for the dummy load and the filter is again adjusted for a minimum SWR indication. Finally, the channel-notching controls are tuned for maximum TVI reduction while maintaining an acceptable SWR ratio (usually less than 1.5:1) as you view the affected TV channel. Adjustment of the SWR controls may be necessary to provide a suitable compromise between minimum SWR and best TV reception without interference.

Test Results. We adjusted the filter for a reflected SWR indication of less than 1.1:1, using dummy loads (equivalent to an SWR of 1:1 and 2:1). We measured the maximum possible filter attenuation in the 54-to-54.8-MHz band. This is the second harmonic range of the CB channel signals that fall within the TV channel-2 band, which is usually the most often affected TV channel. Our measurement yielded a 95-dB attenuation figure for the second harmonic.

The output of a signal generator tuned to TV channel 2 was then applied directly to the TV receiver we used during our tests. The signal level was adjusted for an output level of 100,000 μV, which is the equivalent of a 17-dB greater level than the FCC's minimum spurious requirement at the output of the transmitter for type acceptance. This, of course, completely obliterated the TV picture. Then, after installing the previously adjusted TVI filter, we obtained clear TV reception. We also checked TV channels 5 and 6 with similar results.

User Comment. One of the advantages of this TVI filter is that it has adjustments for providing the lowest SWR as "seen" by the transmitter for best matching and maximum transfer of power to the transmission line. The filter, therefore, doubles as a so-called "antenna matcher," even if it is not needed for reducing TVI.

There were several combinations of adjustments that resulted in a low SWR with minimum TVI. Some power loss is usually experienced whenever a filter is placed between transmitter and transmission line. But with the Model XL-1000, when 4 watts of CB power was applied to the input of the filter, a loss of 0.1 to 0.5 watt resulted, depending on the particular tuning combination and the initial SWR before the filter was installed. This amount of loss is insignificant and is outweighed by the advantages gained by the use of the filter.

With the aid of a sweep generator and an oscilloscope to produce a visual display of the filter's characteristics, we observed that the steepness of the high-frequency cutoff slope varied according to the combinations of control settings we used. In some cases, signals somewhat beyond 40 MHz were attenuated by only 10 to 20 dB. Optimum adjustment of the controls, therefore, can often be slightly critical.

It should be borne in mind that a low-pass filter at the output of the transmitter can minimize or eliminate TVI that is produced by spurious emissions transmitted only through the antenna system. It will not eliminate TVI that results from direct radiation through the transceiver's case, power, or microphone cables, where the fundamental signal is strong enough to overload the TV receiver. This causes spurious signals to be generated within the TV receiver itself.

One of the common causes of TVI is the transmission of spurious signals via the antenna system. From our test results, it is obvious that the Model XL-1000 TVI filter should clean up most cases of objectionable TVI.

Note that the adjustments for minimum SWR do not change the actual SWR along the transmission line that may be due to a mismatch at the antenna and may also cause other losses. The adjustments of the TVI filter simply make the reflected input impedance of a line mismatched at the antenna appear like a low SWR to provide the best power transfer to the line.

SHURE MODEL 526T COMMUNICATION MICROPHONE

Amplified base-station mike has gain control and VOX control provision.

THE Shure Model 526T transistorized table microphone is designed for CB and amateur radio base-station applications. The base of the mike contains a one-transistor amplifier that is powered by a standard 9-volt battery. A flat push-to-talk switch plate covers the full width of the front of the base. A knob-operated control is provided for adjusting the output level of the mike over an approximate 20:1, or 26-dB, range. Although the microphone element is open only in the front, where it is protected by a mesh screen, it is essentially omnidirectional.

The combined frequency response of microphone cartridge and built-in preamplifier is roughly 200 to 6000 Hz. The response is broadly peaked in the range between 2000 and 5000 Hz. With an output impedance of 5000 ohms, the mike is designed to operate into load impedances of 1000 ohms or greater.

The base of the microphone measures roughly 5⅞"D × 4¼"W (15 × 11 cm). Atop the upright supporting column, the slightly upward-tilted microphone stands about 10" (25.4 cm) above the table. The mike weighs approximately 2 lb (920 g). Retail price is $42.00.

General Description. The push-to-talk switch is spring loaded to automatically shut off the mike when released. However, by pulling the switch plate forward, the mike can be locked in the on position. (The amplifier draws current only when the mike is on.)

The nondetachable 7′ (2.1-m) cable that comes attached to the mike has three conductors and a shield. Two of the conductors are used for operating the transmitter's relay control circuits. The mike can also be used with VOX-equipped transmitters. A slide switch located under the base of the mike, with positions labelled VOX and NORMAL, must be set to VOX, which disables the push-to-talk transmitting control line. At the same time, the control plate of the push-to-talk switch must be locked in the on position to energize the transistor preamplifier. For non-vox transmitters, the switch must be left in the NORMAL position.

The mike is designed to be compatible with the high r-f fields that surround a powerful ham transmitter. It is also shielded against hum pickup. Its shaped frequency response gives high intelligibility under difficult transmission and reception conditions. All nonmetallic portions of the base and pedestal column are made of high-impact plastic.

Laboratory Measurements. The microphone's response was measured by placing it in front of a loudspeaker and recording its output on a graphic response plotter. During the test, the speaker was driven with a sine-wave signal that was swept from 20 to 20,000 Hz. A calibrated laboratory standard microphone, placed as close as possible to the test mike, was used to make a second plot on the same chart. The differences between the two were then replotted to provide the response of the Shure mike. (The reference mike's response was flat to within a fraction of a decibel over the operating range of the Shure mike.)

The final response curve was very similar to that illustrated in the instruction sheet that accompanied the Shure mike. It was within ±1 dB from 300 to 1200 Hz, rising to a maximum of about +11 dB at 3000 Hz and dropping rapidly beyond 5000 Hz. The low-frequency response dropped at a rate of about 18 dB/octave below 300 Hz.

The average output voltage of the microphone under close-talking conditions was about 10 mV with the level control set to minimum. It was about 200 mV when the control was advanced to maximum. The response of the mike was omnidirectional, with no significant change in quality or output level for any direction.

User Comment. We made a tape recording of the output of the mike and listened to the playback to judge its overall sound quality. It was surprisingly natural, even on a wide-range recording, exhibiting some crispness due to the 3000-Hz peak.

To judge the effectiveness of the mike in communication situations, we used it with a 1-kW amateur SSB station, comparing it with our regular station mike, a wide-range cardioid designed for PA and recording applications. Comments from stations we worked generally favored the Shure mike, citing its clarity and "punch" compared to the somewhat bland sound of the other mike. The Model 526T mike is very sensitive. Even with its gain control set to minimum, we were able to place it on the desk and talk from a distance of 1′ to 2′ (30.5 to 61 cm) without loss of effectiveness.

We had been concerned about the possibility of r-f pickup causing difficulties with the built-in preamplifier, but we encountered no such problems. Needless to say, such problems would be highly unlikely to emerge with the lower power of CB transmitters. The omnidirectional response of the mike caused it to pick up some room reverberation and the sound of the cooling fan on our linear amplifier, but not to any objectionable degree. The ability of our regular mike's cardioid pattern to reject unwanted sounds is a point in its favor, but not everyone would operate the Shure mike in close proximity to a fairly noisy fan.

Since the internal frequency response of our SSB transmitter is limited to about 2600 Hz, which is somewhat below the peak of the mike's response, we were probably not obtaining the full benefit of the mike's shaped characteristic. In CB service, we would expect the mike to be an outstanding performer, just as we consider it to be a strong adjunct to any amateur station.

CIRCLE NO. 105 ON FREE INFORMATION CARD

0030 CIRCLE NO. 20 ON FREE INFORMATION CARD

Amateur Radio

By Herbert S. Brier, W9EGQ

ONE-WAVELENGTH LOOP ANTENNAS

PERHAPS the most difficult decision to be made in setting up an amateur station is which antenna to use. Unlike hf receivers, transmitters, and transceivers, antennas vary so much in appearance (and performance) that sometimes they're not recognizable as such. On 80 and 40 Meters, the half-wave dipole is the most popular. But it is not always convenient or possible to install one. Furthermore, although the dipole is a dependable but not spectacular performer, many competitive designs have been developed.

One such antenna is the one-wavelength loop, examples of which are shown in the figure. It has found enthusiastic acceptance among a small number of amateurs, but many are not familiar with its operating characteristics. Computer analyses indicate that the loop is superior to half-wave dipoles at any height so that its lowest points are no less than a few feet off the ground. Also, its dimensions are such that an 80-Meter loop will often fit in spaces that can't accommodate a dipole.

Various Configurations. Predictably, experimentation by amateurs has resulted in a number of variations on the loop theme. For example, the square or Quad loop at (A) can be fed at the center of one of its horizontal (point X) or vertical (point Y) side. Horizontal feed results in a horizontally polarized field and a radiation pattern similar to that of a half-wave dipole. Maximum radiation occurs broadside to the loop—the exact opposite of the pattern obtained with a "small" loop. Feeding the loop on its side produces a low-angle, vertically polarized radiation pattern. This is good for DX chasing even when the loop is fairly close to the ground. The loop's nominal impedance is 60 ohms, and can therefore be fed with 50-ohm coaxial cable (either directly or through a 1:1 balun). The resulting SWR will be under 1.5:1.

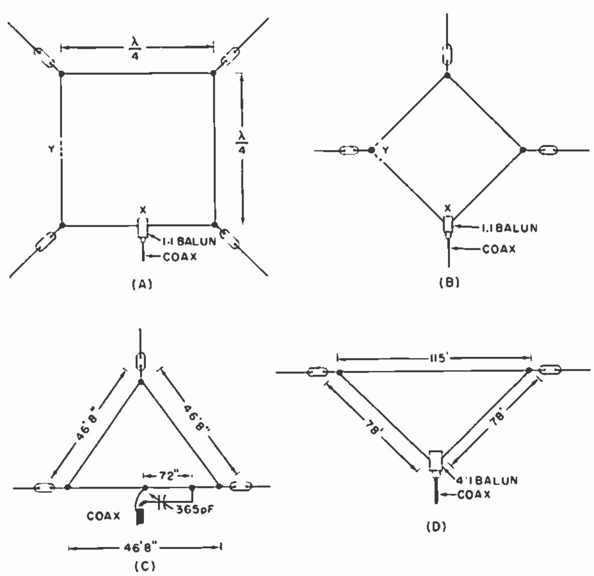
Rotating the Quad 90 degrees yields a Diamond loop, illustrated at (B). It may be fed at the bottom (point X) or side (point Y) corner, and will radiate horizontally or vertically polarized signals, respectively. A good match to 50-ohm coax will be obtained. Performance of the two loop configurations is very similar, but some operators claim that the Diamond is slightly more efficient.

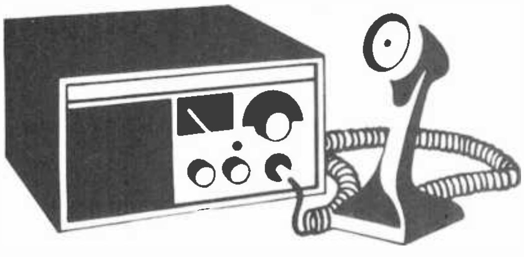
One-wavelength loops can also take on triangular shapes. The 40-Meter equilateral triangle (C) originally constructed by WB6UFW, is a real winner if a center support at about 50 feet is available. Its 50-ohm feedline is gamma matched to the center of the triangle's base. The gamma conductor is 72 inches (182.9 cm) long, spaced six inches (15.2 cm) from the loop conductor. A 365-pF receiving-type variable capacitor is adjusted for minimum feedline SWR at the design frequency of the antenna. After the capacitor is properly adjusted, it should be enclosed in a weatherproof plastic box to protect it from the elements. According to WB6UFW, it outperforms by far the conventional inverted V it has replaced for overseas DX work.

Another triangle, constructed by G3AQC, differs in several respects from WB6UFW's loop. First of all, it operates on the 80-Meter band. Also, its base is nominally a half-wavelength, with a few feet at each end bent over to save space. Its lengths are 115 feet or 35.05 m (base) and 78 feet or 23.77 m (sides). The loop emits a low-angle, vertically polarized signal, but some high-angle, horizontally polarized components are radiated because the antenna is fed at one corner with balanced feeders. An antenna coupler is used to match the line to the transmitter output. G3AQC reports that this antenna is an effective 3.5-MHz DX performer, and requires a single 60-to-65-foot (18.29-to-19.8-m) center support.

G3ZTH has literally turned G3AGC's and WB6UFW's ideas upside down by putting the 115-foot (35.05-m) horizontal run at the top rather than at the base. Two 78-foot (23.77-m) sides complete the triangle, going from the ends of the horizontal run down to a point centered below it. The antenna is illustrated at (D). It is fed at the bottom, presenting a feedpoint impedance of 180 ohms. A 4:1 balun will step this down for a good match to 50-ohm coax, and an SWR of 1.1:1 at the design frequency should be obtained. Besides being a good performer on 80 Meters, it will also work well on 40, 20, 15 and 10 Meters.

If you want to experiment with simple one-wavelength loops, calculate the required loop length using the formula: length (in feet) = 1000/frequency (in MHz). Mark the center point before stringing the wire. Standard 12- or 14-gauge copper or "electric fence" wire is available from the larger mail order/department stores. ◇





CB Scene

By Ray Newhall, KWI6010

UNCLE CHARLIE TALKS TO CB'ERS

IF YOU pass through Norfolk, Virginia, within the next few weeks and happen to hear the Good Buddies on channel 19 talking KFCC-1000, you can be sure that his handle is "Uncle Charlie". On the other hand, he may be on any other channel where the action is. One thing you should know is that the voice on the other end belongs to an FCC Field Operations agent.

Similar call signs may show up in other parts of the country. KFCC is the prefix the FCC has chosen for itself (as a government radio station, they do not have to use any call sign) so that CB'ers will know that they are talking to the *real* "Uncle Charlie." This is all a part of the FCC's new enforcement policy which may soon be known as "E^2" . . . or, "Educate, then Enforce."

The only ground rules to follow when you talk with "Uncle Charlie" are to operate on a rig that you believe to be legal (NO linears), and to use your call sign. He'll chat with you and answer any questions you might have about the Citizens Radio Service, its rules, or the technical attributes of your equipment. The rig he'll use is a standard commercial base unit with a legal antenna, but that is where the similarity of his station and yours stops. His rig is surrounded by a six-foot high by eight-foot wide instrument console. In the bat of an eye he can measure your operating frequency, determine your modulation level (in percent), and analyze your sidebands and harmonic emissions. In a nutshell, within a few seconds he'll know more about your station that you do.

You have "Uncle Charlie's" guarantee that during any period a KFCC station is in direct contact with CB'ers there will be no citations issued to legally licensed operators in the area. That brings us to the second phase of the new enforcement policy.

Russian Roulette—FCC Style. *News item:* Des Moines, Iowa, August 25, 1976. Search and seizure warrants were served on several operators of illegal CB equipment today, resulting in the confiscation of illegal CB radio equipment worth more than $5000.00.

News item: Baltimore, Md., October 27, 1976. Coordinated raids were conducted by FCC agents and Federal marshals armed with search and seizure warrants for the purpose of confiscating illegal radio transmitters and arresting illegal operators. Nineteen persons were arrested, and more than $65,000 worth of illegal CB and modified amateur radio equipment was impounded. The raids were prompted by numerous charges of illegal operation documented by FCC personnel over several weeks of surveillance. Penalties for unlicensed operation of a radio transmitter can range up to $10,000 fines *and* a year in jail! Illegal operations by licensed operators can result in fines of $500.00 per day.

This is only a small beginning to a new enforcement effort by the FCC. Illegal operations in the light of this might be likened to playing a form of Russian Roulette, because the presence of the FCC operatives is never known until it is too late. Those illegal operators who get caught, lose their equipment, and face federal charges which might take them out of circulation *personally*.

I recently visited the Field Operations Division of FCC at their Norfolk, Virginia facilities. We watched station KFCC-1000 in action, and listened as dozens of CB'ers waited in line to talk with Uncle Charlie in person. Many intelligent questions were asked and answers were given. The FCC considers this direct contact program amazingly successful and is pleased with the response of the citizens. It claims that one of the greatest benefits is that the CB'ers have been able to give the FCC insights into the CB scene. The pilot project in Norfolk has provided the basis for budget requests to expand the KFCC project to communities throughout the country, like a traveling circus.

New Enforcement Vehicles. While in Norfolk, I took advantage of the first opportunity the FCC has provided the news media or the public to inspect their CB enforcement vehicles. We were specifically asked not to take pictures of these vehicles. I believe that restriction was a mistake, because they are plain, four-door sedans without markings or visible antennas. In fact, I was standing next to one of these instrumented vehicles when I unknowingly asked one FCC employee to show me where they were actually located.

I examined two different models. The one now operating in most every state has no special equipment which is obviously visible from the exterior. Instrumentation consists only of an unobtrusive "left-right" meter permanently mounted in the dashboard. It looks like a gas gauge. These units are particularly effective in locating moving mobile units on the highway. All the FCC enforcer needs is to get close enough to observe the operator talking on his rig while he gets a reading on his instruments. He records the vehicle's marker tag, and he has him nailed. The CB'er will never know he has been spotted until he receives a show-cause notice.

The second unit is a prototype of things to come. It looks like a miniature version of the KFCC-1000 base operation. Although there is still no outward evidence of any monitoring equipment, it includes frequency counters, modulation and spectrum analysis scopes, and an automatic direction finder (ADF) which points out the bearing within ± 2 degrees. The bearing is displayed instantaneously and automatically. It only requires that the mike be keyed briefly (¼ second or less) to lock onto the bearing and continue to display it to the operator to plot on a local road map. Two such short transmissions are sufficient to locate the very building or street corner where the offending transmitter is to be found.

The moral of this story is that FCC now has the means, and will soon have the budget, to police most areas of the country. They have no intention of "getting" every rule violator, but they do plan to make such a severe example of those they do catch that it will truly be a game of "Russian Roulette".

The Target. Emphasis of the FCC's new enforcement program will be con-

If you can't go to college for your career in electronics –read this!

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centrated in seven major violation areas (listed here in order of importance):

- Unauthorized use of a transmitter
- Use of unauthorized frequencies
- Overpowered equipment
- Obscene language
- False distress signals
- Use of radio in a criminal act
- Intentional disruption of communications

The FCC thinks it can achieve its goal—and so do I. The KFCC-1000 operation in Norfolk has been so successful that there is almost *no* unlicensed operation in that area, even by transients on channel 19. Careful samplings country-wide show conclusively that unlicensed operation is down to less than 10%, as opposed to over 50% 18 months ago.

The most serious and commonplace violation today is the illegal use of linear amplifiers. As a result television interference (TVI) has increased by several hundred percent within the past year. At least 60% of this increase results directly from the use of linears. About 75% of all TV sets within ¼ mile of a linear will experience TVI as a result of the harmonic interference the linear creates.

In coming months, the TV public will be told the truth about TVI and how to determine when TVI is the fault of their own TV sets or of their CB neighbor. They will be advised to write the FCC in all cases where TVI is confined to channels 2 or 5, because these are strong indications that the fault lies with harmonics produced by the CB system. Two or more complaints from the same local area will soon point the DF cars directly to those linears. The game is about to become more interesting. Those CB'ers who operate legally powered rigs on a clean antenna system have little to fear. Except where linears are involved, most TVI problems result from weaknesses in the TV sets themselves. The 95th Congress is expected to consider legislation requiring TV manufacturers to build sets with greater immunity to external interference. But you must remember that the new rules require the CB'er to assume a responsibility for the elimination of TVI caused by his own transmitter.

If you have the opportunity to talk with Uncle Charlie at KFCC-1000, do so. He will tell you how your rig is performing, or he'll advise you how to get any other information you may need. ◇

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Computer Bits

By Stephen B. Gray

MONITORS, OR CONTROL PROGRAMS

AS STRANGE as it may seem, at least half a dozen hobby computers have an almost bare front panel. These include the Southwest Technical 6800, PolyMorphic Poly 88, Wave Mate Jupiter II, Veras F8, and the OSI Challenger. All have only one or two switches on the front panel—one for power on/off and perhaps one for reset.

Why, then, are there so many other hobby computers with several dozen toggle switches and LED's on the front (the Altair 8800b and Imsai 8080, for instance)? One reason is tradition: it's always been done that way in commercial computers. Perhaps the most important reason is not so obvious: using all those switches and lights provides a certain feeling of power, of controlling something. The hobbyist who selects an Altair 8800b over a Southwest 6800 is more likely to drive a stick-shift car than one with automatic transmission, for the very same reason: he wants that hands-on feeling of control.

But aren't there some things you can do only with switches? Hardly any. Almost anything you can do with the switches on the front of the Electronic Tool Company's ETC-1000, you can do with Processor Technology's bare-front SOL, using *software* (programs fed into the computer) or *firmware*. (Firmware is a word used in the world of commercial computers, but seldom if ever in hobby computers. It is a set of subroutines stored permanently in the computer, usually in some type of read-only memory, or ROM.)

Some hobby computers have front-panel switches whose functions might seem difficult or impossible to implement with software or firmware. But it turns out that Memory Protect, for instance, can be duplicated by writing a software routine to set certain areas of memory off-limits to the program. A software routine can be written to provide the Single Step function, for stepping a program through its paces one cycle at a time.

One of the few things, if not the only thing, you can do with front-panel switches that you can't do with a monitor is this: some computers can sense the position of certain front-panel switches under program control, and use this "up or down" information to perform (or inhibit) various functions.

Monitors. The firmware that enables a Southwest or PolyMorphic or Wave Mate computer to operate with a nearly naked front panel is called a monitor, or control program. This is simply a set of subroutines written in a ROM, to supervise the sequencing and processing of user programs. As Southwest puts it, their monitor is a "permanently programmed memory that contains the necessary information to configure the machine for use with a terminal."

Some computers use a standard monitor, such as the Motorola Mikbug, found in the Southwest Technical 6800 and the M&R Astral 2000. Others use monitors developed for the specific computer, and not available to other manufacturers, such as in the KIM-1 (KIM stands for Keyboard Input Monitor).

Memory Loader. A memory loader, sometimes called a "bootstrap loader," has to be put into the computer first, to guide the user programs to the proper memory locations. Beginning computer hobbyists are sometimes quite surprised to find that a program can't be read directly into an "unprepared" computer. The computer doesn't know what to do with it, doesn't know where to put it, without a loader.

On a micro without a monitor, this loader has to be fed in by hand, via toggle switches, each time the computer is turned on, before programs can be read in. The loader is short, only about 20 bytes for the Altair 8800b, for instance. On the Southwest 6800, the loader is automatically called up from the Mikbug, as soon as the 6800 is turned on. If at any time you want to use the loader or any other monitor subroutine, press RESET, the 6800 goes into restart mode, and an asterisk shows up on the screen or printer. This means the Mikbug control programs are ready for an input. Other monitors use similar "ready" indicators.

Suppose you've been developing a program and have stored it on tape. To load that program into the Southwest

6800 (for example), you put the casette into your tape reader, and enter an L on the keyboard. The monitor goes through its "Memory Loader Function," which involves several dozen bytes of subroutine stored in the Mikbug, and supervises the loading of your program into memory. After loading is completed, push RESET, which causes the asterisk to show up again.

If you want to examine and perhaps change the contents of any part of memory, key in an M and the 4-character hex code for the memory address to be examined. The terminal will print the address and its contents. To make a change, press the space bar and enter the new data. The terminal then prints the next memory address in sequence, and its contents. If you're satisfied with those contents, enter any character except a space, and the terminal will print the following memory address and its contents. Thus the monitor's "memory examine and change function" automatically displays one address after another, with its contents, for as many addresses as you wish. When you're through, press the space bar and the carriage-return key. Another asterisk will be printed.

To load hex address A000 with 9E, you press only a few keys on the terminal keyboard. Without a monitor, you'd have to set a total of 24 switches, in binary, to 1010 0000 0000 0000, and then set eight data switches, to 1001 1110.

What happens if you select an address that turns out to be in ROM, PROM or a protected area of RAM? The monitor senses that the contents of such a memory location can't be changed, and causes the terminal to print a question mark.

Looking at Registers. If at any time you want to look at the contents of the computer's registers, and perhaps change one or more, then, in the case of the Mikbug, you key in an R, which calls up the monitor's "Display Contents of MPU Registers Function," and prints the contents of the condition code register, B and A accumulators, index register, program counter, and stack pointer. And on the following line, an asterisk. Changes are made in the same way as with the Memory Examine and Change Function.

To run the program you've been developing, press the G key, calling up the "Go to User's Program Function." If your program doesn't run properly, press RESET, which places the computer back under control of the Mikbug and prints an asterisk.

Print or Punch. Once the program is debugged, or if for any other reason you want to print or punch it, enter an M and the beginning address (in locations A002 and A003) and the ending address (in locations A004 and A005) of what you want to print or punch, and after an asterisk is printed, enter a P, which initiates the "Print/Punch Memory Function." At the end of this operation, the terminal again prints an asterisk.

There you have five highly important subroutines or functions, without which the computer is useless. Although each function is called up with a single character, the firmware behind the monitor's seemingly simple functions takes up 512 bytes of ROM, and a listing of the five takes seven pages of print. All five functions, incidentally, are important when working with assembly language, but the M and R functions aren't of much use in BASIC.

Mikbug. The Mikbug was designed by Motorola for use only with the MC6800 MPU. Programs written for a Mikbug-oriented computer may not run on another computer unless it also uses a Mikbug monitor. This is why people who try to run Southwest 6800 programs on the MITS Altair 680b, or vice versa, are in for a surprise, since although the 680b uses the 6800 MPU, it uses a monitor developed exclusively for MITS by Micro-Soft. So the programs aren't interchangeable. The Sphere computers, also based on the 6800, use yet another monitor, called PDS. (The MITS Altair 680b, incidentally, works both sides of the street, since it has a monitor *and* a full set of front-panel switches and lights.)

Without Monitor. If your computer doesn't have a monitor, you'll have to insert a variety of these control subroutines to take care of reading in data from the keyboard or from tape, displaying register contents, printing output, examining and changing memory, going to the user program, etc. Either you key them in with toggle switches, or feed them in from tape, if you have a tape reader. Each time you wish to use one of these routines, you set the front-panel switches to the starting address of that routine.

In addition to making the development and running of programs easier, the monitor also permits using all of your RAM memory, since none of it has to be taken up with storing monitor-type subroutines.

Adding a Monitor. If your computer has no monitor, you can add one. Get a memory board, install enough RAM's, and use a battery to power the RAM's so that the monitor routines you write in the RAM's won't vanish when the main power switch is turned off. This method is used to protect memory in case of power failure during computer operation. For example, Seals Electronics (7338 Baltimore Ave., Suite 200, College Park, MD 20740) has an 8k memory board, with battery standby that fits the Altair bus. Processor Technology's 4KRA and 8KRA static RAM memory modules, also Altair-compatible, will "retain memory for 4-5 hours when powered by two D flashlight cells," and longer when using more powerful batteries.

Or you could use rechargeable batteries and build a separate power supply to provide a trickle charge to keep the batteries going. However, you'd need a common ground for the two power supplies, as well as a diode switching arrangement. Thus, when the computer is turned on, the RAM's are powered from the computer's power supply, and not from the batteries. ◇

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Art's TV Shop

By Art Margolis

THE ABNORMAL TEMPERATURE CAPER

From the front of the shop a voice yelled, "Art, it's happening—come quick!" It was Charles from the next store, the Hair Emporium. He ran toward the back room, where I had been washing up. Waving his arms frantically, he shouted, "That #×$% color set is acting up again!" (He had recently had an RCA CTC53 color receiver installed to entertain his patrons while he worked on their tresses. Not too long after that, it had developed an intermittent condition.)

Sure enough, as I entered his shop, I could see that the picture had narrowed from the top and bottom, with a few inches of black space showing. I calmed Charles down, patting him on the shoulder. The repair looked simple enough. A 13GF7 dual triode in the CTC53 receiver performs the vertical oscillator and output functions. It was probably drawing a little too much current, dropping voltages and reducing gain. I took the back off the receiver, I installed a new 13GF7, and full vertical sweep returned. Charles beamed.

Since the trouble had been intermittent, and the receiver was on a shelf out of harm's way, I left the cheater cord attached and the back off. I explained to Charles that it might not be fixed yet, so we'd better let it play for the rest of the day before buttoning the receiver up into its cabinet.

"Aw, it's fixed. Just look at it!" he said. After a further explanation, he went along with my suggestion. I left the receiver on and went back to my shop.

About three hours later, I was greeted with a blaring, "Art, Art—it's doing it again! It's doing it again . . . "

I sighed, picked up my caddy and the RCA CTC53 service manual, and reviewed the situation in my mind as I walked over to Charlie's place. The symptoms were clear-cut—not enough vertical sweep. This certainly indicated trouble in the vertical oscillator/output area.

Further, the trouble was probably heat-related. The receiver worked fine at first, and shrinking really didn't start for about three hours. I knew for sure that it wasn't the vertical tube, because I had just installed a new one. However, the same situation was still coming back. It could be that a capacitor starts leaking a bit when the heat gets to it.

So, one approach would be to spray an aerosol coolant on the capacitors

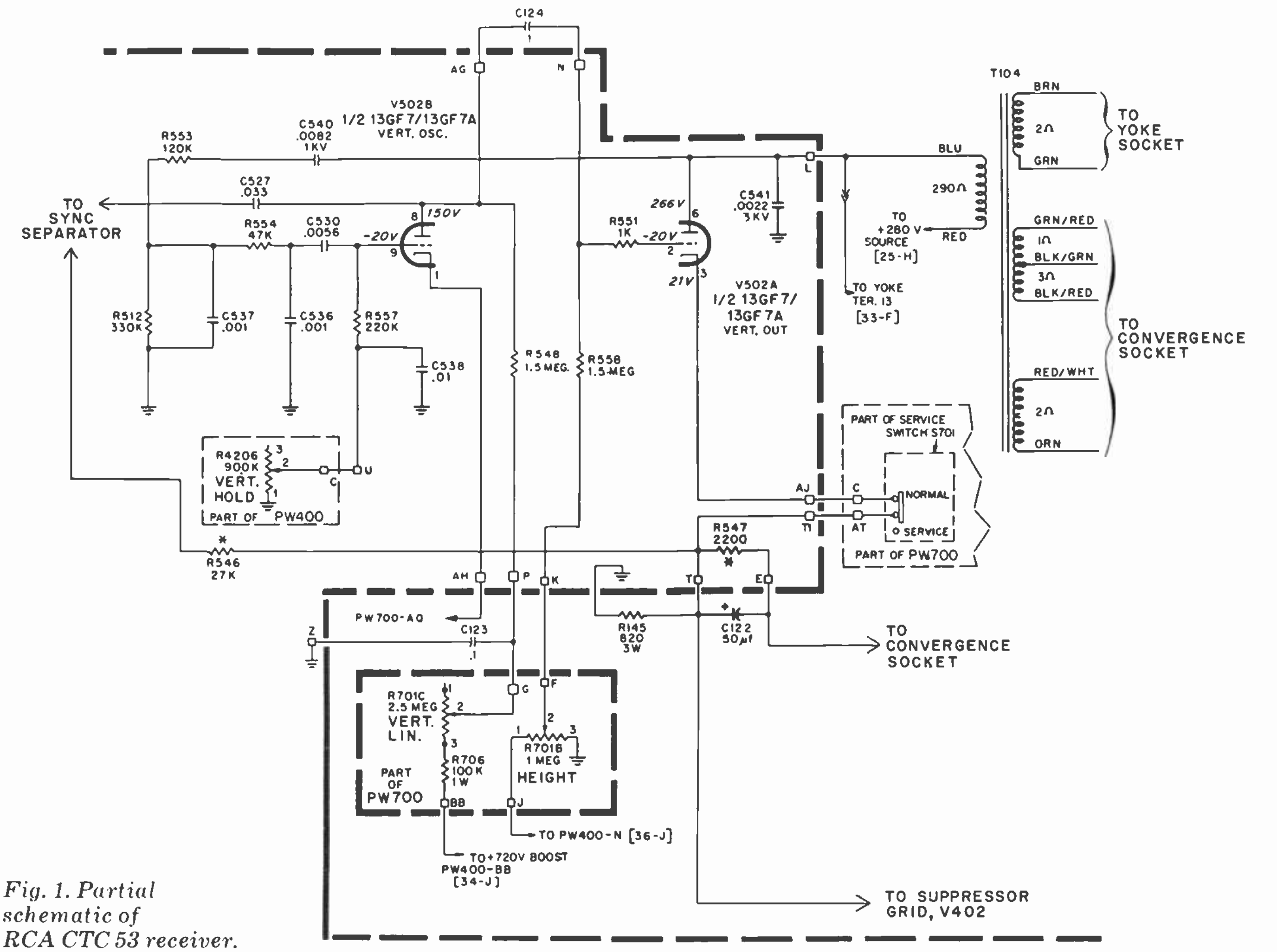

Fig. 1. Partial schematic of RCA CTC 53 receiver.

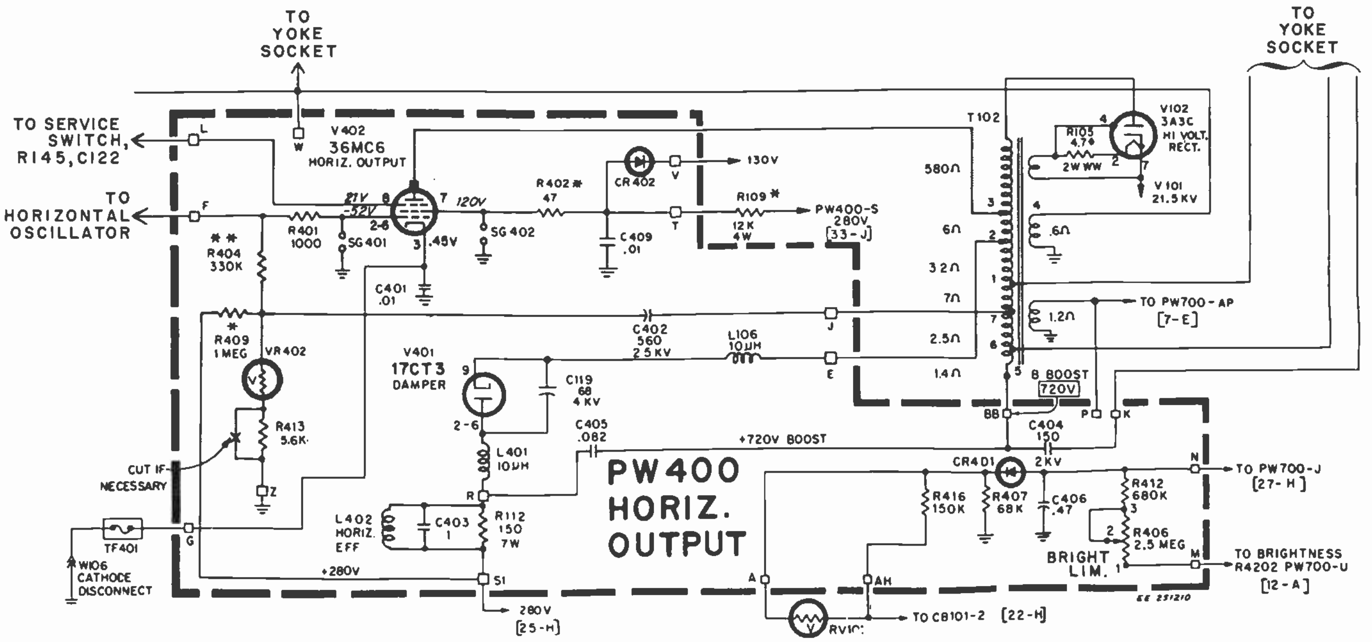

Fig. 2. Horizontal output circuit.

around the 13GF7. One hit of the spray on the heat-sensitive cap and the picture should spread right out. Then, a new capacitor could be quickly installed.

I entered the Hair Emporium and spread the schematic out on the counter. The 13GF7 dual triode is both the vertical oscillator and output tube. The oscillator, comprised of both sections of the tube, is a plate-coupled multivibrator. A modified sawtooth developed in V502B is fed through *C124* to *V502A*. (See Fig. 1.)

The sawtooth is amplified and reshaped by *V502A*. The amplitude of the triode's input is 200 V and its output is 750 V (both peak-to-peak). A portion of the output goes to the vertical output transformer *(T104)* for vertical sweep and convergence purposes. Another portion feeds the signal back through *C540* and *R553* to the input of *V502B*, thus sustaining the 60-Hz multivibrator. The VERTICAL HOLD control is a part of the RC input network to the control grid of *V502B*. It adjusts the network characteristic so that the large 750-V spike is attenuated and shaped into a proper 55-V (p-p) waveform at 60 Hz.

The VERTICAL LINEARITY pot, a series resistor, connects the Boost B+ to the plate of *V502B*. When properly adjusted, the pot drops the 750-volt boost B+ down to about 150 V. This changes the triode's gain and thus varies the vertical sweep.

The HEIGHT pot divides the voltage developed from the *V502A* control grid to ground. Another parallel leg goes down into the brightness limiter circuit. Uh oh—there's *CR401*, also in series. If it shorts or opens, it could change the control grid bias of −20 V. Have to be sure to check that—it's a possible culprit.

The cathode of *V502A* goes to the SERVICE switch. When that's open (in the SERVICE position), it kills the vertical sweep. The cathode's 21-volt bias is developed across the 820-ohm, 3-watt resistor *(R145)*. A 50-μF capacitor *(C122)* couples some of the 14-V (p-p) signal developed across *R145* into the convergence socket. Another tap sends the 21-volt bias into the suppressor grid of the horizontal output tube, *V402* (See Fig. 2).

I got behind the receiver, attached the extension tube to the can of aerosol coolant and began spraying the capacitors around the 13GF7. I could see the picture from different angles in the many mirrors Charles had in his shop.

I froze C540 and *C541*, but nothing happened. Then, I developed frost on *C536*, *C537*, and *C530*. No luck—the picture was still slightly shrunken.

Charles asked, "What are you doing?"

I smiled and said, "One of the possibilities is that a capacitor begins to leak after it heats up. With this coolant spray, I can pinpoint the bad one when I hit it."

Nothing happened. Well, I figured, no-go on a leaky capacitor. Might as well go get my meter and take some voltage readings. I walked back to my shop, leaving the receiver on.

Once I was in the shop, a few phone calls came in. It took me about 20 minutes to get back to Charles's place. He was waiting for me at the door, smiling smugly. "I found the trouble," he announced.

I smiled. "Sure, Charles, you'll show me after I take a few voltage readings."

"No, Art, I'm serious! I know what the trouble is!"

Taking a deep breath, I set up my multimeter. Charles became annoyed.

"Let me show you. Come on, don't be that way," he said.

I raised my hands and stepped away. "OK, show me," I said.

He quickly grabbed a hand-held hair dryer, and switched it on. I could feel the wave of heat. He was using one of those 1500-watt blow dryers. He disappeared behind the TV, and I fixed my gaze on the picture tube.

At first, nothing happened. Then, the picture started to shrink further from the top and bottom. Next, the sides of the picture started falling in, too. Finally, it began to darken and lose sync. What in the world?

I walked around to the rear of the receiver. Charles was directing a blast of hot air at the horizontal output tube, overheating it. That #+*! horizontal tube was somehow causing the loss of vertical sweep. Charles stood back proudly, and with his head held high said, "Well?"

I shrugged, "Looks like you've got it, Charles." I turned off the receiver and pulled out the tube—a 31LZ6.

Then it clicked. A factory service note I received a few months back came to mind. Replace the 31LZ6 with a 36CM6. The original tubes sometimes developed warped suppressor grids, shorting their dc voltage to other elements in the tube. And, I recalled with a sigh, the suppressor was taking its 21 volts from the cathode of the vertical output tube.

I put in a new 31CM6. The picture looked better than ever, and has had a full, bright sweep ever since. ◇

Inside Basic Electronics

By Sol. D. Prensky

THE SEMICONDUCTOR DIODE

THE SEMICONDUCTOR diode is a two-electrode device composed of a material that is neither an insulator nor a conductor. It is one of the most common electronic devices in use today. Here are its basic operating principles and a look at a few diode applications.

Electrons and Holes. How well a material conducts electricity primarily depends on the number of *charge carriers* within it that are able to move. In a conducting metal, there are many electrons that orbit the metal atoms at relatively large distances. These *conduction band* electrons will migrate from one atom to another when they are given a slight "push," such as that provided by a battery.

In an insulating glass or ceramic, all of the atoms' electrons are tightly bound within the molecular structure of the material. That is, the material is most stable when the outer electrons of each atom are shared by the atoms surrounding it in "covalent bonds." These *valence band* electrons are held in place so strongly that they will move only when large amounts of energy are applied to tear them away from the parent atoms. At that point the insulator "breaks down" and current will flow through it.

Each atom of the two widely used semiconductor elements (germanium and silicon) has four valence band electrons that can be shared with neighboring atoms. These atoms are most stable when they have a total of eight valence electrons. So, in a pure silicon crystal, each atom is surrounded by four other silicon atoms and shares one valence electron with each neighbor. This results in four covalent bonds—every atom is effectively surrounded by eight valence electrons. But note that this bonding requires all available outer-orbit electrons. There are none left that can move around the crystal structure. Thus, pure silicon and germanium are not very efficient conductors.

There are two ways that this situation can change. First, a bound electron can gain enough energy (usually from heat) to escape the parent atom. It will then wander around the crystal, which is mostly empty space, as a negative charge carrier. But what happens back at the broken bond? A *hole* or electron deficiency now exists. If another electron (valence or conduction band) passes by, it can fall into the hole. Although this hole then no longer exists, a new one appears at the previous position of the vagabond electron. We can thus say that an electron moving from right to left is equivalent to a hole moving from left to right. Furthermore, we can consider the hole to be a positive *charge carrier*, and can talk about hole current.

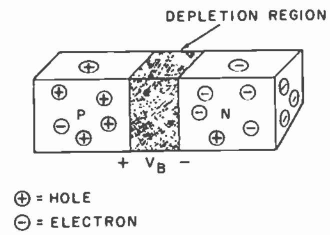

Fig. 1. Diagram of a pn semiconductor junction.

The second way to generate free charge carriers in a semiconductor crystal is to add foreign atoms. This process, called *doping*, will add holes or electrons, depending on the type of dopant used. If we replace one silicon atom with one that has five valence electrons, a free electron is added. Here's why. Four of the new valence electrons will form covalent bonds with neighboring electrons, but one will be left over. It is fairly loosely bound to its parent atom, and will move away when moderately "pushed." The result is n-type semiconductor material with one negative charge carrier added for each dopant atom that is introduced.

If we then take a pure silicon crystal and remove one atom, replacing it with one with three valence electrons, a hole is created. The surrounding atoms want to share four electrons, but only three are available. An electron deficiency exists, and p-type material is created. One positive charge carrier is added when one dopant atom replaces a silicon atom.

As more and more dopant atoms are added and/or the crystal temperature is increased, a greater number of charge carriers is available and the semiconductor becomes more of a conductor.

Junctions. When a piece of p-type material is joined to a piece of n-type material, a pn junction is formed (Fig. 1A). Electrons and holes near the junction combine, creating a high-resistance *depletion region* in which no free charge carriers are found. A *barrier potential* (V_B) is also generated. This electric field prevents holes from the p side from reaching the n region, and prevents electrons from the n region from crossing over into p territory. In other words, no *majority carriers* with average energy levels can cross the junction. However, high-energy majority carriers can cross the junction. Thermal energy (among other things) can generate *minority carriers* (free electrons in p material, holes in n areas). These minority carriers can also cross the junction because the barrier potential does not oppose them. The resulting average current is zero because probability dictates that the number of minority and high-energy majority carriers will be equal.

If an external voltage source and a milliameter are connected to the junction as shown in Fig. 2A, current will flow. The voltage source, if its output is large enough, will push the majority carriers hard enough to overcome the repulsion of the barrier potential. Also, the depletion region will narrow and its resistance will decrease. The amount of current flowing through the junction will depend on the output of the voltage source. If it is less than the barrier potential, no current will flow (ideally). If it is much greater than the barrier potential, a large current will flow.

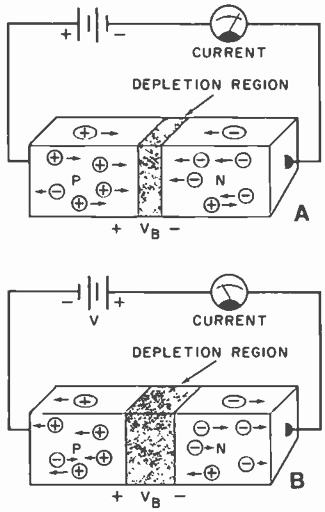

Fig. 2. When junction is forward biased (A), it conducts. When reverse biased (B), it does not.

Now, if we reverse the polarity of the external source (Fig. 2B), the free electrons in the n material are pulled away from the junction toward the positive battery terminal, and the holes in the p region will move toward the negative terminal. The depletion region will widen. After a short period of time, equilibrium is reached and no more charge carriers will move except for a small reverse minority current. However, if the reverse-polarity source voltage is increased to a critical *breakdown voltage*, a large current will flow through the junction. Although this can destroy the diode, we can use this effect to our advantage in certain applications if we limit the breakdown current.

Graphing the junction current versus applied voltage for a typical pn junction yields the I-V curve shown in Fig. 3. If the p side is positive with respect to the n side, the diode will conduct once the barrier potential is exceeded, with rapid increases in current after this point is reached. This condition is called *forward bias*. If the n side is positive with respect to the p side (*reverse bias*), a small reverse current will flow up to the breakdown point. At that voltage the junction will start to conduct and will conduct heavily as slightly greater voltages are applied.

A germanium pn junction will display a barrier potential of about 0.2 volt. The barrier potential of a silicon junction is approximately 0.7 volt. When a junction of gallium-arsenide alloy is formed, such as that in a light-emitting diode, a barrier potential of about 1.7 to 2.4 volts will result.

The Ideal Diode. The schematic symbol for the semiconductor diode is shown in Fig. 4A, along with a view of the pn junction. Neglecting nonideal effects, we can describe the behavior of the diode fairly simply. When the anode (arrow) is positive with respect to the cathode (bar), the diode is forward biased and acts like a closed SPST switch or short circuit. When the anode is negative with respect to the cathode

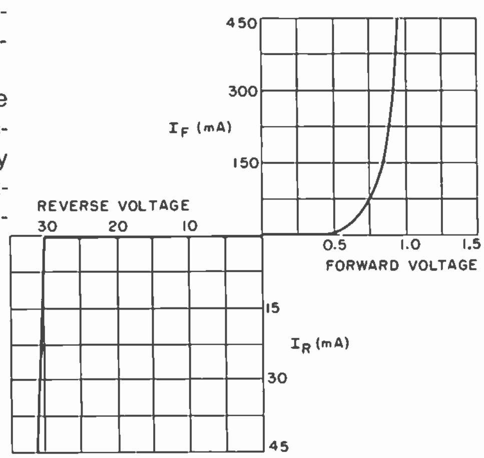

Fig. 3. The IV characteristic curve of a typical silicon pn junction.

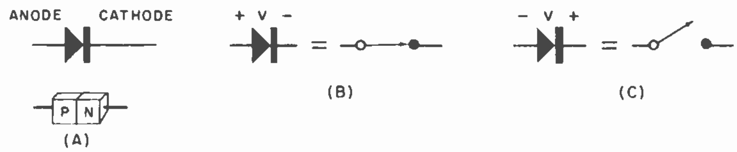

Fig. 4. Schematic symbol (A) and idealized forward (B) and reverse (C) biased semiconductor diode.

(reverse bias), the diode acts like an open circuit or switch. This behavior is shown in Fig. 4B and 4C. It is the basis of all diode rectifier and switching circuits.

For example, a simple half-wave rectifier (Fig. 5) uses a diode to convert ac to dc. On the positive half cycles of V_{AB} the diode conducts and delivers power to the load. (Note that "conventional current," opposite to the flow of electrons, travels in the direction indicated by the diode arrow.) When the polarity of V_{AB} reverses, the diode is reverse biased and acts as an open circuit. Thus no current can flow through the load resistor on negative half cycles of V_{AB}. If we view the waveform of the voltage across the load on an oscilloscope, we will see a series of half sine waves. This is pulsating dc which can be smoothed out by connecting a capacitor in parallel with the load. An RC filter can also be used for this purpose.

Another basic diode circuit, the crystal radio receiver, is shown in Fig. 6. This is an updated version of the early crystal set, which originally used a galena (lead sulfide) crystal as the detector or rectifier. In this circuit, the galena crystal is replaced by a 1N34 germanium diode. Ferrite inductor *L* and the tuning capacitor *C* form a resonant circuit which selectively passes signals from the antenna (20 or more feet of copper wire) to detector *D1*. The diode allows only the positive side of the signal to reach the rest of the circuit. Capacitor *C1*, a disc ceramic type, filters the radio-frequency portion of the rectified or detected signal to ground, because it contains no useful information. The envelope or audio portion of the signal is coupled to the crystal earphone by *C2*, a 0.1-μF disc ceramic or Mylar capacitor. The circuit requires no external power source and will receive many signals on the AM broadcast band. Parts are available from almost any electronics store.

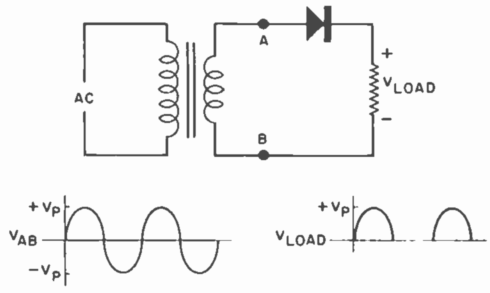

Fig. 5. A simple half-wave rectifier using a semiconductor diode.

Figure 7 illustrates a simple zener diode circuit. Here, the constant-voltage breakdown characteristic of the silicon diode is employed to obtain a regulated voltage output. The diode is reverse biased, to the breakdown point, but current through it is limited by series resistor *R*. To use this circuit effectively, you must know the maximum and minimum current demands of the load, the value of the input voltage and the required output voltage. Once these quantities are known, simple algebra is used to find the required series resistance and specific diode type. The optimum value of *R* can be calculated by the equation: $R = (V_{INmin} - V_Z)/1.1\ I_{LOAD}\ max$. After *R* is determined, you can calculate the required diode power dissipation using the equation: $P_Z = V_Z(V_{IN\ max} - V_Z)/R - I_{LOAD\ min}]$. For example, if we wish to power a 9-volt radio drawing 200 to 350 mA, we choose V_Z as 9.1V, the nearest commercially available zener voltage. Then, $R = (12 - 9.1V)/1.1 \times 0.35$ A or 7.5 ohms. The required power dissipation P_D is 9.1 [(12 − 9.1)/7.5 − 0.2] or 1.7 watts. Therefore, a 9.1-volt, 5-watt zener diode should be used.

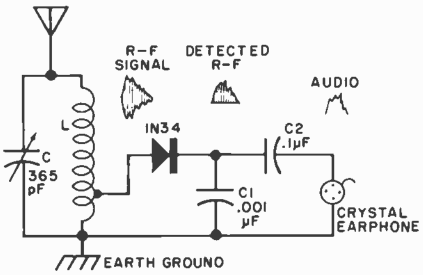

Fig. 6. Schematic of the modern "crystal set."

Nonideal Effects. Although we considered the diode as a closed switch when forward-biased and an open switch when reverse-biased, this idealization neglects some aspects of diode behavior. First, when the diode conducts, a forward voltage drop exists across it. This voltage drop is equal in magnitude to the barrier potential (V_B) of the junction. For a germanium diode, it is about 0.2 volt; for a silicon diode, 0.7 volt; for a gallium-arsenide diode, 1.7 volts. The diode will not conduct until the applied voltage exceeds this value. For example, the half-wave rectifier of Fig. 5 will deliver a peak voltage to the load of V_p-V_B if the forward voltage drop is considered. When V_p is high—say, 50 volts—the small V_B can be ignored. But in small-signal circuits, such as the crystal receiver of Fig. 6, the barrier potential must be taken into account. The 1N34 will not rectify signals below the 200-mV level—it will simply act as an open circuit on both sides of the r-f cycle.

Another nonideal effect that the diode displays is resistance. When it is forward biased, it acts not as a short circuit, but as a fairly low resistance (from about 5 to 1000 ohms, depending on diode type). When reverse biased up to the breakdown point, the diode acts as a high resistance—from a few hundred thousand ohms to several megohms, again varying with diode type. Reverse resistance allows a reverse current I_R to flow. Ordinarily, this current is very small—on the order of microamperes for germanium and nanoamperes for silicon. But reverse current doubles for each 10°C increase in junction temperature and can become troublesome. In many diode circuits, the forward (bulk) and reverse resistances can be neglected. But in some applications they will greatly influence circuit behavior.

Junction capacitance is another nonideal effect which must be considered in some circuits. You will recall that the basic *pn* junction consists of two conducting media (the *p* and *n* regions) separated by a high resistance (the depletion region). This is another way of saying that the junction is a capacitor.

We know that a capacitor's capacitance depends, among other things, on the spacing of the conducting plates. This is also true of junction capacitance. When the junction is forward biased, the depletion region shrinks and the "plates" are closer. The result is an increase in junction capacitance. When the junction is reversed biased, the depletion region grows and the "plates" are further apart. Thus, the junction capacitance decreases.

Junction capacitance can be a desirable or undesirable phenomenon, depending on the diode application. In some r-f circuits, this voltage-variable capacitance is used in place of a mechanical variable capacitor for tuning purposes. Special diodes called varactors are manufactured for this specific application. They are usually reverse biased, and can exhibit capacitances up to several hundred picofarads. However, in many cases, such as highspeed switching circuits, junction capacitance is most undesirable. The diode's capacitance must either charge up or discharge before the diode turns fully "on" or "off." This reduces the maximum switching frequency of the diode. In high-frequency linear circuits, diode capacitance must be kept low enough to prevent the junction from acting more like a capacitor than a diode. For this reason, special Schottky and "hot-carrier" diodes with very small junction capacitances have been developed.

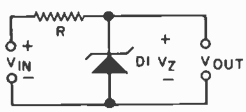

Fig. 7. Basic zener diode voltage regulator.

Diode Types. There are currently thousands of different diode types listed in industrial electronics catalogs. Fortunately, most diodes can be included in a major functional group. For example, *signal diodes* are used in linear circuits as rectifiers or detectors. In small-signal circuits, germanium types such as the 1N34 are sometimes preferred over silicon diodes such as the 1N914 or 1N4148 because they turn on at lower forward voltages. Peak inverse voltage—the maximum reverse voltage the diode can safely handle—varies from about 25 to 75 volts. Maximum forward current ranges from 10 to 250 mA.

Power rectifier diodes are designed for use in power supplies. Almost all of them are silicon. Forward current ratings vary from 500 mA or so up to tens of amperes. Peak inverse voltages range from 50 to several thousand volts. The 1N4000 series of 1-A rectifiers is especially popular with hobbyists.

Switching diodes are widely used in digital logic circuits. The emphasis here is on low-junction capacitance rather than high PIV and forward current ratings. *Mixing* diodes are used in communications gear for heterodyning. They are often produced on a common silicon block so that several closely matched diodes are available in one package. Ring modulators and double-balanced mixers are typical applications. *Zener* diodes, mentioned earlier, are used for voltage regulation. Such diodes are available with zener voltages up to 200 volts and power dissipation ratings up to 50 watts.

Finally, *light emitting diodes*, which are widely used as pilot lights and in alphanumeric displays, should be mentioned. They are becoming available in a larger range of colors and light outputs. LED's potentially can replace the cathode ray tubes in oscilloscopes, televisions, etc. Although the semiconductor diode as we know it today has been with us for about only thirty years, it has revolutionized the world of electronics. ◇

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Electronics Library

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by Robert L. Goodman

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Published by Tab Books, Blue Ridge Summit, PA 17214. 226 pages. $5.95 soft cover, $8.95 hard cover.

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by John Eargle

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Published by Van Nostrand Reinhold Co., 450 West 33 St., New York, NY 10001. 323 pages. $16.95 hard cover.

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by Alfred W. Barber

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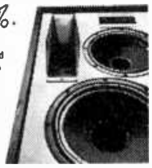

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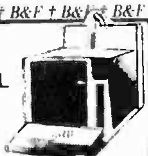

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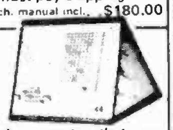

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2N5771	.70
2N5774	12.00
2N5777	.60
2N5778	.55
2N5780	.92
2N5811	.40
2N5817	.40
2N5818	.40
2N5819	.45
2N5822	.58
2N5824	.25
2N5826	.26
2N5827	.30
2N5828	.34
2N5828A	.40

2N6000	.50
2N6001	.52
2N6002	.54
2N6004	.60
2N6014	.66
2N6015	.68
2N6027	.50
2N6028	.60
2N6034	.72
2N6035	1.00
2N6037	.92
2N6072	.20
2N6076	.20
2N6099	.80
2N6101	1.06
2N6103	1.10
2N6109	.80
2N6121	.66
2N6122	.68
2N6123	.88
2N6124	.80
2N6125	.68
2N6126	.88
2N6155	2.00
2N6218	.64
2N6219	.60
2N6220	.58
2N6222	.30
2N6223	.30
2N6224	.32
2N6225	.34
2N6375	1.90
3N84	1.80
3N85	3.60
3N128	1.40
3N153	1.20
3N163	2.10
3N189	3.40
4N26	2.10

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2SC828	.75
2SC829	.75
2SC1226A	1.25
2SC1359	.90
2SC1973	1.30
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CARBON FILM RESISTORS (5%)

Only in Multiples of 100 pcs per value (ohms)

¼W . . . $1.69 per 100
½W . . . $1.79 per 100

10	100	1.0K	10K	100K	1.0M
11	110	1.1K	11K	110K	1.1M
12	120	1.2K	12K	120K	1.2M
13	130	1.3K	13K	130K	1.3M
15	150	1.5K	15K	150K	1.5M
16	160	1.6K	16K	160K	1.6M
18	180	1.8K	18K	180K	1.8M
20	200	2.0K	20K	200K	2.0M
22	220	2.2K	22K	220K	2.2M
24	240	2.4K	24K	240K	2.4M
27	270	2.7K	27K	270K	2.7M
30	300	3.0K	30K	300K	3.0M
33	330	3.3K	33K	330K	3.3M
36	360	3.6K	36K	360K	3.6M
39	390	3.9K	39K	390K	3.9M
43	430	4.3K	43K	430K	4.3M
47	470	4.7K	47K	470K	4.7M
51	510	5.1K	51K	510K	5.1M
56	560	5.6K	56K	560K	5.6M
62	620	6.2K	62K	620K	6.2M
68	680	6.8K	68K	680K	6.8M
75	750	7.5K	75K	750K	7.5M
82	820	8.2K	82K	820K	8.2M
91	910	9.1K	91K	910K	9.1M

1" (26mm) GaAsP LED NUMERIC DISPLAY

EP1000
(Common Anode)
1 Piece – $4.90
3 Pieces – $13.00
5 Pieces – $19.00

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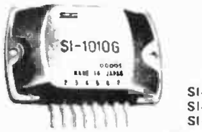
PLESSEY SL1600 APPLICATIONS MANUAL

Contains 114 pages circuit data, system design and technical data for SL1600 Series Radio Communications Integrated Circuits.
$1.95



SANKEN HYBRID AUDIO POWER AMPLIFIERS

SI-1010G (10W output) . . . $ 6.90
SI-1020G (20W output) . . . $13.95
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APRIL SPECIAL

AM1702A-6
ORIGINAL AMD
1.5 MSEC GUARANTEED
1 PIECE – $6.00
8 PIECES – $45.00

MATSUO DIPPED TANTALUM CAPACITORS

MF	V	$	MF	V	$
.1	35	.33	6.8	16	.40
.15	35	.33	6.8	35	.45
.22	35	.33	10.0	16	.42
.33	35	.33	10.0	25	.45
.47	35	.33	10.0	35	.90
.68	35	.33	15.0	20	.45
1.0	35	.33	15.0	35	1.32
1.5	35	.40	22.0	16	.45
2.2	20	.33	33.0	20	1.32
2.2	35	.40	47.0	20	1.53
3.3	35	.42	68.0	16	1.62
4.7	35	.45			

PLESSEY POLYESTER (CAPACITOR) MINI BOX

MF	V	$	MF	V	$
.001	1000	.14	.039	250	.15
.0012	1000	.14	.047	250	.15
.0015	1000	.14	.056	250	.15
.0018	1000	.14	.068	250	.15
.0022	1000	.14	.082	250	.17
.0027	1000	.14	.1	100	.17
.0033	1000	.14	.12	100	.18
.0039	630	.14	.15	100	.20
.0047	630	.14	.18	100	.21
.0056	630	.14	.22	100	.23
.0068	630	.14	.27	100	.26
.0082	630	.14	.33	100	.30
.01	630	.14	.39	100	.33
.012	630	.14	.47	100	.36
.015	400	.15	.56	100	.44
.018	400	.15	.68	100	.47
.022	400	.15	.82	100	.54
.027	400	.15	1.0	100	.60
.033	250	.15			

CONTINENTAL SPECIALTIES

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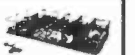
Build & test circuits as fast as you think

PB-6	$15.95	PB103	$59.95
PB100	19.95	PB104	79.95
PB101	29.95	EX300	9.95
PB102	39.95	EX600	10.95

PLESSEY SAMPLER

300 METALIZED CAPACITORS
18 DIFFERENT STD. VALUES
$26.00



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With built-in regulated short-proof power supplies

PB203	5V, 1 amp regulated power supply	$ 75.00
PB203A	5V, 1 amp and ±15V, ½ amp regulated power supply	120.00

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Simultaneously displays static and dynamic logic states of DTL, TTL, HTL or CMOS DIP ICs. Pocket size. $74.95

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Displays static and dynamic states of digital ICs such as C-MOS, HTL, TTL, DTL & RTL. Selectable threshold control. $124.95

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Compact, circuit powered multifunction logic probe. Multi-family compatability. DTL/TTL/HTL/CMOS. Traces logic levels and pulses through digital circuitry. $44.95.

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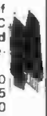
Plug-in, wire, test, modify or expand without patch cords or solder. Snap together to form breadboard needed

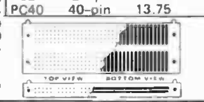
PN/Description	Term'ls	Price
QT59S Socket	118	$12.50
QT59B Bus	20	2.50
QT47S Socket	94	10.00
QT47B Bus	16	2.25
QT35S Socket	70	8.50
QT35B Bus	12	2.00
QT18S Socket	36	4.75
QT12S Socket	24	3.75
QT8S Socket	16	3.25
QT7S Socket	14	3.00

PROTO-CLIP



For power-on/hands off signal tracing. Bring IC leads up from PC board surface for fast trouble-shooting.

PC14	14-pin	$ 4.50
PC16	16-pin	4.75
PC24	24-pin	8.50
PC40	40-pin	13.75



BREADBOARD JUMPER WIRE KIT

Each kit contains 350 wires cut to 14 different lengths from 0.1" to 5.0'. Each wire is stripped and leads are bent 90° for easy insertion. Wire length is classified by color coding. All wire is solid tinned 22 gauge with PVC insulation. The wires come packed in a convenient plastic box.
BK-1 . . . . $9.95

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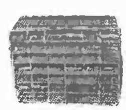

1/4 WATT KIT
42 Different Values (68Ω to $4.7\ M\Omega$)
20 Each Value

1/2 WATT KIT
42 Different Values (68Ω to $4.7\ M\Omega$)
20 Each Value

1/4W – $24.90 PER KIT
1/2W – $25.90 PER KIT
COMPLETE WITH STORAGE BIN

CORDLESS HOBBY-WRAP TOOL–BW-630

- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (0.025 inch)
- Complete with built-in bit and sleeve

$34.95 (batteries not included)

WIRE-WRAP KIT – WK-2-W

WRAP ● STRIP ● UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 ft. White 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths – pre-stripped white wire

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WIRE WRAP TOOL WSU-30

WRAP ● STRIP ● UNWRAP – $5.95

WIRE WRAP WIRE – 30 AWG

25 ft. min. $1.25   50 ft. $1.95   100 ft $2.95
1000 ft $15.00 SPECIFY COLOR: White, Yellow, Red, Green Blue or Black

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LOW PROFILE, SOLDER, TIN

	1-24	25-49	50 UP
8 Pin	.16	.15	.14
14 Pin	.19	.18	.17
16 Pin	.21	.20	.19
18 Pin	.28	.27	.26
20 Pin	.34	.33	.32
22 Pin	.36	.35	.34
24 Pin	.37	.36	.35
28 Pin	.44	.43	.42
36 Pin	.59	.58	.57
40 Pin	.62	.61	.60

STANDARD, SOLDER, TIN

8 Pin	.25	.23	22
14 Pin	.27	.25	.24
16 Pin	.30	.27	.25
18 Pin	.35	.32	.30
22 Pin	.70	.65	.60
24 Pin	.49	.45	42
28 Pin	.99	.90	.81
36 Pin	1.39	1.26	1.15
40 Pin	1.59	1.45	1.30

STANDARD, SOLDER, GOLD

8 Pin	.30	.27	.24
14 Pin	.35	.32	.29
16 Pin	.38	.35	.32
18 Pin	.52	.47	.43
22 Pin	.70	.63	.57
24 Pin	.70	.63	.57
28 Pin	1.10	1.00	.90
36 Pin	1.75	1.40	1.26
40 Pin	1.75	1.59	1.45

WIREWRAP GOLD (Level No. 3)

10 Pin	.45	.41	.37
14 Pin	.39	.38	.37
16 Pin	.43	.42	.41
18 Pin	.75	.68	.62
24 Pin	1.05	.95	.85
28 Pin	1.40	1.25	1.10
36 Pin	1.59	1.45	1.30
40 Pin	1.75	1.55	1.40

FAIRCHILD TECHNOLOGY KITS

Complete Specifications on Back of Each Kit

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FTK0001	0.5" High Common Cathode Digit	$ 1.00
FTK0002	0.5" High Common Anode Digit	1.00
FTK0003	0.357" High Common Cathode Digit	0.75
FTK0004	0.8" High Common Cathode Digit	2.00
FTK0005	0.8" High Common Anode Digit	2.00

0.8" HIGH DISPLAY ARRAYS

FTK0010	12 Hour, 3½ Digit Clock Display	7.00
FTK0011	24 Hour, 4 Digit Clock Display	8.00

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FTK0020	10 Red LED Lamps	1.00
FTK0021	5 Mixed Colored LED Lamps	1.00
FTK0022	10 LED Mounting Clips	1.00
FTK0023	5 Three Piece LED Mounting Adapters	1.00

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FTK0031	5 Round Lens Photo Transistors	1.00
FTK0032	3 Flat Lens Photo Darlingtons	1.00
FTK0033	3 Round Lens Photo Darlingtons	1.00

PHOTOARRAYS

FTK0040	9-Element Tape Reader Array	16.00
FTK0041	12-Element Card REader Array	24.00
FTK0042	Reflective Opto Coupler	4.00

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FTK0050	3 General Purpose Opto Couplers	1.00
FTK0051	Darlington Opto Coupler	1.00

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KITS

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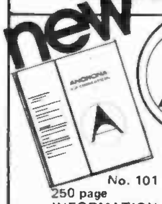

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Over the years we've sold thousands of 12V, 8A supplies. 1st hams started using them for AC powering their transceivers... then labs and service shops used them for bench supplies... now, CBers are discovering them. Over the years we've refined and improved. Our 1977 model has crowbar overvoltage protection, a custom wound transformer, short protection, .05V regulation, current limiting, adjustable output 11-14V, RF bypassing...and all parts (except xfrmr, diode bridge, & filter caps) mount on the circuit board for easy assembly. Please add sufficient postage; excess refunded. $39.95 + post.

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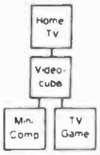
Turn your home T.V. into a Monitor



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2N3906 PNP Si TO-92	5/$ 1.00
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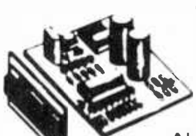

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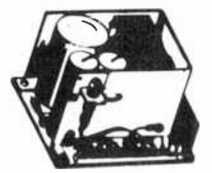

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7409	.25	7473	.45	74151	1.25
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7411	30	7475	.80	74154	1.25
7413	85	7482	1.75	74155	1.21
7416	43	7483	1.15	74157	1.30
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7425	43	7490	.69	74166	1 70
7427	.37	7491	1.20	74174	1 95
7428	.33	7492	.82	74175	1.95
7430	.26	7493	.82	74180	1 05
7432	31	7494	.91	74181	3.55
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74H04	33	74H21	33	74H73	.59
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4013AE	.52	4030AE	.65
4015AE	1 25	4037AE	4 50
4016AE	65	4040AE	2.40
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CA3058	1.90	NE555V	.45	USF7733393	2.40
CK707P	.45	PA771131	.45	995879	6.50
C5134J	1.15	PL994551	.45	996079	12.50
C5135J	1.20	RC14370B	.35	998979	9.00
C5136	1.25	SC9962P	.70	936-5D	1.10
IC3(GE)	1.50	SC9966P	1.25	9313DC	1.20
LM301AN	.35	SN15830N	.50	93L28DC	2.75

POSITIVE VOLTAGE REGULATORS

LM340K-5	1.95
LM340K-6	1.95
LM340K-8	1.95
LM340K-12	1.95
LM340K-15	1.95
LM340K-18	1.95
LM340K-24	1.95
LM340T0-5	1 75
LM340T0-6	1.75
LM340T0-8	1.75
LM340T0-12	1.75
LM340T0-15	1 75
LM340T0-18	1.75
LM340T0-24	1.75

NEGATIVE REGULATORS AVAILABLE

IC's ON THE MOVE

BBD : BUCKET BRIGADE DEVICE
MM3001 19.50 MN3002 11.70 MM3003 9.45
HALL IC : DN834 1.25 DN837 1.50
DN835 1.35 DN838(NEW)
SN76001 1.75 SN76002 1.95
PLL02A MIDLAND PHASE LOCK LOOP 12 00

MICROPROCESSOR CHIPS

1404A	3.25	2102	2.50	MM5013	3.25
C1702A	19.95	C2708	95.00	8008	19.95
2101	6.95	C4702A	19.95	8080A	29.95

MK4200 P-11 4096x1 Bit Dymanic Ram 9.95
C5101 3 1024 Bit (256x4) Static C-Mos Ram 4.50
MC14514 4 Bit Latch 4 to 16 Line Decoder 4.25

CALL OR WRITE FOR FURTHER INFORMATION.
SPEC'S AVAILABLE

ELECTROLYTIC CAPACITORS

2.2MF50	AXIAL LEADS	.15
3.3MF10	AXIAL LEADS	.15
3.3MF10	NO POLARITY	.15
10MF25	AXIAL LEADS	.15
10MF50	AXIAL LEADS	.15
10MF150	AXIAL LEADS	.20
25MF35	AXIAL LEADS	.15
30MF25	AXIAL LEADS	.15
47MF25	RADIAL LEADS	.15
47MF50	RADIAL LEADS	.20
100MF16	RADIAL LEADS	.15
100MF25	RADIAL LEADS	.20
500MF50	AXIAL LEADS	.60
1000MF35	AXIAL LEADS	.65

CARBON RESISTORS

Minimum 5 Pc's Per Value

QUANTITY PRICING	5-25	30-95	100-495
¼w5%	.06	.05	.04
½w5%	.08	.07	.06

STANDARD RESISTANCE VALUES
OHMS

10	270	820	4.7K	27K
22	300	910	5.1K	33K
47	330	1.0K	6.8K	47K
51	470	1.5K	7.5K	100K
100	510	2.2K	8.2K	330K
150	560	2.7K	10K	1.0M
220	680	3.3K	15K	
240	750	3.9K	22K	

HOBBY SPECIALS

YOU TEST 'EM $AVE BIG MONEY

Power Pac	100 Asst. (includes Case T03, T066 T0220, T0202)	$2.99
Transistor/ Diode Pac	100 Asst. (includes Case T05, T039, T018, D07, 0041)	$1.99
I.C Pac	100 Asst (includes 14 & 16 Pin)	$3.50
Resistor Pac	50 Asst. (Assorted values)	$1.50
Mos Fet Pac	10 Asst. (many top #'s Case T072)	$0.99
SCR Pac	100 Asst. (similar to C103 Series) Case to 92. VR:10-100V, I:400MA, IGT:200MA	$4.00

ZENER DIODES
½ & 1 Watt 10% .30 each UP TO 33V.
GREATER THAN 33V CALL FOR PRICING

PACE/PATHCOM PART #'S

130079	4.00	IP20-0123	2.75
1300821	.65	IP20-0131	2.50
13-0122	1.75	IP20-0141	3.00
83-0005	2.00	IP20-0142	3.00
83-0007	2.50	IP20-0139	.43
83-0008	2.00	IP20-0154	6.00
83-0015	3.00	IP20-0155	2.50
IP20-0005	3.00	IP20-0161	4.00
IP20-0016	.40	IP20-0177	2.75
IP20-0034	.85	IP20-0176	2.85
IP20-0037	.85	IP20-0191	.72
IP20-0045	2.00		
IP20-0073	2.75		
IP20-0093	2.50		

JAPANESE TRANSISTORS ★ CB, AUDIO, INDUSTRIAL

2SA52	.60	2SC206	1.00	2SC774	1.75	2SC1173	.95	2SD77	1.00
2SA316	.75	2SC240	1.10	2SC775	2.75	2SC1175	.65	2SD81	3.25
2SA473	.75	2SC291	.65	2SC776	3.00	2SC1209	.55	2SD88	1.50
2SA483	1.95	2SC292	3.00	2SC777	4.00	2SC1213	.75	2SD118	3.25
2SA489	.80	2SC320	.75	2SC778	4.00	2SC1226A	1.25	2SD130	1.25
2SA490	.70	2SC352	.75	2SC781	3.00	2SC1237	4.50	2SD141	2.25
2SA505	.70	2SC353	.75	2SC783	1.00	2SC1239	4.00	2SD151	2.25
2SA564	.50	2SC371	.70	2SC784	.70	2SC1243	1.50	2SD170	2.00
2SA628	.65	2SC372	.70	2SC785	1.00	2SC1293	.85	2SD180	2.75
2SA643	.85	2SC394	.70	2SC789	1.00	2SC1306	4.75	2SD201	1.95
2SA647	2.75	2SC458	.70	2SC793	2.50	2SC1307	5.75	2SD218	4.75
2SA673	.85	2SC460	.70	2SC796	3.15	2SC1308	4.75	2SD235	1.00
2SA679	3.75	2SC478	.80	2SC797	2.50	2SC1317	.60	2SD300	2.50
2SA682	.85	2SC481	1.85	2SC798	3.10	2SC1318	.70	2SD313	1.10
2SA699	1.30	2SC482	1.75	2SC799	4.25	2SC1325	4.95	2SD315	.75
2SA699A	1.45	2SC491	2.50	2SC802	3.75	2SC1327	.70	2SD316	2.50
2SA705	.55	2SC495	1.10	2SC803	4.00	2SC1338	1.75	2SD317	1.25
2SA815	.85	2SC497	1.60	2SC815	.75	2SC1346	.80	2SD318	.95
2SA816	.85	2SC502	1.50	2SC828	.75	2SC1347	.80	2SD325	1.25
		2SC515	.80	2SC829	.75	2SC1364	1.50	2SD341	.95
2SB22	.65	2SC517	4.25	2SC830	1.60	2SC1377	5.50	2SD350	3.25
2SB54	.70	2SC535	.75	2SC838	.70	2SC1383	.75	2SD352	.80
2SB56	.70	2SC536	.65	2SC839	.85	2SC1384	.85	2SD380	5.70
2SB77	.70	2SC537	.70	2SC922	.55	2SC1409	1.25	2SD389	.75
2SB128	2.25	2SC563	2.50	2SC929	.70	2SC1410	1.25	2SD390	.75
2SB152	4.50	2SC607	1.25	2SC930	.65	2SC1447	1.25		
2SB173	.55	2SC614	3.80	2SC938	.65	2SC1448	1.25	2SF8	3.00
2SB175	.55	2SC615	3.90	2SC943	1.50	2SC1449	1.30	2SCF8	3.50
2SB178	1.00	2SC616	4.15	2SC945	.65	2SC1475	1.50	2SCF6	1.25
2SB186	.60	2SC617	4.25	2SC959	3.15	2SC1507	1.25	HEPS3001	3.25
2SB187	.60	2SC620	.80	2SC960	2.75	2SC1509	1.25	JSP7001	.75
2SB235	7.00	2SC627	1.75	2SC984	1.50	2SC1569	1.25	MRF8004	3.00
2SB303	.65	2SC642	3.50	2SC996	4.90	2SC1674	1.75	MPS8000	1.25
2SB324	1.00	2SC643	3.75	2SC1010	.80	2SC1675	1.75	MPS8001	1.25
2SB337	2.10	2SC644	.70	2SC1012	.80	2SC1678	5.50	MPSU02	.50
2SB367	1.60	2SC681	2.50	2SC1013	1.50	2SC1679	4.75	MPSU31	4.00
2SB370	.65	2SC684	2.10	2SC1014	1.50	2SC1756	1.25	SK3047	3.75
2SB405	.85	2SC687	2.50	2SC1017	1.50	2SC1760	2.15	SK3048	3.25
2SB407	1.65	2SC696	3.00	2SC1018	1.50	2SC1816	4.50	SK3049	4.75
2SB415	.85	2SC699	4.75	2SC1030	4.75	2SC1908	.70	SK3054	1.25
2SB461	1.25	2SC710	.70	2SC1051	2.50	2SC1909	4.75	2SK19	.75
2SB463	1.65	2SC711	.70	2SC1060	.75	2SC1957	1.50	2SK30	1.00
2SB471	1.75	2SC712	.70	2SC1061	1.65	2SC1973	1.50	2SK33	1.20
2SB474	1.50	2SC713	.70	2SC1069	3.50	2SC1974	4.90	2SK41	1.75
2SB476	1.25	2SC731	3.00	2SC1079	3.75	2SC1975	4.90	3SK22Y	2.75
2SB481	2.10	2SC732	.70	2SC1080	3.75	2SC2028	1.10	3SK40	2.75
2SB492	1.25	2SC733	.70	2SC1096	1.20	2SC2029	4.75	3SK45	2.75
2SB495	.95	2SC735	.70	2SC1098	1.15	2SC2074	3.00	3SK49	2.75
2SB507	.90	2SC739	.70	2SC1115	2.75			4004	3.00
2SB511	.70	2SC715	.70	2SC1166	.70	2SD45	2.00	4005	3.00
2SB531	3.00	2SC756	3.00	2SC1167	4.25	2SD65	.75	40080	1.25
2SB556	3.50	2SC762	1.90	2SC1170	4.00	2SD68	.90	40081	1.50
2SB135	.95	2SC773	.85	2SC1172B	4.25	2SD72	1.00	40082	3.00

POPULAR JEDEC SEMICONDUCTORS

1N34	.25	2N918	.60	2N2218	.25	2N2906A	.30	2N3646	.14	2N4220A	.45
1N60	.25	2N930	25	2N2218A	.30	2N2907	.25	2N3730	2.50	2N4234	.95
1N270	.40	2N956	.30	2N2219	.25	2N2907A	.30	2N3731	3.75	2N4400	.16
1N914	.10	2N960	.90	2N2219A	.30	2N2913	.75	2N3740	1.00	2N4401	.16
		2N962	.95	2N2221	.25	2N2914	1.20	2N3771	1.75	2N4402	.16
2N173	1.75	2N967	.95	2N2221A	.30	2N2916A	3.65	2N3772	1.90	2N4403	.20
2N174	3.50	2N1136	1.75	2N2222	.25	2N3019	.50	2N3773	3.00	2N4409	.16
2N178	.90	2N1142	2.25	2N2222A	.30	2N3053	.30	2N3819	.40	2N4410	.16
2N327A	1.15	2N1300	1.00	2N2223	1.00	2N3054	.70	2N3823	.70	2N4416	.75
2N334	1.20	2N1301	1.10	2N2270	.40	2N3055	.75	2N3856	.20	2N5061	.30
2N336	.90	2N1302	1.25	2N2323	1.00	2N3227	1.00	2N3866	.85	2N5064	.50
2N338A	1.05	2N1303	.70	2N2324	1.35	2N3247	3.40	2N3903	.16	2N5130	.20
2N398B	1.50	2N1304	1.25	2N2325	2.00	2N3250	.50	2N3904	.16	2N5133	.15
2N404	.75	2N1305	.75	2N2326	2.85	2N3375	6.50	2N3905	.16	2N5138	.15
2N443	2.50	2N1306	1.35	2N2327	3.80	2N3393	.20	2N3906	.16	2N5198	3.75
2N456	1.30	2N1307	.75	2N2328	4.25	2N3394	.17	2N3925	3.75	2N5294	.50
2N501A	3.00	2N1308	1.50	2N2329	4.75	2N3414	.17	2N3954	3.50	2N5296	.50
2N508A	.45	2N1309	.90	2N2368	.25	2N3415	.18	2N3954A	3.75	2N5306	.20
2N555	.75	2N1552	3.25	2N2369	.25	2N3416	.19	2N3955	2.45	2N5354	.20
2N652A	1.25	2N1554	1.25	2N2484	.32	2N3417	.20	2N3957	1.25	2N5369	.20
2N677	6.00	2N1557	1.15	2N2712	.18	2N3442	1.85	2N4036	.75	2N5400	.40
2N706	.25	2N1560	2.80	2N2894	.40	2N3553	1.50	2N4037	.80	2N5401	.50
2N706B	.75	2N1605	.35	2N2903	3.30	2N3563	.20	2N4093	.85	2N5457	.35
2N711	.90	2N1613	.30	2N2904	.25	2N3565	.20	2N4124	.16	2N5458	.30
2N711B	1.10	2N1711	.30	2N2904A	.30	2N3638	.20	2N4126	.16	CIO3Y	.25
2N718	.25	2N1907	4.10	2N2905	.25	2N3642	.20	2N4141	.20	C106B1	.50
2N718A	.30	2N2060	1.85	2N2905A	.30	2N3643	.20	2N4142	.20		
2N720A	.50	2N2102	.40	2N2906	.25	2N3645	.20	2N4143	.20		

SILICON UNIJUNCTIONS

2N2160	.65	MU4892	.50
2N2646	.45	MU4893	.50
2N2647	.55	MU4894	.50
2N4851	.75	2N6027	55
2N4852	.75	2N6028	.70
2N4870	.50	D5E37	.35
2N4871	.50	MU10	.35
MU4891	.50	MU20	.40

HARDWARE ★ IC SOCKETS

Nylon Screws, Nuts & Rivets (Complete Kit, 50 pc's)	1.99
Trans H/W Mica, Bushings & Screws	
Case T03, T066 & T0220 (Specify Type, 10 Sets)	1.00
MK20 T03 Complete Mounting Kit	5/.99
MK25 T066 Complete Mounting Kit	5/.99
IC Socket 8 Pin T05 Pkg of 2	1.00ea.
IC Socket 10 Pin T05 Pkg of 2	1.22ea.
IC Socket 14 Pin DIL Pkg. of 1	.25ea.
IC Socket 16 Pin DIL Pkg. of 1	.27ea.

RECTIFIERS

	10 For	100 For
IN4001	.60	5.00
IN4002	.70	6.00
IN4003	.80	7.00
IN4004	.90	8.00
IN4005	1.00	9.00
IN4006	1.10	10.00
IN4007	1.20	11.00

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7400N TTL

SN7400N	.16	SN7459A	.25		
SN7401N	.16	SN7460N	.22	SN74154N	1.00
SN7402N	.21	SN7470N	.45	SN74155N	.99
SN7403N	.16	SN7472N	.39	SN74156N	.99
SN7404N	.18	SN7473N	.37	SN74157N	.99
SN7405N	.24	SN7474N	.32	SN74160N	1.25
SN7406N	.20	SN7475N	.50	SN74161N	.99
SN7407N	.29	SN7476N	.32	SN74163N	.99
SN7408N	.25	SN7479N	5.00	SN74164N	1.10
SN7409N	.25	SN7480N	.50	SN74165N	1.10
SN7410N	.18	SN7482N	.98	SN74166N	1.25
SN7411N	.30	SN7483N	.70	SN74167N	5.50
SN7412N	.33	SN7485N	.89	SN74170N	2.10
SN7413N	.45	SN7486N	.39	SN74172N	8.95
SN7414N	.70	SN7488N	3.50	SN74173N	1.50
SN7416N	.35	SN7489N	2.49	SN74174N	1.25
SN7417N	.35	SN7490N	.45	SN74175N	.99
SN7420N	.21	SN7491N	.75	SN74176N	.90
SN7421N	.33	SN7492N	.49	SN74177N	.90
SN7422N	.49	SN7493N	.49	SN74180N	.99
SN7423N	.37	SN7494N	.79	SN74181N	2.49
SN7425N	.29	SN7495N	.79	SN74182N	.95
SN7426N	.29	SN7496N	.89	SN74184N	1.95
SN7427N	.37	SN7497N	4.00	SN74185N	2.20
SN7429N	.42	SN74100N	1.00	SN74186N	15.00
SN7430N	.26	SN74107N	.39	SN74187N	6.00
SN7432N	.31	SN74121N	.39	SN74188N	3.95
SN7437N	.27	SN74122N	.39	SN74190N	1.19
SN7438N	.27	SN74123N	.50	SN74191N	1.19
SN7439N	.25	SN74125N	.60	SN74192N	.89
SN7440N	.15	SN74126N	.60	SN74193N	.89
SN7441N	.89	SN74132N	1.09	SN74194N	1.25
SN7442N	.59	SN74136N	.95	SN74195N	.75
SN7443N	.75	SN74141N	1.15	SN74196N	1.25
SN7444N	.75	SN74142N	4.00	SN74197N	.75
SN7445N	.75	SN74143N	4.50	SN74198N	1.75
SN7446N	.81	SN74144N	4.50	SN74199N	1.75
SN7447N	.69	SN74145N	1.15	SN74200N	5.59
SN7448N	.79	SN74147N	2.35	SN74279N	.90
SN7450N	.26	SN74148N	2.00	SN74251N	1.79
SN7451N	.27	SN74150N	1.00	SN74284N	6.00
SN7453N	.27	SN74151N	.79	SN74285N	6.00
SN7454N	.20	SN74153N	.89	SN74367N	.75

MANY OTHERS AVAILABLE ON REQUEST
20% Discount for 100 Combined 7400's

CMOS

CD4000	.25	CD4035	1.85	74C04N	.75
CD4001	.25	CD4040	2.45	74C10N	.65
CD4002	.25	CD4042	1.90	74C20N	.65
CD4006	2.50	CD4044	1.50	74C30N	.65
CD4007	.25	CD4046	2.51	74C42N	2.15
CD4009	.59	CD4047	2.75	74C73N	1.50
CD4010	.59	CD4049	.79	74C74	1.15
CD4011	.25	CD4050	.79	74C90N	3.00
CD4012	.25	CD4051	2.95	74C95N	2.00
CD4013	.47	CD4053	2.95	74C107N	1.25
CD4016	.56	CD4060	3.25	74C151	2.90
CD4017	1.35	CD4066	1.75	74C154	4.00
CD4019	.55	CD4069	.45	74C157	2.15
CD4020	1.49	CD4071	.45	74C160	3.25
CD4022	1.25	CD4081	.45	74C161	3.25
CD4023	.25	CD4511	2.50	74C163	3.00
CD4024	1.50	CD4518	2.50	74C164	3.25
CD4025	.25	MC14566	3.00	74C173	2.60
CD4027	.69	74C00N	.39	74C193	2.75
CD4028	1.65	74C02N	.55	74C195	2.75
CD4029	2.90			MC4044	4.50
CD4030	.65			MC14016	.56

LINEAR

LM300H	.80	LM370N	1.15	LM1310N	2.95
LM301H	.35	LM373N	3.25	LM1351N	1.65
LM301CN	.35	LM377N	4.00	LM1414N	1.75
LM302H	.75	LM380N	1.39	LM1458C	.65
LM304H	1.00	LM380CN	1.05	LM1496N	.95
LM305H	.95	LM381N	1.79	LM1556V	1.85
LM307CN	.35	LM382N	1.79	LM2111N	1.95
LM308H	1.00	NE501K	8.00	LM2901N	2.95
LM308CN	1.00	NE510A	6.00	LM3065N	.69
LM309H	1.10	NE531H	3.00	LM3900N	.55
LM309K	.99	NE536T	6.00	LM3905N	.60
LM310CN	1.15	NE540L	6.00	LM3909	1.25
LM311H	.90	NE550N	.79	LM5556N	1.85
LM311N	.90	NE555V	.39	MC5558V	1.00
LM318CN	1.50	NE560B	5.00	LM7525N	.90
LM319N	1.30	NE561B	5.00	LM7535N	1.25
LM320K-5	1.35	NE562B	5.00	8038B	4.95
LM320K-5.2	1.35	NE565H	1.25	LM75450	.49
LM320K-12	1.35	NE565N	1.25	75451CN	.39
LM320K-15	1.35	NE566CN	1.25	75452CN	.39
LM320T-5	1.75	NE567H	1.95	75453CN	.39
LM320T-5.2	1.75	NE567V	1.50	75454CN	.39
LM320T-8	1.75	LM703CN	.45	75491CN	.79
LM320T-12	1.75	LM709H	.29	75492CN	.89
LM320T-15	1.75	LM709N	.29	75494CN	.89
LM320T-18	1.75	LM710N	.79	RCA LINEAR	
LM320T-24	1.75	LM711N	.39	CA3013	2.15
LM323K-5	9.95	LM723H	.55	CA3023	2.56
LM324N	1.80	LM723N	.55	CA3035	2.48
LM339N	1.70	LM733N	1.00	CA3039	1.35
LM340K-5	1.95	LM739N	1.00	CA3046	1.30
LM340K-6	1.95	LM741CH	.35	CA3059	3.25
LM340K-8	1.95	LM741CN	.35	CA3060	3.25
LM340K-12	1.95	LM741-14N	.39	CA3080	.85
LM340K-15	1.95	LM747H	.79	CA3081	2.00
LM340K-18	1.95	LM747N	.79	CA3082	2.00
LM340K-24	1.95	LM748H	.39	CA3083	1.60
LM340T-5	1.75	LM748N	.39	CA3086	.85
LM340T-6	1.75	LM1303N	.90	CA3089	3.75
LM340T-8	1.75	LM1304N	1.19	CA3091	10.20
LM340T-12	1.75	LM1305N	1.40	CA3123	2.15
LM340T-15	1.75	LM1307N	.85	CA3130	1.39
LM340T-18	1.75			CA3140	1.25
LM340T-24	1.75			CA3600	1.75
LM350N	1.00			RC4194	5.95
LM351CN	.65			RC4195	3.25

74LS00 TTL

74LS00	.29	74LS74	.49	74LS139	1.95
74LS02	.29	74LS75	.69	74LS151	1.55
74LS03	.29	74LS76	.49	74LS153	1.89
74LS04	.35	74LS83	1.75	74LS157	1.55
74LS05	.35	74LS85	2.49	74LS162	2.25
74LS08	.29	74LS86	.49	74LS163	2.25
74LS10	.29	74LS90	1.25	74LS164	1.95
74LS13	.69	74LS92	1.25	74LS175	1.95
74LS14	1.75	74LS93	1.25	74LS181	3.69
74LS20	.29	74LS95	1.95	74LS190	2.85
74LS26	.39	74LS96	1.89	74LS191	2.85
74LS27	.39	74LS107	.59	74LS192	2.85
74LS28	.39	74LS109	.59	74LS193	2.85
74LS30	.29	74LS112	.59	74LS194	1.89
74LS32	.39	74LS132	1.25	74LS195	1.89
74LS40	.39	74LS136	.59	74LS257	1.75
74LS51	.29	74LS138	1.89	74LS260	.55
74LS55	.29			74LS279	.79
74LS73	.49			74LS670	3.95

CLOCK CHIPS

MM5309	6 Digit, BCD Outputs, Reset PIN	$9.95
MM5311	6 Digit, BCD Outputs, 12 or 24 Hour	4.95
MM5312	4 Digit, BCD Outputs, 1 PPS Output	4.95
MM5314	6 Digit, 12 or 24 Hour, 50 or 60 Hz	4.95
MM5316	4 Digit, Alarm, 1 PPS Output	6.95
MM5318	Video Clock Chip, For Use With (MM5841 - $9.95)	9.95
CT7001	6 Digit, Calendar, Alarm, 12 or 24 Hour	5.95

DATA HANDBOOKS

7400	Pin-out & Description of 5400/7400 ICS	$2.95
CMOS	Pin-out & Description of 4000 Series ICS	$2.95
Linear	Pin-out & Functional Description	$2.95

ALL THREE HANDBOOKS $6.95

FAIRCHILD TECHNOLOGY KITS FAIRCHILD

DIGITS

FTK0001	0.5" High Common Cathode Digit	$1.00
FTK0002	0.5" High Common Anode Digit	1.00
FTK0003	.357" High Common Cathode Digit	.75
FTK0004	0.8" High Common Cathode Digit	2.00
FTK0005	0.8" High Common Anode Digit	2.00

0.8" HIGH DISPLAY ARRAYS

FTK0010	12 Hour, 3½ Digit Clock Display	7.00
FTK0011	24 Hour, 4 Digit Clock Display	8.00

LED LAMPS

FTK0020	10 Red LED Lamps	1.00
FTK0021	5 Mixed Colored LED Lamps	1.00
FTK0022	10 LED Mounting Clips	1.00
FTK0023	5 Three Piece LED Mounting Adapters	1.00

PHOTO TRANSISTORS

FTK0030	5 Flat Lens Photo Transistors	1.00
FTK0031	5 Round Lens Photo Transistors	1.00
FTK0032	3 Flat Lens Photo Darlingtons	1.00
FTK0033	3 Round Lens Photo Darlingtons	1.00

PHOTO ARRAYS

FTK0040	9-Element Tape Reader Array	16.00
FTK0041	12 Element Card Reader Array	24.00
FTK0042	Reflective Opto Coupler	4.00

COUPLERS

FTK0050	3 General Purpose Opto Couplers	1.00
FTK0051	Darlington Opto Coupler	1.00

MOS CLOCK CIRCUITS

FTK0400	Digital Clock Calendar Circuit (FCM7001)	7.00
FTK0401	Digital Clock/Calendar with BCD Outputs (FCM7002)	7.00
FTK0402	Direct Drive Digital Clock Circuit with AC Output (FCM3817A)	5.00
FTK0403	Direct Drive Digital Clock Circuit with DC Output (FCM3817D)	5.00
FTK0405	Direct Drive Digital Clock Calendar Circuit (FCM7015)	6.00

KITS

FTK0106	Automobile Clock Kit	40.00

DISCRETE LEDS

.125" dia.		
XC209	Red	10/$1
XC209	Green	4/$1
XC209	Orange	4/$1
XC209	Yellow	4/$1

.190" dia.		
XC111	Red	10/$1
XC111	Green	4/$1
XC111	Yellow	4/$1
XC111	Orange	4/$1

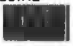
.200" dia			.185" dia.			.200" dia.		
XC22	Red	10/$1	XC526	Red	10/$1	XC556	Red	10/$1
XC22	Green	4/$1	XC526	Green	4/$1	XC556	Green	4/$1
XC22	Yellow	4/$1	XC526	Yellow	4/$1	XC556	Yellow	4/$1
XC22	Orange	4/$1	XC526	Orange	4/$1	XC556	Orange	4/$1
SSL-22	RT	4/$1	XC526	Clear	4/$1	XC556	Clear	7/$1

.085" dia.
MV50 — 6/$1

INFRA-RED LED
¼" x ¼" x 1/16"
Flat 5/$1.00

SPECIAL * — XC556 Red 100/$8.00 1000/$60.00 — SPECIAL *

DISPLAY LEDS

DL 707  UL338

TYPE	POLARITY	HT		TYPE	POLARITY	HT	
MAN 1	Common Anode	.270	2.95	MAN 3640	Common Cathode-orange	.300	1.75
MAN 2	5 x 7 Dot Matrix	.300	4.95	MAN 4710	Common Anode-Red	.400	1.95
MAN 3	Common Cathode	.125	3/1.00	DL701	Common Anode-red	.300	.99
MAN 4	Common Cathode	.187	1.95	DL704	Common Cathode	.300	.99
MAN 7	Common Anode	.300	1.25	DL707	Common Anode	.300	.99
MAN 7G	Common Anode-green	.300	1.95	DL 728	Common Cathode	.500	.95
MAN 7Y	Common Anode-yellow	.300	1.95	DL741	Common Anode	.600	1.50
MAN 52	Common Anode-green	.300	.99	DL 747	Common Anode	.600	2.25
MAN 64	Common Anode-red	.400	.99	DL 750	Common Cathode	.600	2.49
MAN 74	Common Cathode	.300	1.50	DL 338	Common Cathode	.110	.50
MAN 82	Common Anode-yellow	.300	.99	FND70	Common Cathode	.250	.75
MAN 84	Common Cathode-yellow	.300	.99	FND503	Common Cathode	.500	1.00
MAN 3620	Common Anode-orange	.300	1.75	FND507	Common Anode	.500	1.00

FACTORY REJECTS ATARI GAME BOARDS

BOARD A — 8½" x 16" — $6.95 ea.
Over 60 each reusable IC's
Misc. Transistors, Resistors, Diodes, Caps, Crystals, Switch, etc
ONLY 500 EA AVAILABLE

DELUXE BOARD B — 11½" x 18" — $9.95 ea.
Over 100 each reusable IC's
Misc. Transistors, Resistors, Diodes, Caps, Crystals, Switches, LEDS, etc
ONLY 500 EA AVAILABLE

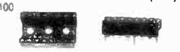
NEW AY-3-8500-1 TV GAME CHIP

- Score display
- Selectable angles, speed and bat size
- Auto or manual ball service
- Realism sounds
- 6 Games — tennis, hockey, soccer, squash, pelota/practice and two rifle games

28 Lead Dual-in-Line
The circuit is intended to be battery powered. Minimum number of external components required for complete system.

$24.95

IC SOLDERTAIL — LOW PROFILE (TIN) SOCKETS



	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.17	.16	.15	24 pin	$.38	.37	.36
14 pin	.20	.19	.18	28 pin	.45	.44	.43
16 pin	.22	.21	.20	36 pin	.60	.59	.58
18 pin	.29	.28	.27	40 pin	.63	.62	.61
22 pin	.37	.36	.35				

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100		1-24	25-49	50-100
14 pin	$.27	.25	.24	28 pin	$.99	.90	.81
16 pin	.30	.27	.25	36 pin	1.39	1.26	1.15
18 pin	.35	.32	.30	40 pin	1.59	1.45	1.30
24 pin	.49	.45	.42				

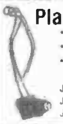
SOLDERTAIL STANDARD (GOLD)

	1-24	25-49	50-100		1-24	25-49	50-100
8 pin	$.30	.27	.24	24 pin	$.70	.63	.57
14 pin	.35	.32	.29	28 pin	1.10	1.00	.90
16 pin	.38	.35	.32	36 pin	1.75	1.40	1.26
18 pin	.52	.47	.43	40 pin	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100		1-24	25-49	50-100
10 pin	$.45	.41	.37	24 pin	$1.05	.95	.85
14 pin	.39	.38	.37	28 pin	1.40	1.25	1.10
16 pin	.43	.42	.41	36 pin	1.59	1.45	1.30
18 pin	.75	.68	.62	40 pin	1.75	1.55	1.40

Plastic Push Button Switch



* 18 AWG Solid Wire - 5" Long
* .50 (wide) X .60 (high) ⅜-27 Thread
* 8 AMP @ 14 Volt - 1 AMP @ 110 Volt

		1-9	10-Up
J-188-1	Push On-Push Off	.59	.49
J-188-2	Normally Open	.59	.49
J-188-3	Normally Closed	.59	.49

MINATURE TOGGLE SWITCH

JMT-221	DPDT	on/off/on	$1.95
JMT-223	DPDT	on/none/on	$1.75
JMT-121	SPDT	on/off/on	$1.50
JMT-123	SPDT	on/none/on	$1.25

CLIPLITE 8/$1.49

LED MOUNTING SYSTEM
use with XC556 LEDS
Specify Colors — Red - Green - Amber - Yellow

DIP SWITCH

These switches feature 7 SPST slide switches in a molded dip. They are ideally suited for microprocessor applications. $1.95

50 PCS. RESISTOR ASSORTMENTS $1.75 PER ASST.

ASST. 1	5 ea.	10 OHM / 27 OHM	12 OHM / 33 OHM	15 OHM / 39 OHM	18 OHM / 47 OHM	22 OHM / 56 OHM	1/4 WATT 5%	50 PCS.
ASST. 2	5 ea.	68 OHM / 180 OHM	82 OHM / 220 OHM	100 OHM / 270 OHM	120 OHM / 330 OHM	150 OHM / 390 OHM	1/4 WATT 5%	50 PCS.
ASST. 3	5 ea.	470 OHM / 1.2K	560 OHM / 1.5K	680 OHM / 1.8K	820 OHM / 2.2K	1K / 2.7K	1/4 WATT 5%	50 PCS.
ASST. 4	5 ea.	3.3K / 8.2K	3.9K / 10K	4.7K / 12K	5.6K / 15K	6.8K / 18K	1/4 WATT 5%	50 PCS.
ASST. 5	5 ea.	22K / 56K	27K / 68K	33K / 82K	39K / 100K	47K / 120K	1/4 WATT 5%	50 PCS.
ASST. 6	5 ea.	150K / 390K	180K / 470K	220K / 560K	270K / 680K	330K / 820K	1/4 WATT 5%	50 PCS.
ASST. 7	5 ea.	1M / 2.7M	1.2M / 3.3M	1.5M / 3.9M	1.8M / 4.7M	2.2M / 5.6M	1/4 WATT 5%	50 PCS.

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) **$10.95 ea.**

$5.00 Minimum Order — U.S. Funds Only
California Residents — Add 6% Sales Tax

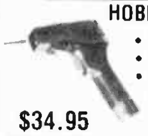
Spec Sheets - 25¢ — Send 35¢ Stamp for 1977A Catalog
Dealer Discount Available — Request Pricing

NOW OPEN SATURDAYS

James ELECTRONICS
1021-A HOWARD AVE., SAN CARLOS, CA. 94070
PHONE ORDERS WELCOME — (415) 592-8097
All Advertised Prices Good Thru April

WIRE WRAP CENTER

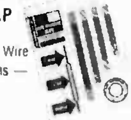
HOBBY-WRAP TOOL-BW-630



- Battery Operated (Size C)
- Weighs ONLY 11 Ounces
- Wraps 30 AWG Wire onto Standard DIP Sockets (0.25 inch)
- Complete with built-in bit and sleeve

$34.95
(batteries not included)

WIRE-WRAP KIT — WK-2-W



WRAP • STRIP • UNWRAP

- Tool for 30 AWG Wire
- Roll of 50 Ft. White or Blue 30 AWG Wire
- 50 pcs. each 1", 2", 3" & 4" lengths — pre-stripped white wire

$11.95

WIRE WRAP TOOL WSU-30

WRAP • STRIP • UNWRAP - $5.95

WIRE WRAP WIRE — 30 AWG

25 ft. min. $1.25 50 ft. $1.95 100 ft. $2.95 1000 ft. $15.00
SPECIFY COLOR — White - Yellow - Red - Green - Blue - Black

CUTTER CRIMPER TOOL (CS-8)

- Plier Nose (serrated-jaw)
- Scissors Action Cutting
- 6 Bolt Cutters (4-40, 5-40, 6-32, 8-32, 10-32, 10-24)
- Crimp Stations (7mm Auto — 22-20 to 12-XO elect.)
- "Up-Front" Wire Cutting
- Scissors Action Stripping (No. 22-20 to No. 10)
- Crimp Stations — insulated (2w-20 to 12-10 elect.)

Actual Size - 8¼" length **$8.50**

Permacel Electrical Tape

- ¾" (wide) X 66 ft. (long) • All weather • Not import

$1.25 per roll — $9.95 per 10 roll package

ZENERS — DIODES — RECTIFIERS

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
1N746	3.3	400mm	4/1.00	1N4005	600 PIV	1 AMP	10/1.00
1N751A	5.1	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N752	5.6	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N753	6.2	400m	4/1.00	1N3600	50	200m	6/1.00
1N754	6.8	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	8/1.00	1N4154	35	10m	12/1.00
1N965B	15	400m	4/1.00	1N4305	75	25m	20/1.00
1N5232	5.6	500m	.28	1N4734	5.6	1w	.28
1N5234	6.2	500m	.28	1N4735	6.2	1w	.28
1N5235	6.8	500m	.28	1N4736	6.8	1w	.28
1N5236	7.5	500m	.28	1N4738	8.2	1w	.28
1N456	25	40m	6/1.00	1N4742	12	1w	.28
1N458	150	7m	6/1.00	1N4744	15	1w	.28
1N485A	180	10m	6/1.00	1N1183	50 PIV	35 AMP	1.60
1N4001	50 PIV	1 AMP	12/1.00	1N1184	100 PIV	35 AMP	1.70
1N4002	100 PIV	1 AMP	12/1.00	1N1185	150 PIV	35 AMP	1.50
1N4003	200 PIV	1 AMP	12/1.00	1N1186	200 PIV	35 AMP	1.80
1N4004	400 PIV	1 AMP	12/1.00	1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR	$1.95
C38M	35A @ 200V	SCR	1.95
2N2328	1.6A @ 200V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC	1.95

TRANSISTORS

MPS A05	5/$1.00	PN3567	3/$1.00	PN4249	4/$1.00
MPS A06	5/$1.00	PN3568	4/$1.00	PN4250	4/$1.00
2N2219A	3/$1.00	PN3569	4/$1.00	2N4400	4/$1.00
2N2221	4/$1.00	2N3704	5/$1.00	2N4401	4/$1.00
2N2222A	5/$1.00	2N3705	5/$1.00	2N4402	4/$1.00
2N2369	5/$1.00	2N3706	5/$1.00	2N4403	4/$1.00
2N2369A	4/$1.00	2N3707	5/$1.00	2N4409	5/$1.00
2N2484	4/$1.00	2N3711	5/$1.00	2N5086	4/$1.00
2N2906A	4/$1.00	2N3724	$.65	2N5087	4/$1.00
2N2907A	5/$1.00	2N3725	$1.00	2N5088	4/$1.00
2N2925	5/$1.00	2N3903	5/$1.00	2N5089	4/$1.00
2N3053	2/$1.00	2N3904	4/$1.00	2N5129	5/$1.00
2N3055	$.89	2N3905	4/$1.00	2N5138	5/$1.00
MJE3055	$1.00	2N3906	4/$1.00	2N5139	5/$1.00
MJE2955	$1.25	2N4013	3/$1.00	2N5209	5/$1.00
2N3392	5/$1.00	2N4014	3/$1.00	2N5951	5/$1.00
2N3398	5/$1.00	2N4123	10/$1.00	C106B1SCR	2/$1.00
				2N5432	$2.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075

100 VOLT MYLAR FILM CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (SOLID) CAPACITORS

	1-9	10-49	50-100		1-9	10-49	50-100
.1/35V	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/25V	.31	.27	.22
.22/35V	.28	.23	.17	3.3/25V	.31	.27	.22
.33/35V	.28	.23	.17	4.7/25V	.32	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.36	.31	.25
.68/35V	.28	.23	.17	10/25V	.40	.35	.29
1.0/35V	.28	.23	.17	15/25V	.63	.50	.40

MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead	1-9	10-49	50-100	Radial Lead	1-9	10-49	50-100
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.15	.13	.10	1.0/16V	.15	.13	.10
4.7/25V	.16	.14	.12	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.12
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

CRYSTALS

THESE FREQUENCIES ONLY

Part #	Frequency	Case/Style	Price
CY1A	1.000 MHz	HC33/U	$5.95
CY2A	2.000 MHz	HC33/U	$5.95
CY3A	4.000 MHz	HC18/U	$4.95
CY7A	5.000 MHz	HC18/U	$4.95
CY12A	10.000 MHz	HC18/U	$4.95
CY14A	14.31818 MHz	HC18U	$4.95
CY19A	18.000 MHz	HC18/U	$4.95
CY22A	20.000 MHz	HC18/U	$4.95
CY30B	32.000 MHz	HC18/U	$4.95

XR-2260KB Kit $27.95 XR-2206KA Kit $17.95

EXAR

WAVEFORM GENERATORS

XR 205	$8.40
XR 2206CP	4.49
XR 2207CP	3.85

STEREO DECODERS

XR 1310CP	$3.20
XR 1310EP	3.20
XR 1800P	3.20
XR 2567	2.99

MISCELLANEOUS

XR 2211CP	$6.70
XR 4136	[illegible]
XR 1468	3.85
XR-1488	5.80
XR 1489	4.80
XR 2208	5.20

TIMERS

XR-555CP	[illegible]
XR-320P	1.55
XR-556CP	1.85
XR 2556CP	3.[illegible]
XR-2240CP	3.2[illegible]

PHASE LOCKED LOOPS

XR 210	5.20
XR 215	6.60
XR 567CP	1.95
XR 567CT	1.70

CONNECTORS

PRINTED CIRCUIT EDGE-CARD

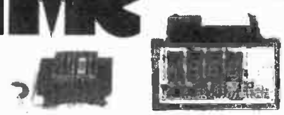
156 Spacing-Tin-Double Read-Out
Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30	PINS (Solder Eyelet)	$1.95
18/36	PINS (Solder Eyelet)	$2.49
22/44	PINS (Solder Eyelet)	$2.95
50/100 (.100 Spacing)	PINS (Solder Eyelet)	$6.95

25 PIN-D SUBMINIATURE

DB25	PLUG	$3.25
DB25	SOCKET	$4.95

3½ DIGIT DVM KIT



This 0-2 VDC .05 per cent digital voltmeter features the Motorola 3½ digit DVM chip set. It has a .4" LED display and operates from a single +5V power supply. The unit is provided complete with an injection molded black plastic case complete with Bezel. An optional power supply is available which fits into the same case as the 0-2V DVM allowing 117 VAC operation.

A. 0-2V DVM with Case $49.95
B. 5V Power Supply $14.95

VECTOR WIRING PENCIL

Vector Wiring Pencil P173 consists of a hand held featherweight (under one ounce) tool which is used to guide and wrap insulated wire, fed off a self contained replaceable bobbin, onto component leads or terminals installed on pre punched "P" Pattern Vectorbord. Connections between the wrapped wire and component leads, pads or terminals are made by soldering. Complete with 250 FT of red wire. **$9.95**

REPLACEMENT WIRE — BOBBINS FOR WIRING PENCIL

W36-3-A-Pkg 3	250 ft	36 AWG GREEN	$2.40
W36-3-B-Pkg 3	250 ft	36 AWG RED	$2.40
W36-3-C-Pkg 3	250 ft	36 AWG CLEAR	$2.40
W36-3-D-Pkg 3	250 ft	36 AWG BLUE	$2.40

1/16 VECTOR BOARD

	0.1" Hole Spacing Part No	P-Pattern L	P-Pattern W	Price 1	Price 2-Up
PHENOLIC	64P44 062XXXP	4.50	6.50	1.72	1.54
	169P44 062XXXP	4.50	17.00	3.69	3.32
EPOXY GLASS	64P44 062	4.50	6.50	2.07	1.86
	84P44 062	4.50	8.50	2.56	2.31
	169P44 062	4.50	17.00	5.04	4.53
	169P84 062	8.50	17.00	9.23	8.26
EPOXY GLASS COPPER CLAD	169P44 062C1	4.50	17.00	6.80	6.12

HEAT SINKS

205-CB	Beryllium Copper Heat Sink with Black Finish for TO-5	$ .25
291-.36H	Aluminum Heat Sink for TO-220 Transistors & Regulators	$ .25
680-.75A	Black Anodized Aluminum	$1.60

HEXADECIMAL ENCODER 19-KEY PAD

- 1 - 0
- ABCDEF
- Return Key
- Optional Key (Period)
- — Key

$10.95 each

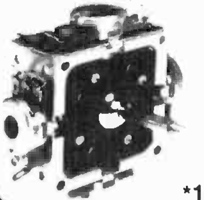
63 KEY KEYBOARD

This keyboard features 63 unencoded SPST keys (unattached to any kind of P.C.B.). A very solid molded plastic 13 x 4 base suits most applications.

$19.95

HD0165 16 LINE TO FOUR BIT PARALLEL KEYBOARD ENCODER $7.95

JOYSTICK



These joysticks feature four potentiometers, that vary resistance proportional to the angle of the stick. Sturdy metal construction with plastics components only at the movable joint. Perfect for electronic games and instrumentation.

***5K Pots $6.95**
***100K Pots $7.95**

MICROPROCESSOR COMPONENTS

8080A	CPU	$19.95	8228	System Controller - Bus Driver	$10.95
8212	8 Bit Input/Output	4.95	MC6800L	8 Bit MPU	35.00
8214	Priority Interrupt Control	15.95	MC6820L	Periph. Interface Adapter	15.00
8216	Bi-Directional Bus Driver	6.95	MC6810AP1	128 x 8 Static RAM	6.00
8224	Clock Generator/Driver	10.95	MC6830L7	1024 x 8 Bit ROM	18.00

CPU'S

8080	Super 8008	24.95
8080A	Super 8008	19.95

SR'S

2504	1024 Dynamic	$ 3.95
2518	Hex 32 Bit	7.00
2519	Hex 40 Bit	4.00
2524	512 Dynamic	2.49
2525	1024 Dynamic	6.00
2527	Dual 256 Bit	3.95
2529	Dual 512 Bit	4.00
2532	Quad 80 Bit	3.95
2533	1024 Static	7.95
3341	Fifo	6.95
74LS670	16 x 4 Reg	3.95

UART'S

AY-5-1013	30K Baud	$5.95

ROM'S

2513	Char. Gen.	$ 9.95
2516	Char. Gen.	10.95
74S387	1024-Bit Programmable	1.95

RAM'S

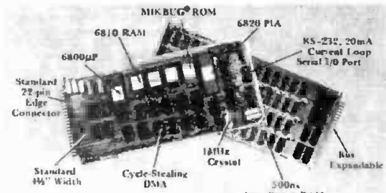
1101	256 x 1	Static	$ 1.49
2101	256 x 4	Static	5.95
2102	1024 x 1	Static	1.75
2107 5280	4096 x 1	Dynamic	4.95
2111	256 x 4	Static	6.95
7489	16 x 4	Static	2.49
8101	256 x 4	Static	6.95
8111	256 x 4	Static	6.95
8599	16 x 4	Static	3.49
91L02	1024 x 1	Static	2.25
74200	256 x 1	Static	6.95
93421	256 x 1	Static	2.95
MM5262	2K x 1	Dynamic	2 for 1.00

PROMS

1702A	2048	Famos	$ 9.95
5203	2048	Famos	14.95
82S23	32 x 8	Open C	5.00
82S123	32 x 8	Tristate	5.00
74S287	1024	Static	7.95
3601	256 x 4	Fast	3.95
2708	8K	Eprom	14.95
6301-1	1024	Tri-State Bipolar	3.49
6330-1	256	Open Collector Bipolar	2.95
6331-1	256	Tri-State Bipolar	2.95

GEMINI-68 The Unique Microprocessing System

Standard 4½" Boards - Dual 22 pin edge Connector NOT A KIT



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STAND ALONE CPU BOARD — Has 384 bytes of RAM on board, serial I/O (RS-232 and 20 ma current loop), cycle stealing direct memory access (DMA), built in soft-ware — selectable echo-back capability. Part # SA-CPU Board **$279.95**

CPU BOARD — Same as above but only has 128 bytes of RAM on board used with 8K RAM board listed below. Part # Gemini 68 CPU Board **$259.95**

8K RAM BOARD — Uses low power static RAMS. 500ns cycle time. 1.5 Amps Max. Part # Gemini 68 RAM Board **$269.95**

8K EPROM BOARD — Uses 5204 EPROMS by AMI or NATIONAL. Shipped with all decode and miscellaneous IC's except the 5204 EPROMS. Part # Gemini 68 EPROM Board **$ 89.95**

Allow approximately four weeks per delivery

SPECIAL REQUESTED ITEMS

MC3061P	3.50	CD4508	6.75	82S115	25.00	3341	6.95
MC4016P (74416)	7.50	CD4515	6.50	5841	9.95	9366	3.95
MC14583	3.50	CD4520	2.70	MK50240	17.50	MC1408L7	9.95
MC14562	14.50	MCM6571	17.50	11C90	19.95	LD110 LD111	25.00 set
CD4059	9.95	MCM6574	17.50	DS0026CH	3.75	AY-5-9100	17.50 ea.
CD4070	.95	MCM6575	17.50	TIL308	10.50	95H90	13.95

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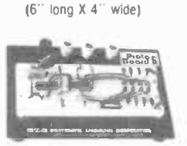
SPECIAL - $39.95

CONTINENTAL SPECIALTIES

PROTO BOARD 6
$15.95
(6" long X 4" wide)



Other CS Proto Boards

PB100	4.5" x 6"	$ 19.95
PB101	5.8" x 4.5"	29.95
PB102	7" x 4.5"	39.95
PB103	9" x 6"	59.95
PB104	9.5" x 8"	79.95
PB203	9.75 x 6½ x 2¾	75.00
PB203A	9.75 x 6½ x 2¾	120.00

(includes power supply)

Logic Monitor $84.95
for DTL, HTL, TTL or CMOS Devices

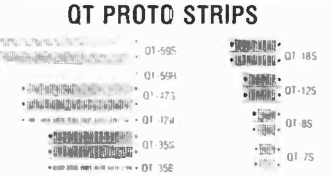
PROTO CLIPS

14 PIN	$4.50
16 PIN	4.75
24 PIN	8.50

DESIGN MATES

DM1 - Circuit Designer 54.95
DM2 - Function Generator 69.95
DM3 - RC Bridge 59.95

QT PROTO STRIPS



QT type	# holes	price
QT-59S	590	12.50
QT-59B	bus strip	2.50
QT-47S	470	10.00
QT-47B	bus strip	2.25
QT-35S	350	8.50
QT-35B	bus strip	2.00
QT-18S	180	4.75
QT-12S	120	3.75
QT-8S	80	3.25
QT-7S	70	3.00

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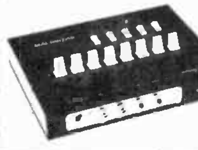
LOGIC ANALYZER KIT

(as shown in Feb. Popular Electronics)

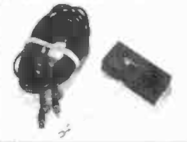


Troubleshoot any type of digital system including Microcomputers.

(includes IC, power supply, PC Board, case and manual)

LA100 KIT $189.00

TV ANTENNA SWITCH



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- Switches 300 ohm to 300 ohm
- Switches 75 ohm to 300 ohm
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"Hear the highway action"

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- 9-volt battery powered
- Portable — attaches to visor
- 23-Channel operation
- Long range reception (Battery not Included)

Actual Size - 4" x 3" x 1½

$9.95

DIGITAL STOPWATCH

- Bright 6 Digit LED Display
- Times to 59 minutes 59.59 seconds
- Crystal Controlled Time Base
- Three Stopwatches in One
- Times Single Event — Split & Taylor
- Size 4.5 x 2.15 x .90 (4½ ounces)
- Uses 3 Penlite Cells

Kit — $39.95
Assembled — $49.95
Heavy Duty Carry Case $5.95

Stop Watch Chip Only (7205) $19.95

Timeband
A Trademark of Fairchild Camera and Instrument Corporation

DIGITAL ALARM CLOCK $16.95

- 24-Hour Alarm
- "DOZE" Button
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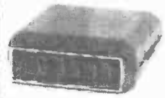
- Large Red Led Display (.8" high)
- AM/PM Indicator
- Seconds Display at touch of button
- SPECIFY BLACK OR IVORY

DIGITAL QUARTZ CAR CLOCK



Complete kit from mounting bracket of the injection molded case down to the three conductor power cord and all components including MM5314 clock chip. Features quartz accuracy of .01%, six digit .35 high LED display, and P.C. Boards. Works on any 12 volt system — motorcycles, boats, vans, motorhomes, autos, and trucks.

DIMENSIONS 4½ x 4 x 2
12 or 24 HOUR MODE

Kit: $29.95
Assembled: $39.95

CASE ONLY (includes hardware, mounting bracket and bezel) $6.50

JE700 CLOCK

12 or 24 Hour

115 VAC

The JE700 is a low cost digital clock, but is a very high quality unit. The unit features a simulated walnut case with dimensions of 6 x 2½ x 1. It utilizes a MAN72 high brightness readout, and the MM5314 clock chip.

$17.95

DIGITAL CLOCK KIT — 3½ INCH DIGITS

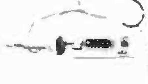
4 DIGIT KIT $49.95	4 DIGIT ASSEMBLED $59.95
6 DIGIT KIT $69.95	6 DIGIT ASSEMBLED $79.95

This clock features big 3½" high digits for viewing in offices, auditoriums, etc. Each digit is formed by 31 bright 0.2" LED's. The clock operates from 117 VAC, has either 12 or 24 hr. operation. The 6 digit version is 27" x 3½" x 1½" and the 4 digit is 18" x 3½" x 1½". Kits come complete with all components, case and transformer.

Specify 12 or 24 Hour When Ordering

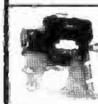
JE803 PROBE

The Logic Probe is a unit which is for the most part indespensible in trouble shooting logic families TTL, DTL, RTL, CMOS. It derives the power it needs to operate directly off of the circuit under test, drawing a scant 10 mA max. It uses a MAN3 readout to indicate any of the following states by these symbols: (HI) - 1 (LOW) - 0 (PULSE) - P. The Probe can detect high frequency pulses to 45 MHz. It can't be used at MOS levels or circuit damage will result.



$9.95 Per Kit
printed circuit board

T²L 5V 1A Supply



This is a standard TTL power supply using the well known LM309K regulator IC to provide a solid 1 AMP of current at 5 volts. We try to make things easy for you by providing everything you need in one package, including the hardware for only.

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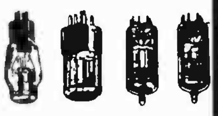

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3AT2	1.65	6BE6	1.55
3BS2	1.79	6BH6	1.59
3CN3	1.74	6BH11	2.13
3CU3	2.06	6BJ6	1.74
3CY3	1.85	6BK4	3.14
3DJ3	1.79	6BK7	2.18
3GK5	1.62	6BL8	1.16
3HA5	1.61	6BM8	1.56
3HQ5	2.39	6BN6	2.07
3JC6	2.16	6BN8	1.73
3V4	2.30	6BN11	3.09
4AU6	1.67	6BQ5	1.65
4BZ6	1.49	6BQ7A	2.19
4CB6	1.16	6BR8A	2.24
4DT6	1.64	6BV11	2.48
4EH7	1.52	6BX6	1.56
4EJ7	1.52	6BZ6	1.32
4HS8	1.58	6C4	1.65
4JC6	2.15	6C5	3.28
4JD6	1.98	6CA4	1.70
4KE8	2.60	6CA7	2.34
4LJ8	1.91	6CB6	1.40
5AQ5	1.61	6CD6	2.98
5AR4	2.15	6CG3	1.65
5CG8	1.71	6CG7	1.28
5EW6	1.71	6CG8	1.82
5GH8	1.98	6CJ3	1.58
5GJ7	1.25	6CL3	1.70
5GS7	1.43	6CL6	2.18
5GX7	1.76	6CL8	2.04
5HZ6	1.26	6CM6	1.77
5JK6	1.77	6CM7	1.80
5JL6	2.10	6CS6	1.76
5KE8	2.60	6CU5	1.73
5LJ8	1.85	6CW4	4.17
5U4GB	1.31	6CW5	1.43
5Y3GT	1.38	6D6	2.39
5Y4GT	2.10	6DA6	2.10
6A8	4.70	6DJ8	2.50
6AB4	1.61	6DK6	1.55
6AC7	3.87	6DL4	2.39
6AC10	1.82	6DQ6	2.25
6AD10	3.86	6DT6	1.40
6AF4	2.31	6DW4	1.58
6AF9	2.39	6DX8	1.17
6AG7	4.53	6E5	3.90
6AH6	2.40	6EA8	1.65
6AJ8	2.10	6EB8	2.52
6AL3	1.28	6EH7	1.61
6AL5	1.37	6EJ7	1.50
6AM8	2.31	6EM7	2.37
6AN8	1.91	6EU7	1.70
6AQ5	1.43	6EW6	1.50
6AQ8	1.49	6EW7	2.51

6F6GT	4.09	6J7	4.35	6L7	4.50
6FG6	1.43	6J10	2.66	6LB6	3.38
6FG7	2.40	6JB6	2.54	6LE8	2.39
6FM7	1.94	6JC6A	1.88	6LF6	3.36
6FQ7	1.28	6JD6	1.94	6LF8	2.46
6GE5	1.64	6JE6GA	3.51	6LH6	3.23
6GF7	2.24	6JF6	2.90	6LJ8	1.85
6GH8	1.32	6JH6	1.50	6LM8	2.04
6GJ7	1.25	6JH8	2.64	6LN8	1.11
6GK5	1.95	6JM6A	2.28	6LR6	3.23
6GK6	1.47	6JN6	2.13	6LT8	1.71
6GM6	1.76	6JS6C	3.12	6LU8	2.01
6GM8	3.30	6JT6	2.54	6LX8	1.11
6GS7	1.52	6JT8	2.01	6M11	3.30
6GU7	1.76	6JU6	2.99	6MB8	1.95
6GW8	1.47	6JU8	1.86	6MD8	2.46
6GX6	1.46	6JV8	1.89	6MG8	1.41
6GX7	1.92	6JW8	1.41	6SA7	3.74
6H6	3.33	6K6GT	1.71	6SG7	3.95
6HA5	1.61	6K7GT	2.40	6SJ7GT	2.33
6HB7	1.62	6K8	3.60	6SK7GT	2.40
6HE5	2.01	6KA8	2.04	6SL7GT	2.40
6HF5	3.96	6KD6	3.54	6SN7GT	1.59
6HF8	2.28	6KE8	2.66	6SQ7GT	2.42
6HQ5	2.13	6KM6	3.54	6T8A	2.01
6HS5	3.09	6KT8	2.28	6T10	2.36
6HS6	2.66	6KV6	2.81	6U8A	1.64
6HS8	2.00	6KZ8	1.71	6U10	1.70
6HV5	3.72	6L6GB	2.57	6V6	4.01
6HZ6	1.34	6L6	4.50	6V6GT	1.92
6J5GT	1.77			6X4	1.52

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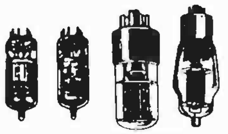

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7KY6	2.16	15BD11A	2.36
7V7	3.60	15CW5	1.43
8A8	1.13	15KY8	3.05
8AC9	2.43	16A8	1.71
8AR11	3.12	16LU8	3.12
8BA11	2.36	17AY3	1.59
8BM11	3.39	17BE3	1.59
8BQ11	2.49	17BF11	2.51
8BU11	2.42	17BR3	1.38
8CB11	3.24	17BS3	1.59
8CG7	1.28	17CT3	1.43
8CW5	1.43	17CU5	1.32
8JU8	1.43	17DW4	1.58
8JV8	1.95	17JM6	2.55
8LT8	1.68	17JN6	2.27
9AQ8	2.31	17JQ6	2.25
9GH8	1.76	17JZ8	1.74
9JW8	1.32	17KV6	3.05
9KX6	2.16	19CG3	1.65
10CW5	1.43	19T8	2.61
10DX8	1.17	20AQ3	1.31
10GF7	2.18	21GY5	2.10
10GK6	1.91	21HB5	2.01
10GN8	2.01	21JS6	4.31
10JT8	2.16	21JZ6	2.24
10JY8	1.56	21LR8	2.09
10KR8	2.15	21LU8	2.04
11AF9	2.39	22JF6	2.79
11AR11	2.60	22JR6	2.99
11BM8	2.09	22KM6	3.23
11BT11	3.17	23Z9	2.15
11FY7	1.67	24JE6	3.36
11KV8	2.31	25CG3	1.46
11LQ8	2.27	29KQ6	3.53
11MS8	1.71	30AE3	1.41
12AB5	1.49	31JS6	3.03
12AT6	1.19	31LQ6	3.20
12AT7	1.43	31LZ6	3.54
12AU6	1.52	33GY7A	2.74
12AU7	1.29	34CE3	1.68
12AV6	1.08	35C5	1.37
12AX7	1.32	35W4	.93
12AZ7	1.83	35Z5GT	1.49
12B4	1.86	36KD6	3.53
12BA6	1.22	38HE7	3.08
12BE6	1.28	38HK7	3.00
12BF11	249	40KG6GA	3.42
12BH7	1.67	42EC4A	1.77
12BY7	1.50	42KN6	2.88
12CL3	1.52	45B5	2.70
12CU5	1.85	50A1	3.30
12DQ6	2.21	50B5	1.28
12DW4	2.19	50C5	1.29
12DW7	1.61	50EH5	1.55
12FX5	1.41	50L6GT	2.06
12GN7	2.34	80	2.50
12HL7	2.04	6267	2.10
12JB6A	2.90	6973	2.03
12MD8	2.00	7025A	1.32
12SL7	2.43	7189A	1.82
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12SQ7	3.72	7247	1.71
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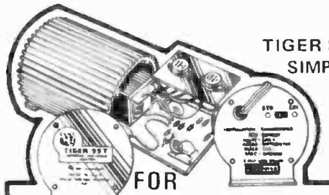

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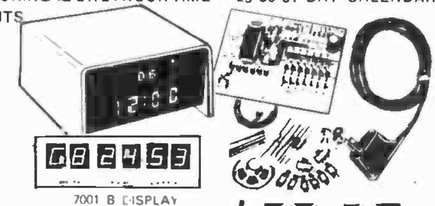

Will alternate time (8 seconds) and date (2 seconds) or may be wired for time or date display only, with other functions on demand. Has built-in oscillator for battery back-up. A loud 24 hour alarm with a repeatable 10 minute snooze alarm, alarm set & timer set indicators. Includes 110 VAC/60Hz power pack with cord and top quality components through-out.

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12/24 HR. OPERATION BIG .4" DIGITS - 50/60 HZ OPERATION.

KIT INCLUDES
- INSTRUCTIONS
- QUALITY COMPONENTS
- 50 or 60 Hz OPERATION
- 12 or 24 HR OPERATION

6-LED Readouts (FNO-359 Red, com. cathode)
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13-Transistors
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5-Diodes
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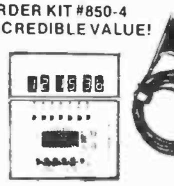
LARGE .4" DIGITS! ORDER KIT #850-4 AN INCREDIBLE VALUE!



$11.95 ea. QTY. 1-5
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"Kit #850-4 will furnish a complete set of clock components as listed. The only additional items required are a 7-12 VAC transformer, a circuit board and a cabinet, if desired."

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NOTE: Entire Clock may be assembled on one PC Board or Board may be cut to remote display. Kit #850-4 will fit Plexiglas Cabinet II.

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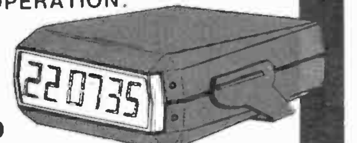
12 OR 24-HOUR OPERATION

MODEL #2001

12 VOLT AC or DC POWERED FOR FIXED OR MOBILE OPERATION.

SIX LARGE .4" DIGITS!



Approx. Size: 1¾"H x 4"W x 4½"D

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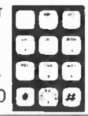

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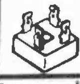

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COMMON ANODE

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74S107	.35
74S112	.35
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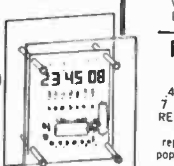

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7406	.20	7470	.30	74160	1.23
7407	.28	7472	.30	74161	.97
7408	.18	7473	.35	74162	1.39
7409	.19	7474	.28	74163	1.09
7410	.16	7475	.49	74164	.99
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7413	.43	7483	.68	74166	1.25
7414	.65	7485	.88	74170	2.10
7416	.35	7486	.40	74173	1.49
7417	.35	7489	2.25	74174	1.23
7420	.16	7490	.43	74175	.97
7422	.30	7491	.75	74176	.89
7423	.29	7492	.48	74171	.84
7425	.27	7493	.48	74180	.90
7426	.26	7494	.78	74181	2.45
7427	.29	7495	.79	74182	.79
7430	.20	7496	.79	74184	1.90
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7437	.25	74105	.44	74187	5.75
7438	.25	74107	.37	74190	1.15
7440	.15	74121	.38	74191	1.25
7441	.89	74122	.38	74192	.95
7442	.59	74123	.65	74193	.85
7443	.73	74125	.54	74194	1.25
7444	.73	74126	.58	74195	.74
7445	.73	74132	.89	74196	1.25
7446	.81	74141	1.04	74197	.73
7447	.79	74145	1.04	74198	1.73
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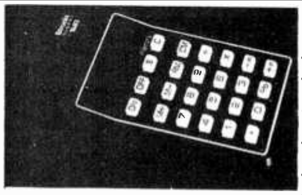

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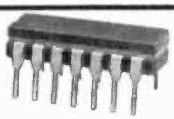

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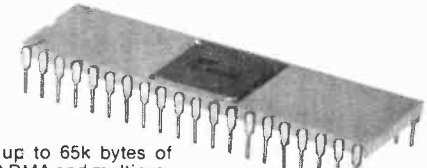

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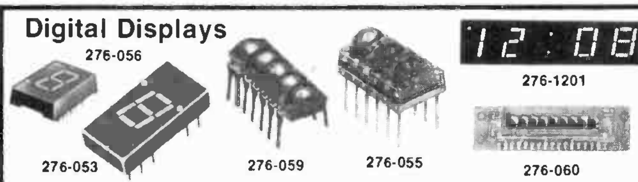

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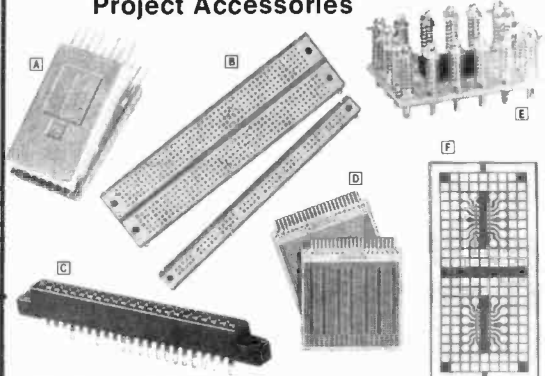

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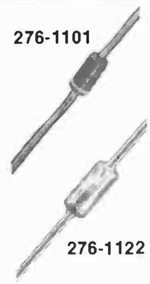

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1N4739	276-562	2/$.89	2/69¢
1N4742	276-563	2/$.89	2/69¢
1N4744	276-564	2/$ 89	2/69¢
1N5401	276-1141	2/$.69	2/59¢
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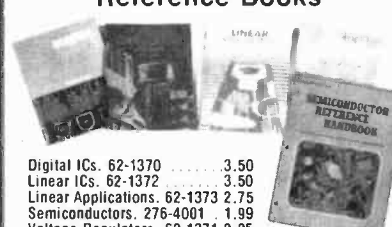
Triac	100V, 6A	276-1002	$1.29	79¢
Triac	200V, 6A	276-1001	$1.39	89¢
Triac	400V, 6A	276-1000	$1.49	99¢

Reference Books



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7414N	.83
7420N	.17
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7438N	.25
7440N	.17
7442N	.78
7447N	.60
7448N	.78
7450N	.17
7473N	.36
7474N	.32
7475N	.49
7483N	.70
7485N	.99
7489N	2.00
7490N	.45
7492N	.45
7493N	.49
74100N	.90
74107N	.39
74121N	.39
74123N	.87
74125N	.45
74132N	1.25
74145N	.89
74150N	.95
74151N	.75
74154N	1.10
74157N	.95
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74LS00N	.28
74LS02N	.28
74LS04N	.34
74LS05	.34
74LS08N	.28
74LS10N	.28
74LS20N	.28
74LS28N	.41
74LS30N	.28
74LS38N	.31
74LS74N	.46
74LS75N	.65
74LS90N	1.10
74LS93N	1.10
74LS95N	1.89
74LS107N	.52
74LS112N	.52
74LS132N	1.15
74LS155N	1.50
74LS163N	2.05
74LS174N	1.85
74LS259N	2.20
74S00 TTL	
74S00	.29
74S02	.29
74S04	.30
74S10	.30
74S74	.68

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LM324N	1.10
LM339N	1.55
LM340K-5	1.60
LM340T-5	1.50
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LM340T-12	1.70
LM340T-15	1.70
LM358N	2.40
LM377	4.50
LM379	5.00
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75452CN	.39
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1N4002	.08
1N4003	.08
1N4004	.08
1N4005	.08
1N4006	.08
1N4733A	.25
1N4734A	.25
1N4735A	.25
1N4736A	.25
1N4739A	.25
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CD4014	1.25
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CD4016	.50
CD4017	1.00
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CD4021	1.20
CD4023	.25
CD4024	.85
CD4025	.25
CD4026	3.85
CD4027	.55
CD4029	1.70
CD4030	.42
CD4040	1.35
CD4042	1.50
CD4043	2.00
CD4044	2.00
CD4049	.62
CD4050	.55
CD4066	.85
CD4068	.25
CD4069	.40
CD4071	.40
CD4072	.40
CD4073	.40
CD4075	.40
CD4076	1.75
CD4078	.40
CD4081	.40
CD4082	.45
CD4508	4.25
CD4510	2.00
CD4511	2.20
CD4515	4.00
CD4520	2.90
CD4527	4.75
CD4528	1.50
CD4583	4.50
CD4585	2.10
CD40192	3.00
74C00	.28
74C04	.33
74C10	.28
74C14	2.10
74C20	.28
74C30	.28
74C48	2.95
74C74	.75
74C106	2.10
74C160	2.00
74C192	2.40
74C221	2.75
74C905	3.00
74C906	1.50
74C925	10.50
74C926	10.50
74C927	12.00
INTERFACE	
8095	.75
8096	.75
8097	.75
8098	.75
8T09	1.25
8T10	4.50
8T20	5.50
8T23	3.10
8T24	3.50
8T25	3.20
8T26	2.75
8T28	2.75
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8T98	2.45

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2102-1	1.80
2107B	8.00
2111-1	7.00
2112-2	7.90
2513B	10.00
21L02-1	2.50
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MM5060	3.20
MM5262	.90
MM5320	5.95
MM5330	9.75
CLOCKS	
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MM5311	3.60
MM5312	4.80
MM5313	3.60
MM5314	3.90
MM5315	4.00
MM5316	5.00
MM5318	8.95
MM5369	2.10
MM5371N	5.50
MM5841	10.80
CT7001	5.80
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MM5375AB/N	4.90
7205	16.50
MM53104	3.00
DS0026CN	3.75
DS0056CN	3.75
MM53104	3.75
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12 Volt 300 ma transformer	1.25
Keyer 8043	14.50
IC Test Clips 1	10
Red 50	43
Black 50	43

CLOCK MODULES
Complete clock module minus transformer and switches

MA1002A, C, E .50"	$8.95
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MA1010E .80"	11.95
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4 digit, 7 function stopwatch/timer circuit new National MM5865 $9.00 PC board $7.50 DM8863 $1.75 10 page spec only, $1.00

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Solder Tin Low Profile

PIN	1 UP	PIN	1 UP
8	15	24	36
14	18	28	43
16	20	36	58
18	27	40	61
22	35		

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8080 with data	19.00
8080A with data	23.50
8212	4.50
8224	8.50
8228	8.50
CDP1802CD	29.50
CDP1802D	35.00

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Green TO18	.20
Orange TO18	.20
Yellow TO18	.20
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Jumbo Yellow	.25
Jumbo Orange	.25
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On none on toggle	1.15
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N82S123	4.00
N82S126	4.85
82S129	4.85
2708	36.00
DM8577	2.90

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100 per type	.025
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2 MHz	4.50	1.8432 MHz	4.50
4 MHz	4.25	2.097152 MHz	7.75
5 MHz	4.25	2.4576 MHz	7.50
10 MHz	4.25	3.2768 MHz	7.50
18 MHz	3.90	5.0688 MHz	4.50
20 MHz	3.90	5.185 MHz	4.50
32 MHz	3.90	5.7143 MHz	4.50
32768 Hz	4.00	18.432 MHz	4.50
3.5795 MHz	1.50	22.1184 MHz	4.50

DISPLAY LEDS

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MM57100 6 Games Chip			$19.95
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LM1889 Modulator			3.00
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		1	100
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MM5369	Divider	2.10	1.40
2102-1	500 NS 1K RAM	1.80	1.30
FND503	.50 Display	1.00	.89
18MHz	Crystal	3.90	2.50
PD411-3	150 NS 4K RAM	8.00	5.75
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MA1013E	.7 Alarm Clock Mod	10.95	8.95
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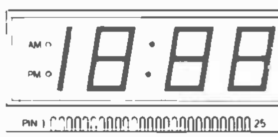

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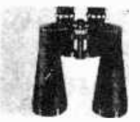

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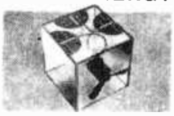

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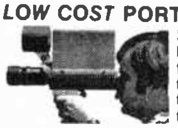

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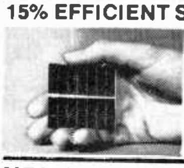

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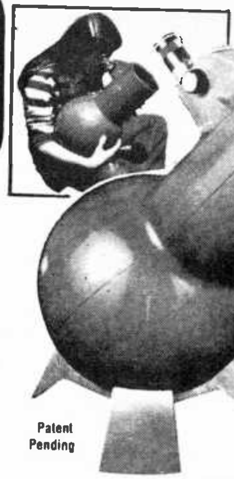

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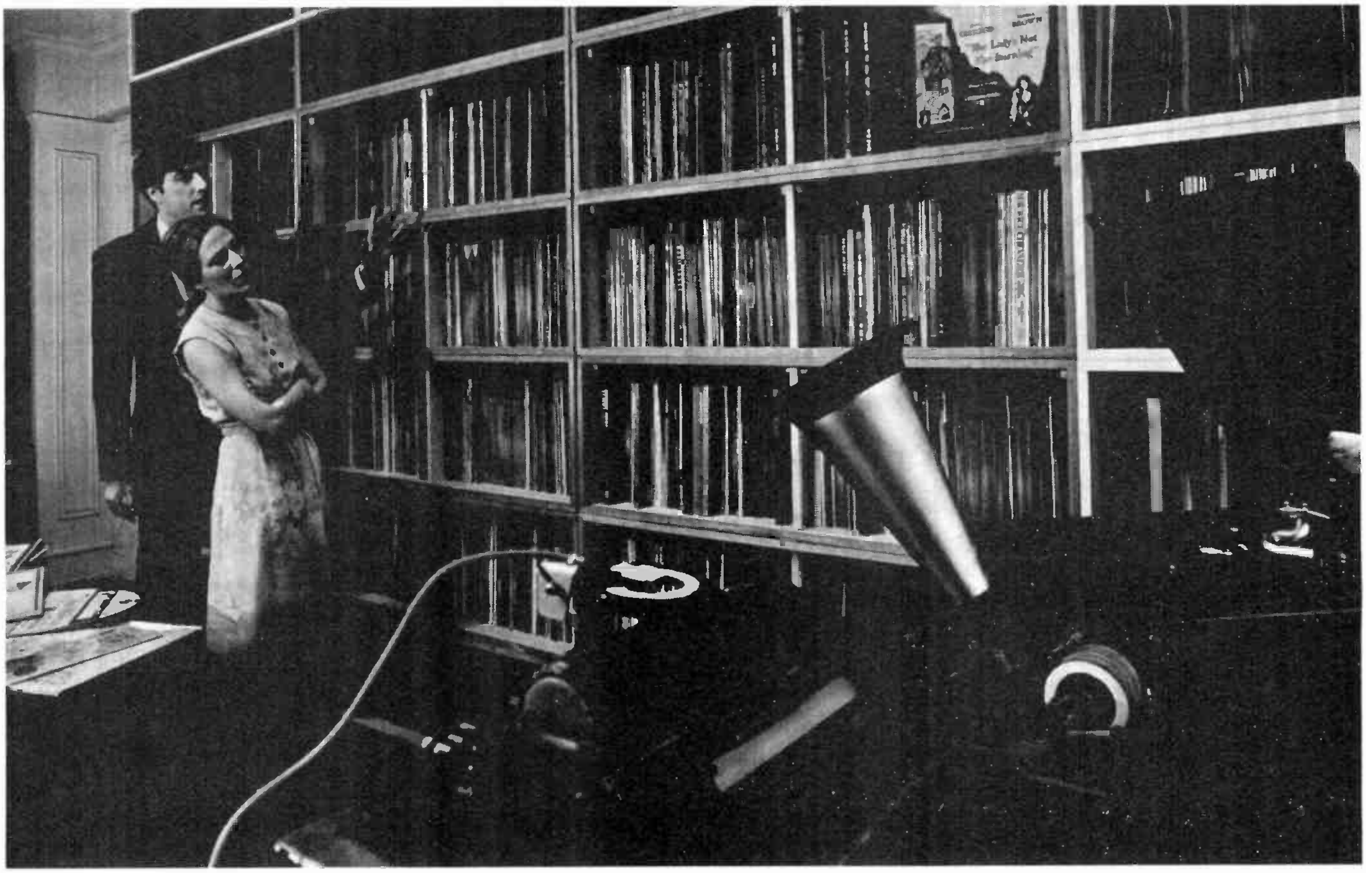
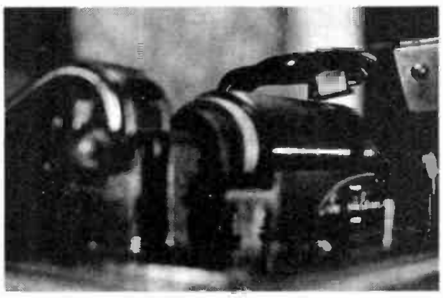
No matter how young or old the recording, the Institute of the American Musical, Inc. relies on Stanton for playback.



Miles Kreuger, shows a portion of the extensive collection to a scholar.

Mr. Kreuger and Mr. Albert Husted, Vice President, show visitors how a Stanton 681 is installed on an original Edison Standard phonograph.



Close-up of the Stanton 681 with special stylus in position on the original Edison Standard phonograph.

Music scholar following the score of *Show Boat* while listening to original cast performances.

Speaking of problems, how would you like to be faced with the need to accurately reproduce the sound from Edison Diamond Discs, Pathés and Aeolian-Vocalions? That's just what the Institute is faced with — and that's precisely why they turned to Stanton cartridges.

The Institute collection consists of approximately 35,000 recordings, from just about every American theatre or film musical since the Berliners of the 1890's through to the latest stereo and quadraphonic recordings. The collection (not counting hundreds of cylinders) is roughly evenly divided between 78's and 33 rpm's. They have original, historic machines to play these accurately, but the arms are heavy and the old styli insensitive and somewhat worn. Furthermore, the acoustic playback does not permit them to filter the surface noise or tape these rare records.

Miles Kreuger, President of the Institute, discussed his problem with other famed and experienced archivists. They all agreed that the Stanton calibrated 681 Series was the answer. Naturally, it is the 681 Triple-E for critical listening and taping with more recent discs; the special 681 stylus for LP's; and, for the old ones, a 681 cartridge, especially wired for vertical response (with a 1 mil stylus).

Today, thanks to Stanton the scholars, authors and researchers, who are dependent on the Institute's materials to pursue their projects, can get perfect to adequate reproduction of any of the material in the collection. The Institute, which is crowded into small quarters, is open by appointment only to qualified people. For the future, it looks forward to the day when it will have the space in its own building to make its collection more readily available.

The work of the Institute is important work . . . Stanton is proud to be an integral part of it.

Whether your usage involves archives, recording, broadcasting or home entertainment, your choice should be the choice of the professionals . . . the Stanton 681 Triple-E.

Write today for further information to: Stanton Magnetics, Terminal Drive, Plainview, N. Y. 11803.

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Johnson CB is all new for 1977. Quietly efficient, beautifully uncomplicated.

Our new 40-channel Messenger CB radios are a study in electronic elegance. With a clean uncluttered appearance; with engineering advances and features you can't get on any other CB. The quietest, most fully featured CB's Johnson has ever designed. The perfect blend of form and function.

But that's what you'd expect from a company that's been making CB radios longer than anyone else in the business. A company that designs and builds the most sophisticated, professional 2-way radio equipment money can buy . . . the E. F. Johnson Company.

And for 1977, Johnson delivers more quality, more features and more value per dollar than ever before. We deliver more because we design and build every Messenger CB right here in the U.S.A. We watch every operation. We control quality every step of the way. We operate every radio before we release it, then we back it up with a **one year parts and labor warranty** plus more than 1,000 Authorized Johnson CB Service Centers.

We started fresh with our 40-channel line. We devised a totally new frequency synthesis system: our exclusive X300D CMOS IC chip . . . a single chip with a complete phase-lock-loop circuit for greater accuracy and reliability.

Other Johnson quality features are: a completely redesigned receiver for quietest operation . . . our exclusive Tapered Automatic Noise Limiter (TANL), the only noise limiting system in CB that adjusts itself for optimum clarity and quieter listening all the time . . . our own voice tailored audio circuitry to drop off unwanted frequencies . . . our unique electronic speech compression for maximum transmit range.

Johnson CB is quality CB. Quiet, efficient, beautifully functional.

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