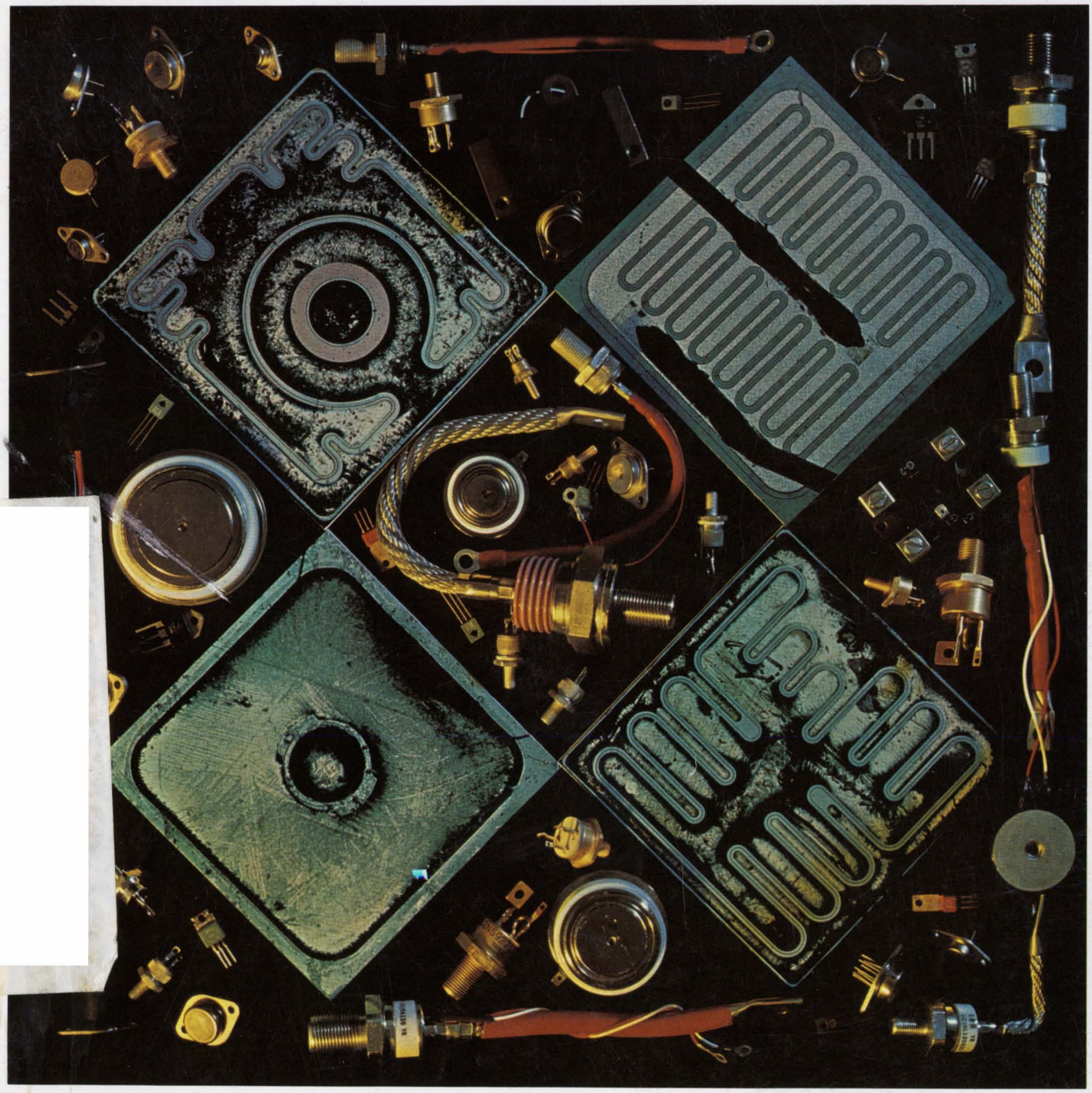
VOL. 21 NO. 23

Electronic Design

FOR ENGINEERS AND ENGINEERING MANAGERS

NOV. 8, 1973

Improvements in power semis have increased their applications but have not made specifying easier. First you must decide whether to use a transistor or a thyristor — and then which of the many devices available in each class. Ratings can mislead and safe operating area specs are often ignored. See page 80.



Good trimmer image!

Low rejection rate, low profile and low cost are putting Dale Trimmers on more prints and boards than ever.

XEROX
uses Dale 8700
Series Trimmers
in its popular
4000 Series Copiers.

Dale is putting a lot of things together to make its trimmers a better deal for you. Our low rejection rate of .93% (including items not related to quality) guarantees more productive time for you and your people. Our low profile 3/4" models give you a choice of cermet and wirewound elements to precisely match your functional needs. Both are completely immersion proof and have pin spacings that shrink packaging requirements by interchanging with many larger models. Matter of fact, Dale trimmers offer broad interchangeability with every competitive line. And that's something to keep in mind when you're looking for more depth in your supply situation.

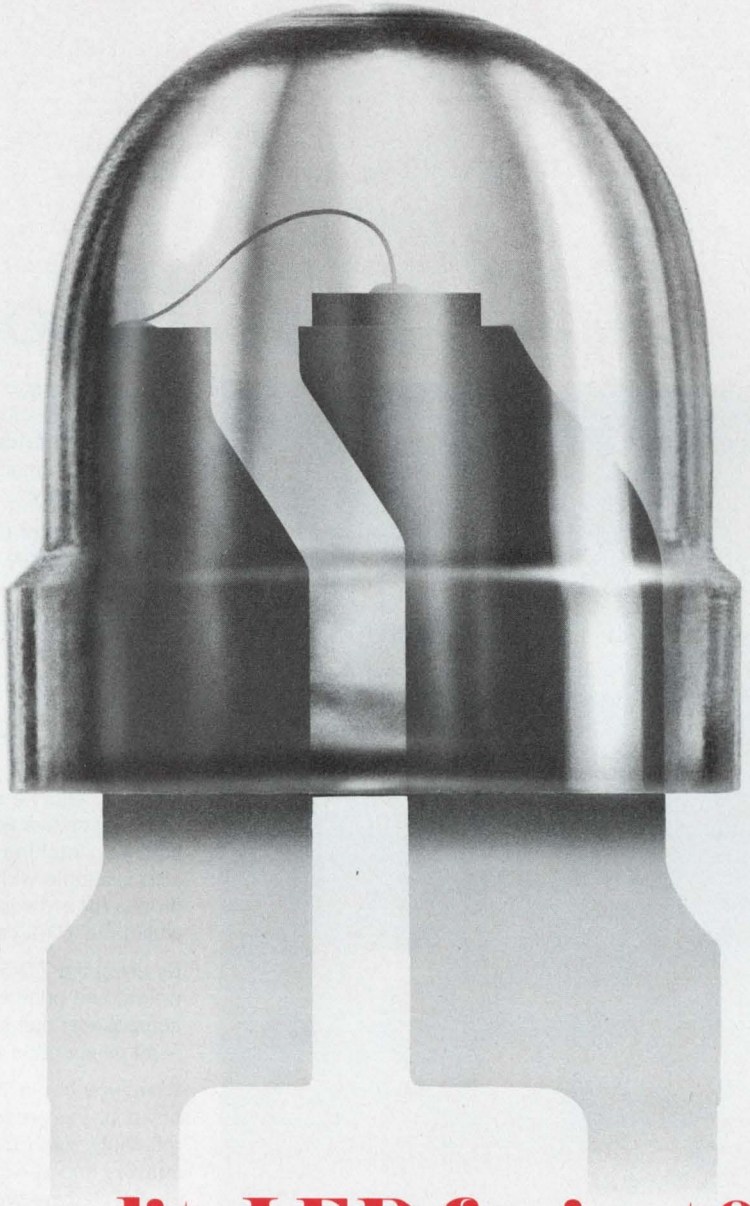
Send for free trimmer interchangeability guide today
...or call 402—564-3131 for complete information.

DEPENDABLE DALE®

DALE ELECTRONICS, INC., 1300 28th Avenue, Columbus, Nebraska 68601
A subsidiary of The Lionel Corporation. In Canada: Dale Electronics Canada, Ltd.

INFORMATION RETRIEVAL NUMBER 243

SURPRISE!



A quality LED for just 9¢*.

Now you can get HP quality in an LED lamp for only 9¢*. That's your price when you order one million. If you only need one thousand, the price is a low 17¢*. And HP is ready to deliver that kind of volume to meet your schedule.

This T-1 size lamp features a new low profile lens for high density application in calculators, cameras, computers, appliances and automobiles. The 5082-4487 and 5082-4488 both have a clear lens and a 0.8 mcd at 20 mA typical light output.

Get the full story from your nearby HP distributor or, write Hewlett-Packard directly.

01333

*US Domestic only.

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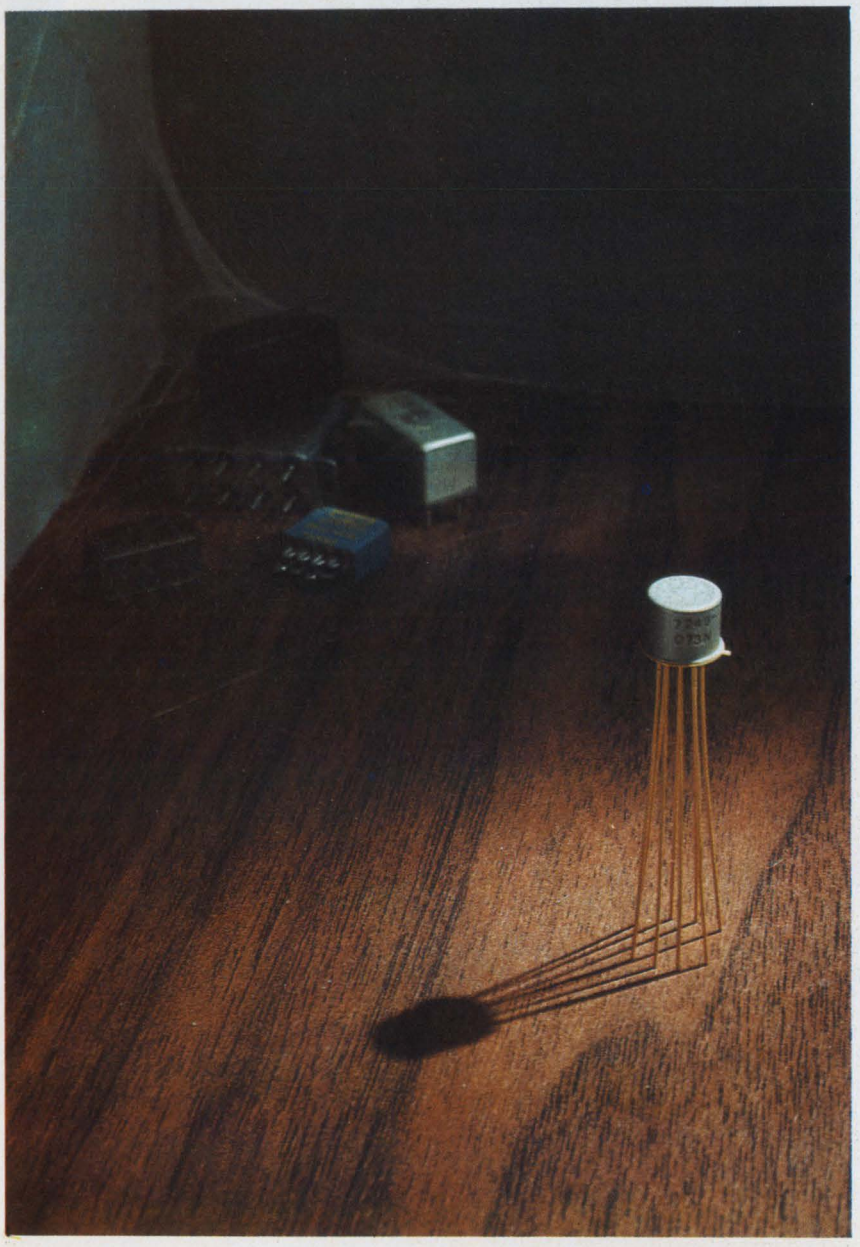
Sales, service and support in 172 centers in 65 countries.
Palo Alto, California 94304. Offices in principal cities throughout the U.S.

INFORMATION RETRIEVAL NUMBER 2

WHAT MADE CRYSTAL CAN RELAYS OBSOLETE?



THE TO-5 RELAY!

Crystal can relays (full size and fractional sizes) have been obsoleted by the outstanding performance, high reliability, low power requirement and cost effectiveness of the TO-5 Relay.

All possibility of contamination is eliminated in the TO-5 Relay. It is completely welded, including the coil termination. This cannot be said for crystal can relays.

Reliability and long life, over ten times greater than the crystal can units, have been designed into the TO-5 Relay.

Teledyne's TO-5 Relays come in hundreds of models, all in the same basic configuration. Typical available models include SPDT, DPDT, sensitive SPDT and DPDT and magnetic latching SPDT and DPDT. Units are also available with transistor drive and diodes for arc suppression, all packaged within the TO-5 case.

By using the TO-5 Relay, reduction in size, weight and number of circuit board components can be realized in your product — all measurable in dollars and cents.

When you buy a Teledyne TO-5 Relay, you buy a 10-year record of remarkable reliability, superior performance, on-time delivery and service from people who really care. Teledyne provides experienced application engineers anxious to assist you with your relay problems.

Send for complete technical data.

3155 West El Segundo Boulevard
Hawthorne, California 90250
Telephone (213) 679-2205

TELEDYNE RELAYS

INFORMATION RETRIEVAL NUMBER 3

VOL. 21 NO.

Electronic Design 23

FOR ENGINEERS AND ENGINEERING MANAGERS

NOV. 8, 1973

NEWS

TECHNOLOGY

PRODUCTS

Departments

Cover: Photo by Art Director, Bill Kelly—Power semiconductors courtesy of General Electric; International Rectifier Corp.; PowerTech, Inc.; RCA; Solitron Devices, Inc.; Texas Instruments, Inc.; Westinghouse Electric Corp.

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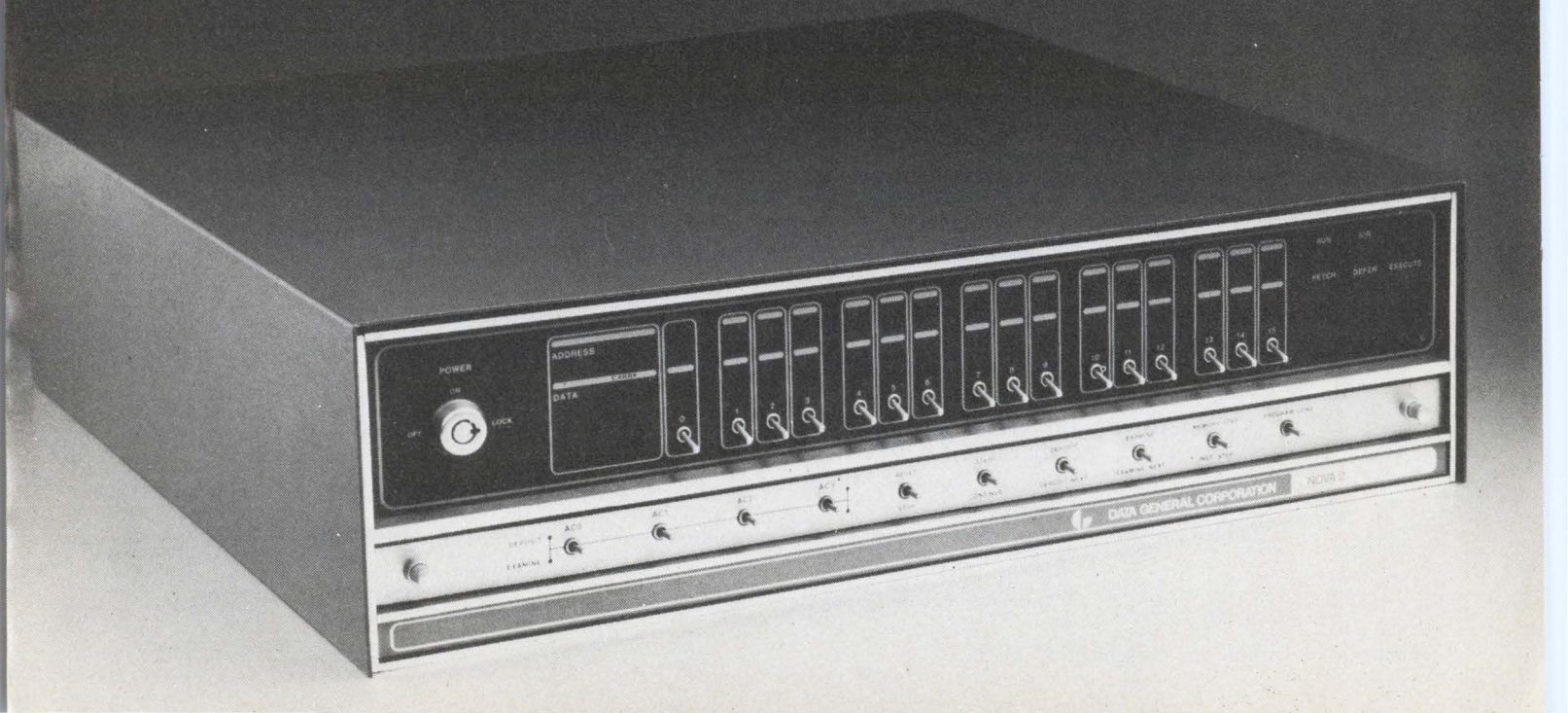
The $5,600 computer you don't have to talk down to.



We've got an idea that ought to interest any OEM who's trying to bring down the price of his product.

Go buy yourself 5* Nova 2's with the new 16K memory boards. (Yes, we know you can probably get away with less memory. Bear with us.)

Now take a look at what you get: a high speed multi-accumulator 16 bit CPU, an I/O system with programmed data transfer, 16 levels of programmed priority interrupt, high speed Direct Memory Access, programmer's console, 4-slot mainframe, power supply and 16,384 words of 1 microsecond memory, expandable to 32K. With 4K and 8K memory modules also available.

That, you'll have to admit, is an awful lot of computer for the money. With twice the memory of other computers in that price range.

Hold on. It gets even better.

With that 16K memory, you won't have to talk down to the computer in machine language. You're going to be able to program in higher level languages.

So your programmers will be able to spend more time on what they want it to do and less on how to say it.

Which means they'll get the job done faster. And you'll get your product out on the market faster.

Both of you are going to save yourselves a lot of time and money.

Think about that for a minute.

Consider how your system costs go down when your programming time goes down.

The $5,600 price tag looks even better now, doesn't it?

And that's before the quantity discounts get figured in.

*Five systems is the minimum order.

The 16K Nova 2

Data General

Southboro, Massachusetts 01772 (617) 485-9100.

Vice President, Publisher
Peter Coley

Editors
Editorial Offices
50 Essex St.
Rochelle Park, N.J. 07662
(201) 843-0550
TWX: 710-990 5071
Cable: Haydenpubs Rochellepark
Editor-in-Chief George Rostky
Managing Editors:
Ralph Dobriner
Michael Elphick
Associate Editors:
Dave Bursky
Jules H. Gilder
Morris Grossman
Seymour T. Levine
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Stanley Runyon
Edward A. Torrero
Richard L. Turmail
Contributing Editors:
Peter N. Budzilovich
Steven A. Erenburg

Editorial Field Offices
East
Jim McDermott, Eastern Editor
P.O. Box 272
Easthampton, Mass. 01027
(413) 527-0183
West
David N. Kaye, Senior Western Editor
2930 West Imperial Highway
Inglewood, Calif. 90303
(213) 757-0183
Northe K. Osbrink, Western Editor
112 Coloma St.
Santa Cruz, Calif. 95060
(408) 426-3211
Washington
Heather M. David, Bureau Chief
2506 Eye St., N.W.
Washington, D.C. 20037
(202) 338-3470

Editorial Production
Marjorie A. Duffy

Art
Art Director, William Kelly
Richard Luce
Anthony J. Fishetto

Production
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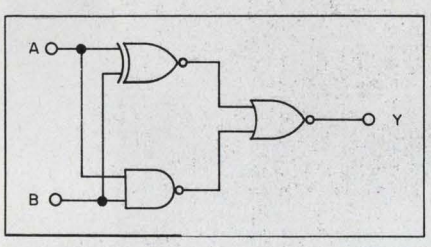
across the desk

Watergate Decoder: It leaves you up creek

Here is an MSI microprocessor circuit termed a Watergate Decoder (see "Introducing a New Gate With Expandable Output," ED No. 16, Aug. 2, 1973, p. 7). It contains the three basic negative logic gates. Information presented in binary by each faction of the Senate subcommittee is entered at either of the two inputs A, B:



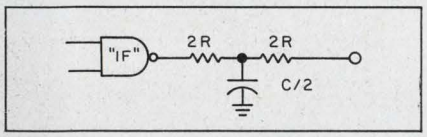
The data are then processed and extracted at output Y, in which the resultant is shown by the following logic equation:

$\overline{A}\overline{B} + \overline{A}B + A\overline{B} + AB = Y$
$\overline{B}(\overline{A} + A) + \overline{A}B + AB = \overline{Y}$
$\overline{B}(\overline{A} + A) + (\overline{A} + A)B = \overline{Y}$
$\overline{B}(1) + (1)B = \overline{Y}$
$\overline{B} + B = \overline{Y}$
$1 = \overline{Y}$
$Y = 0$

Ken Slotkowski
Body Engineering
Electrical Components
Ford
20000 Rotunda Dr.
Dearborn, Mich. 48121

. . . And the "IF" gate

Regarding the recent discovery of the H_2O gate and its subsequent bugs, we at Beckman Instruments would like to inform you of development of an "IF" gate. In its most common form the inverted "IF" drives an R-C Tee network. We haven't been able to figure out if it is of any use yet, but it sure is NIF-T:



Russell L. Gephart
Test Equipment Design Engineer
Beckman Instruments, Inc.
Spinco Div.
1117 California Ave.
Palo Alto, Calif. 94304

Nonexploitable woman decries 'bad taste' ads

It is totally inconceivable to this nonexploitable woman why an EE would cancel his subscription to ELECTRONIC DESIGN because of "pornographic advertisements," (see "Women," ED No. 17, Aug. 16, 1973, p. 41).

Webster defines pornography as follows: "The depiction of erotic behavior intended to cause sexual excitement." I have looked at every ad in every issue of ED for years. The most erotic material I can remember is an ad on mating connectors.

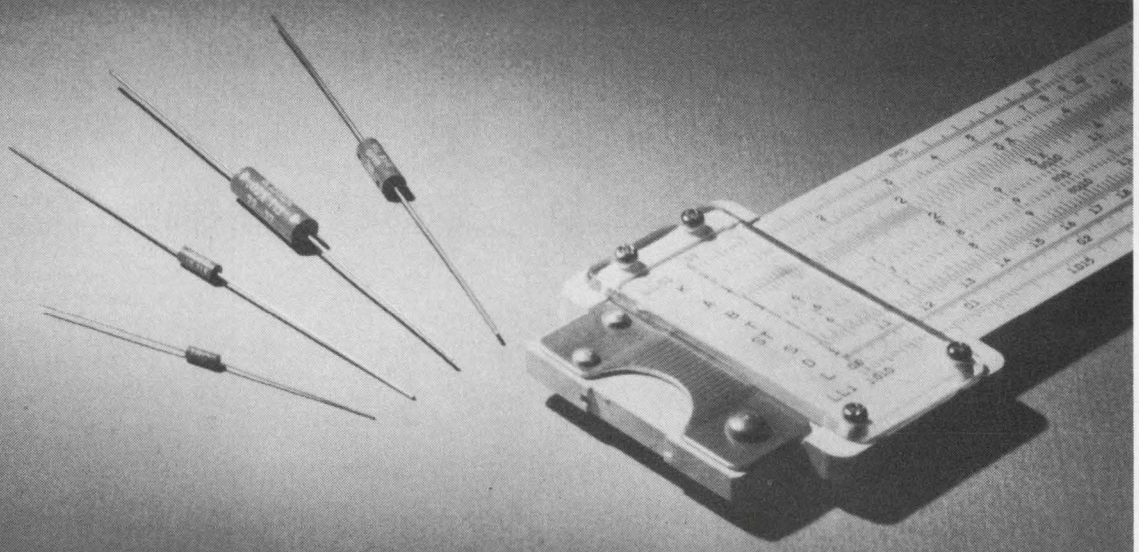
I fully concur with your position. Bad taste in advertising is abundant. But all too often it is successful. Guardian is a prime example of an advertiser whose taste is all in the mouth. I have no objections to the "Guardian Angel," as it is a great tie-in. But I do object to the over-all clutter and gar-

(continued on page 13)

Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St. Rochelle Park, N.J. 07662. Try to keep letters under 200 words. Letters must be signed. Names will be withheld on request.

New generation of high-performance, low-cost, ultra-precision resistors

Tolerances: .01% to 1%
Temp. Coeff.: 5 to 25 PPM/°C
T.C. Matching: to 1 PPM/°C



Caught in a cost/performance bind on precision resistors? Solve the problem with TRW/IRC's new MAR Series of ultra-precision metal film resistors. Where speed and precision count, they offer the ultimate in cost/performance ratio. And by "performance," we mean *better* than premium wirewounds.

With the MAR Series, you get an ultra-stable, ultra-precision resistor with an extremely low temperature coefficient. You also get the non-measurable noise, low voltage coefficient and stress stability previously available only in precision wirewounds. Yet you still have the high-frequency response, reliability, pulse stability and resistance/size ratio of metal film.

Also available as part of the MAR technology are resistor matched sets and modules providing additional performance and cost advantages. For comprehensive technical data and MAR samples, contact your TRW representative. Or write TRW/IRC Fixed Resistors, 2850 Mt. Pleasant St., Burlington, Iowa 52601. Phone: (319) 754-8491.

IRC TYPE	RESISTANCE RANGE* (Ohms)	TEMPERATURE COEFFICIENTS −20° C to +85° C (± ppm/°C)	TOLERANCES (± %)	POWER RATING @ 85° C (Watts)	VOLTAGE RATINGS (Volts)	DIMENSIONS IN INCHES Body Length (L Max.)	Body Diameter (D Max.)	Lead Gage (A)
MAR3	20—100K	T10 = 15	1.00, 0.50, 0.25,	1/20	200	.191	.082	#26 .016**
MAR5	20—250K	T13 = 10	0.10, 0.05, 0.02,	1/10	250	.281	.102	#22 .025
MAR6	20—500K	T16 = 5	0.01	1/8	300	.425	.155	#22 .025
MAR7	20—1 Meg			1/4	500	.650	.195	#22 .025

*Wider ranges available. Contact factory. **Lead length 1.00 ±.062.

TRW® IRC RESISTORS

INFORMATION RETRIEVAL NUMBER 7

THE PERFECT CHAPERON

— For Your System's Sake

Keep the proper relationship between input voltages and your systems with nine new ICs.

The MC7900CP series three-terminal negative voltage regulators have a rating for all reasons. Besides the −5.0, −6.0, −8.0, −12, −15, −18, and −24 V complements to our MC-7800 series, new −2.0 and −5.2 V versions offer superb MECL* system compatibility.

It's difficult to foil these fast paced protectors. Their rated output current is a strong 1.0 A plus; even up to 1.5 A with the proper heat sink and input voltage.

No matter how delicate the situation, these single monolithic chip devices put voltage in its place. Internal short-circuit current limiting, internal thermal overload protection, and safe-area compensation make them uncorruptible in nearly any operating condition.

Line and load regulation are well controlled, too, with output voltage tolerances of less than ±5%.

And these guardians come fully prepared for the job. In most applications, only a capacitor is necessary. Nothing more. Not even for on-card regulation.

You can employ these Case 199-04 Thermopad* packaged escorts for an economical $2.75 (100-up) for any of the voltage ratings. They're waiting at your local Motorola sales office or franchised distributor. For your peace of mind, post us at Box 20912, Phoenix, Arizona, 85036, to get further information.

The MC7900 series IC voltage regulators.

Upholding the virtues of your system.

*Trademark of Motorola Inc.

MOTOROLA LINEAR
—practical innovations for systems design!

INFORMATION RETRIEVAL NUMBER 8

We make components for guys who can't stand failures.

There's no such thing as a little failure to some guys. Either your system will perform as you designed it, or it won't. Either the right answer comes out or it doesn't. Anything less is too much to bear.

At Corning we make our components as if all your customers were just that demanding. We build an extra measure of performance into everything we make. Because, like you and the guys who use your equipment, we can't stand failures either.

Some examples:

We make components you can depend on, like our metal film resistors—both standard and flame-proofs. Components like our glass, ceramic and glass/ceramic capacitors. Like our solid tantalum capacitors—hermetic and non-hermetic, polar and non-polar, miniature and microminiature. And like our discrete component networks—available with custom combinations of discrete microminiature resistors, capacitor chips and diodes in a dual in-line package.

Metal films in particular:

Take our metal film resistors, for example. They've demonstrated the extremely low failure rate of 0.00013% per 1000 hours, based on approximately one billion unit test hours. This quality is why Corning resistors have been used in high reliability programs such as Minuteman, Safeguard, Mercury, Gemini, Apollo, Mariner and Poseidon, and in virtually every other military program requiring resistors. They're qualified to the new Established Reliability specs, too.

100,000 hours without failure:

The following will demonstrate what we mean when we say that our metal film resistors have proven stability: In 1956, Remington Rand Univac Division of Sperry Rand Corporation began testing 1500 Corning N20, ½ watt, 1% resistors in a 40°C ambient under various power stressing conditions. Resistance deviations resulting from this program were minimal and unsurpassed in the industry. To confirm the stability characteristics demonstrated in the Remington Rand Univac Test, Corning remounted 600 of the original resistors in a 25°C ambient early in 1962, accumulating more than 100,000 total test hours to date. Not a single unit has exceeded a 2% $\triangle$R from initial resistance at time zero!

Flame proof, too:

Our metal film resistors are available in flame-proof grades, too. Their unique coating precludes flaming. And they're constructed to open under overload—rather than shorting-out as many resistors do—to protect other more expensive parts of your system.

For complete details on our metal film resistors and all of Corning's other extra reliability components, write for our new "General Design Guide" to: Corning Glass Works, Electronic Products Division, Corning, New York 14830.

And for information on availabilities, call your local authorized Corning distributor or D.I.A.L. EEM: (800) 645-9200, toll free. Or in New York state, call collect: (516) 294-0990.

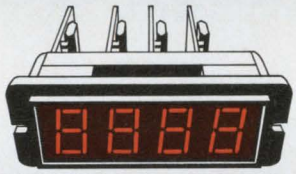
CORNING
ELECTRONICS

Dialight sees a need:

(**Need:** A large 5/8" high LED readout at a low $4.95* price.)

See Dialight.

Each digit in this bezel assembly contains a Dialight light-emitting diode, decoder/driver, and resistor network that produces a bright, highly visible readout that can be easily installed in a panel. The readout display is supplied with discrete gallium phosphide or gallium arsenide phosphide diodes arranged in a seven-segment format. These generate a bright, highly legible red character (0.625 inch high—the largest size character in the industry) with the lowest power consumption for a character of this size. Ideal for mounting on a control panel, or in a digital clock, meter, credit-card verifier, TV channel indicator, or hospital room status-board indicator. The contrast ratio between the illuminated and non-illuminated segments is further enhanced by a one-piece red nonglare window.



(continued from page 7)

ish colors. Yet the ad won in your "Top Ten" awards. (Bourns' advertising falls into this nauseous category also.)

If a reader does not like or approve of an ad, then he shouldn't buy the product. Conversely he should buy products contained in appealing ads. Or write the advertiser expressing his feelings. But don't put the responsibility for censorship on you—or anybody for that matter.

Let me correct an earlier statement. There is something more erotic in ELECTRONIC DESIGN than ads for mating connectors. Your picture, Mr. Rostky.

Marci Williams
President

Spectra Advertising Inc.
3822 Campus Dr.
Newport Beach, Calif. 92660

Bourns replies

Ms. Williams, like any citizen of this nation, is certainly entitled to express her opinion on any subject—as an individual. However, her comments, made in the mode of a professional advertising practitioner, are quite another matter, because to the noninvolved reader such comments take on the weight of an authoritative, expert opinion, when in actuality they merely reflect her individual, subjective reactions.

What is tasteful? What is garish? It's all in the eyes of the individual beholder. Ugly is sometimes appealing! How many people would rave about the tasteful elegance of the Volkswagen? Or sigh with ecstasy over the muted, well-ordered colors and uncluttered composition of a Picasso or Braque!

A client employs advertising people for one simple objective: to communicate the product message. He pays a significant amount of dollars to attain this objective. In an environment where competition for the reader's attention is extremely fierce, *sometimes* it becomes necessary to employ brilliant (garish) colors, points-of-emphasis (cluttered) layout as tools to make extraordinary impact on the reader's ad-saturated mind. Just such tools were employed in two recent Bourns ads. Neither ad would ever win so much as an honorable mention in the Art Directors Show for "clean layout," "tasteful" color coordination, etc. Nor were they so designed.

They did, however, generate more readers inquiries about the products than any other two ads in the company's 25-year history! Bad taste? We leave that to each reader's personal judgement. Successful? It attained the objectives.

Ms. Williams' further statement was ever so much more intriguing: "If a reader doesn't like or approve of an ad, he shouldn't buy the product." If that doesn't smack of a cut-off-your-nose-to-spite-your-face philosophy! If ad readers, or TV viewers, were to follow that advice, multitudes wouldn't buy toothpaste, bath or laundry soap, aspirin, laxatives or deodorant. Whew! Think of all the foul-mouthed, stinking, constipated people with headaches!

Roland R. Shane
Director of Advertising

Bourns
1200 Columbia Ave.
Riverside, Calif. 92507

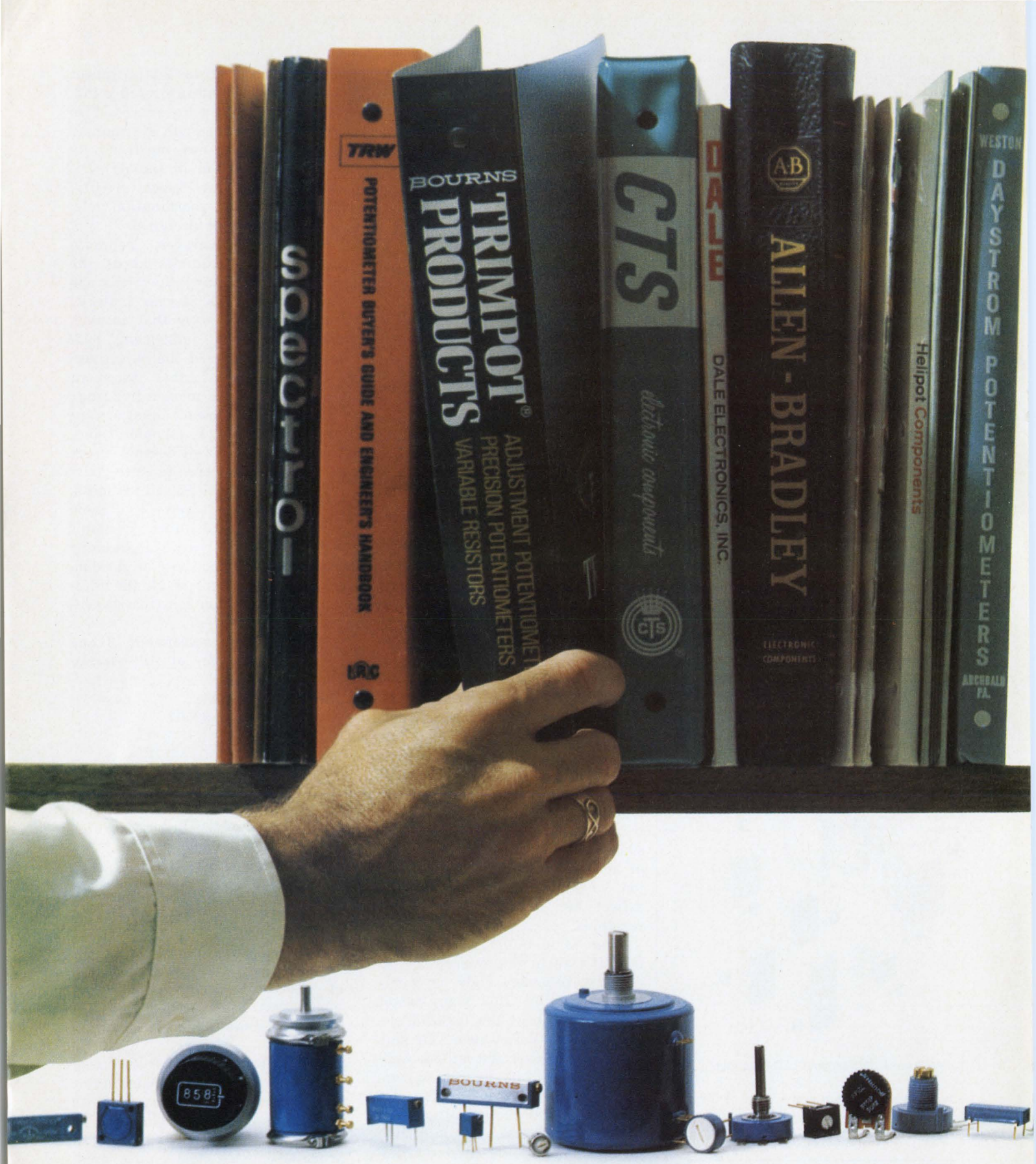
Guardian replies

I am very distressed by Ms. Williams' reference to me as a "great tie-in." Evidently she is under the misapprehension that I am not truly *the* Guardian Angel of electronic engineers, and believes that I am merely the figment of some adman's imagination.

I suppose I should become used to this sort of agnosticism. After all, there are probably many people who don't believe in Santa Claus, the Jolly Green Giant or the Man from Glad. Ah, how empty must be a life without faith!

I completely agree, however, with Ms. Williams' objection to the "garish color" and "over-all clutter" with which I'm surrounded in Guardian ads. I much prefer a

(continued on page 16)


TRW
POTENTIOMETER BUYER'S GUIDE AND ENGINEER'S HANDBOOK
IRC
BOURNS
TRIMPOT®
PRODUCTS
ADJUSTMENT POTENTIOMETERS
PRECISION POTENTIOMETERS
VARIABLE RESISTORS
CTS
electronic components
DALE
DALE ELECTRONICS, INC.
A-B
ALLEN-BRADLEY
ELECTRONIC COMPONENTS
Helipot Components
WESTON
DAYSTROM POTENTIOMETERS
ARCHBALD PA.
BOURNS

Who has the broadest line of Potentiometers?

It stands to reason that we wouldn't ask the headline question unless we were certain of the answer.

And we are. Unquestionably, the answer is **BOURNS**

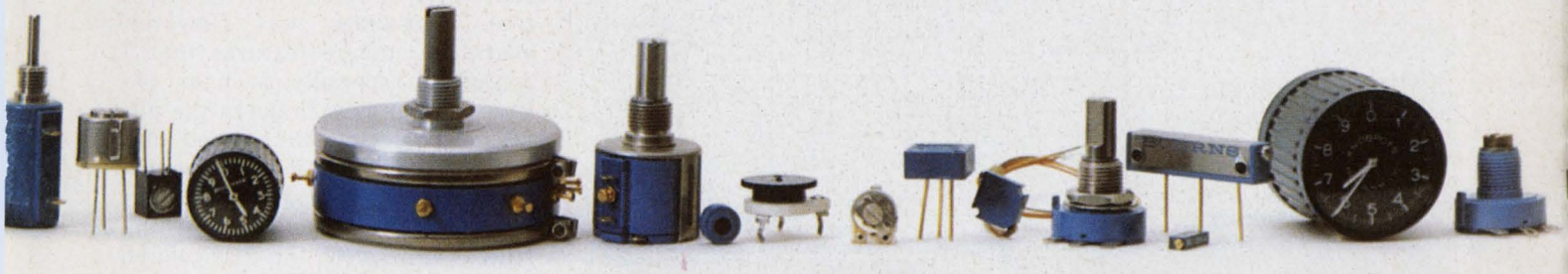
Compare catalogs if you like. You'll find over 12,000 model/terminal/resistance combinations offered in our ***TRIMMER POTENTIOMETER*** section. Single-turn and multi-turn . . . round, square and rectangular — BOURNS has them all, in wirewound or cermet models.

No need to look elsewhere for a complete line of ***PRECISION POTENTIOMETERS***. Check the precision section of the Bourns catalog. Over 20 different standard bushing mount models are displayed, including the unique KNOBPOT® integral dial/potentiometer family. If you have servo-mount requirements, or need "something special". . . our fully staffed custom design and manufacturing organization is at your service. Promptly.

More? You bet.

Bourns popular "SPACE SAVER" line of cermet ***CONTROLS*** are finding wide acceptance in cost-conscious consumer and industrial applications. You can expect to see exciting developments in this line.

Our cermet and composition open frame ***VARIABLE RESISTORS*** are super for budget PC board applications. They're priced as low as 10¢ in production quantities. They're from Bourns, so you can count on cost-effective quality and service . . . even at such low prices.



When you think of variable resistive components . . . look no farther than your Bourns Master Catalog. It's your supermarket of quality, cost-effective resistive components.

BOURNS INC

TRIMPOT PRODUCTS DIVISION • 1200 COLUMBIA AVE., RIVERSIDE, CALIF. 92507

INFORMATION RETRIEVAL NUMBER 11

(continued from page 13)

serene environment of soft pastels, but they insist on displaying their products and they insist on their Guardian blue and gold. If only I were the Guardian Angel of art directors, I would sure do something about it.

I find myself in agreement with another of Ms. Williams' points: Your picture is erotic, Mr. Rostky.

The Guardian Angel

Guardian Electric
Manufacturing Co.
1550 W. Carroll Ave.
Chicago, Ill. 60607

A bald, unashamed, unsolicited plug

Your magazine was of such help to me recently in suggesting an inexpensive practical solution to a motor-control program that I want you to know of my appreciation.

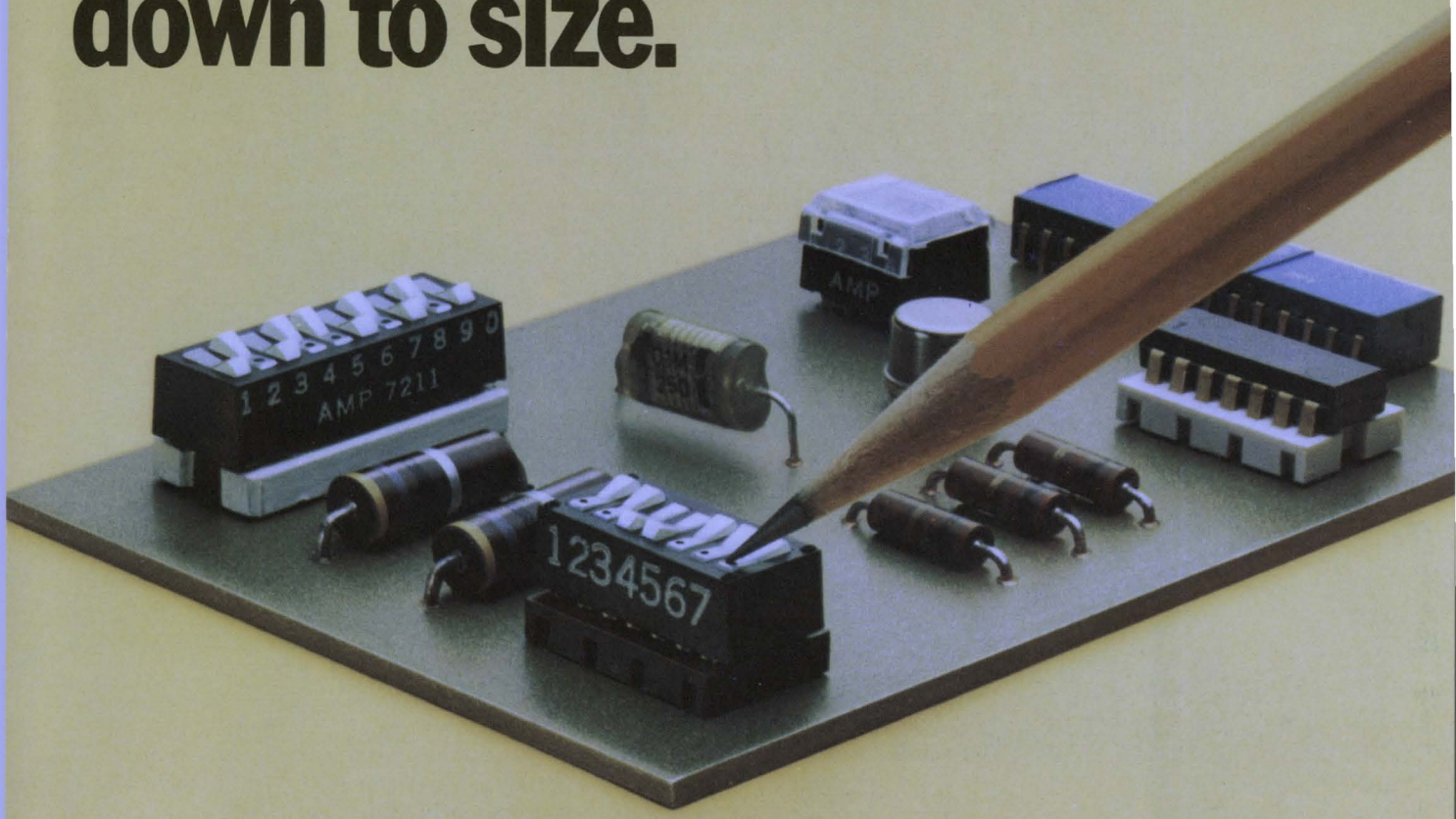
For the past few years I have been designing special-purpose industrial-control systems, and these are mostly to JIC specifications—a very different world from the military and commercial electronics areas in which I first worked. Presently this world is oriented predominantly to electro-mechanical devices, but it is rapidly opening up to the advantages of solid-state controls. Designs are often a hybrid of relays, with some solid state added.

Since I work in industrial controls, I find your magazine very useful. It is my link with the working man's state of the art in electronics. I read several other trade magazines, too. However, yours has unique features that I appreciate especially, such as (1) Focus, which tells in depth the pitfalls of working in a particular area; (2) The articles by managerial engineers; and (3) Your general editorial policy of telling it as it is without the rose-colored glasses of vendor specs. These things make your magazine uniquely useful.

Peter Haas
Consultant

113 Richmond Ave.
Ridgewood, N.J. 07450

AMP cuts on-board programming problems down to size.

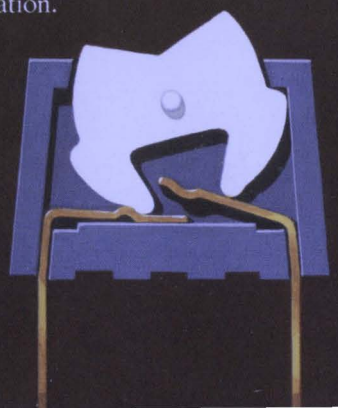


Down to the size of a DIP header—with our miniature Dual In-Line Switch. Because you can use it to program IC's right on the board without remote wiring, it cuts packaging costs, too.

This versatile switch gives you 4 to 10 single-pole, single-throw switches packaged in a housing with leads on .100 x .300-inch centers. Rocker buttons operate at the touch of a pencil to permit instant programming of data input terminals, computer peripherals, testing and control instrumentation. Plug it into a DIP header or into one of several other AMP IC interconnection products. Or flow solder it directly into the pc board. Gold-over-nickel plating on phosphor bronze contacts makes the DIP switch ideal for "dry circuit" applications. Protective covers are available for all switch sizes, 4 to 10 positions.

For information on other AMP switches, just turn the page.

Easy rocker action ensures fast, positive "on-off" switching; off-center rocker design prevents accidental closing from vibration.



AMP pc board switches match

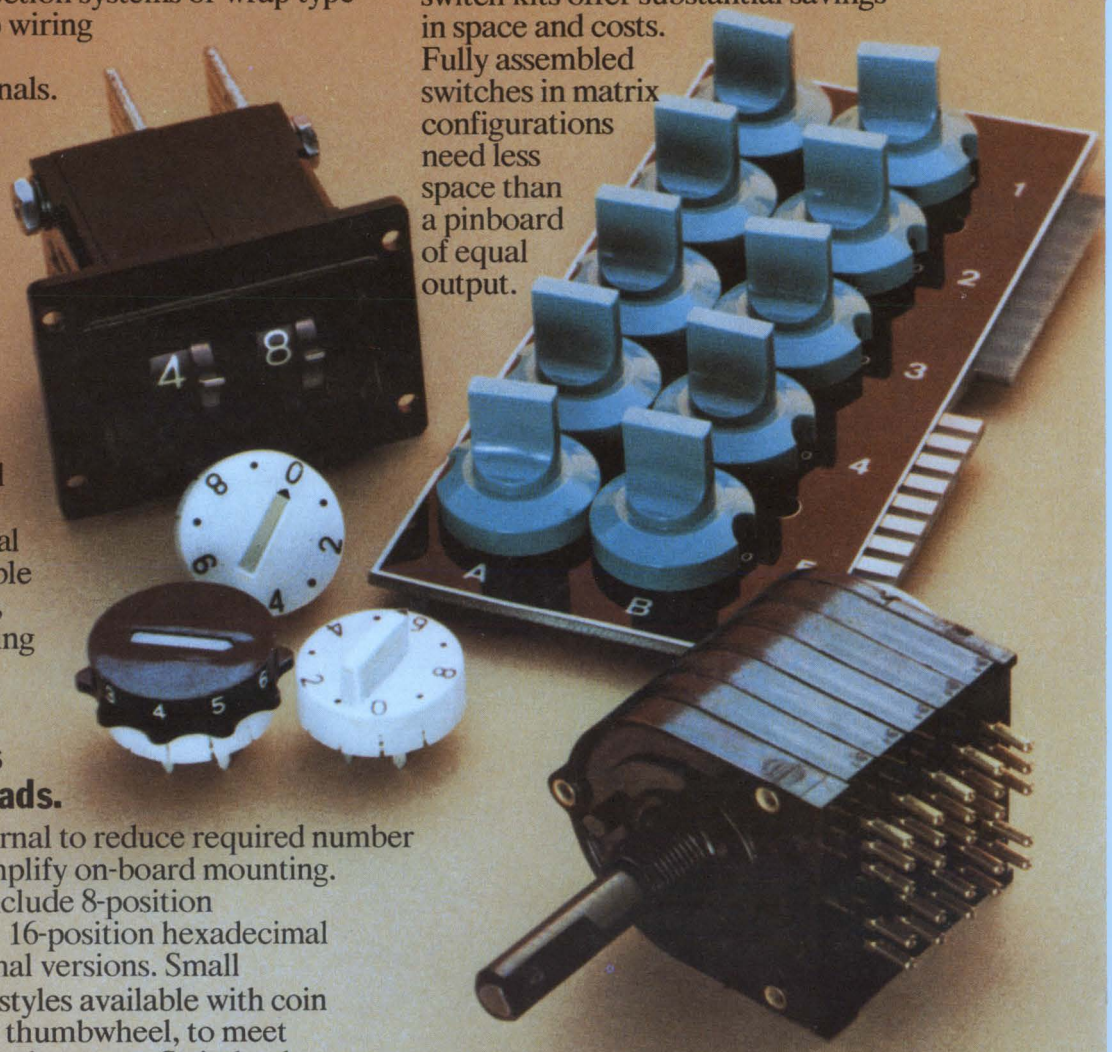
AMP pc board switches are suitable for a broad range of digital memory, sequencing, X-Y coordinate, input/output, and other program switching applications. Some are designed to be mounted to the same pc board as other circuit components. Other AMP switches can be panel mounted and interconnected to mother/daughter board with AMP pc connectors for fast, dependable connect/disconnects. All provide savings in packaging space and assembly costs by performing required program functions without remote switch wiring.

Thumbwheel switches offer broad interconnection flexibility.

Wide choice of back-end design options include contacts for use with post and receptacle interconnection systems or wrap-type and TERMI-POINT clip wiring methods, as well as extended board terminals. Extended board terminals can be flow soldered and will accept pc edge connectors and soldered wires. Compact 10-position switches can be used singly or in "ganged" units; are easily mounted in panel cutouts—from front or rear. Decimal and BCD outputs are standard, with optional coded formats available for special data entry, control or programming applications.

Decimal rotary switch kits eliminate need for external switch wiring.

Because they can be readily designed into the logic board with related components, switch kits offer substantial savings in space and costs. Fully assembled switches in matrix configurations need less space than a pinboard of equal output.



PC rotary switches minimize output leads.

All coding is internal to reduce required number of tab outputs and simplify on-board mounting. Output capabilities include 8-position BCO, 10-position BCD, 16-position hexadecimal plus single-pole decimal versions. Small diameter, low profile styles available with coin slot, bar-type knob or thumbwheel, to meet specific packaging requirements. Switch tabs can be flow soldered or hand soldered to etched circuit patterns.

Multilayer rotary switch provides easy coding changes.

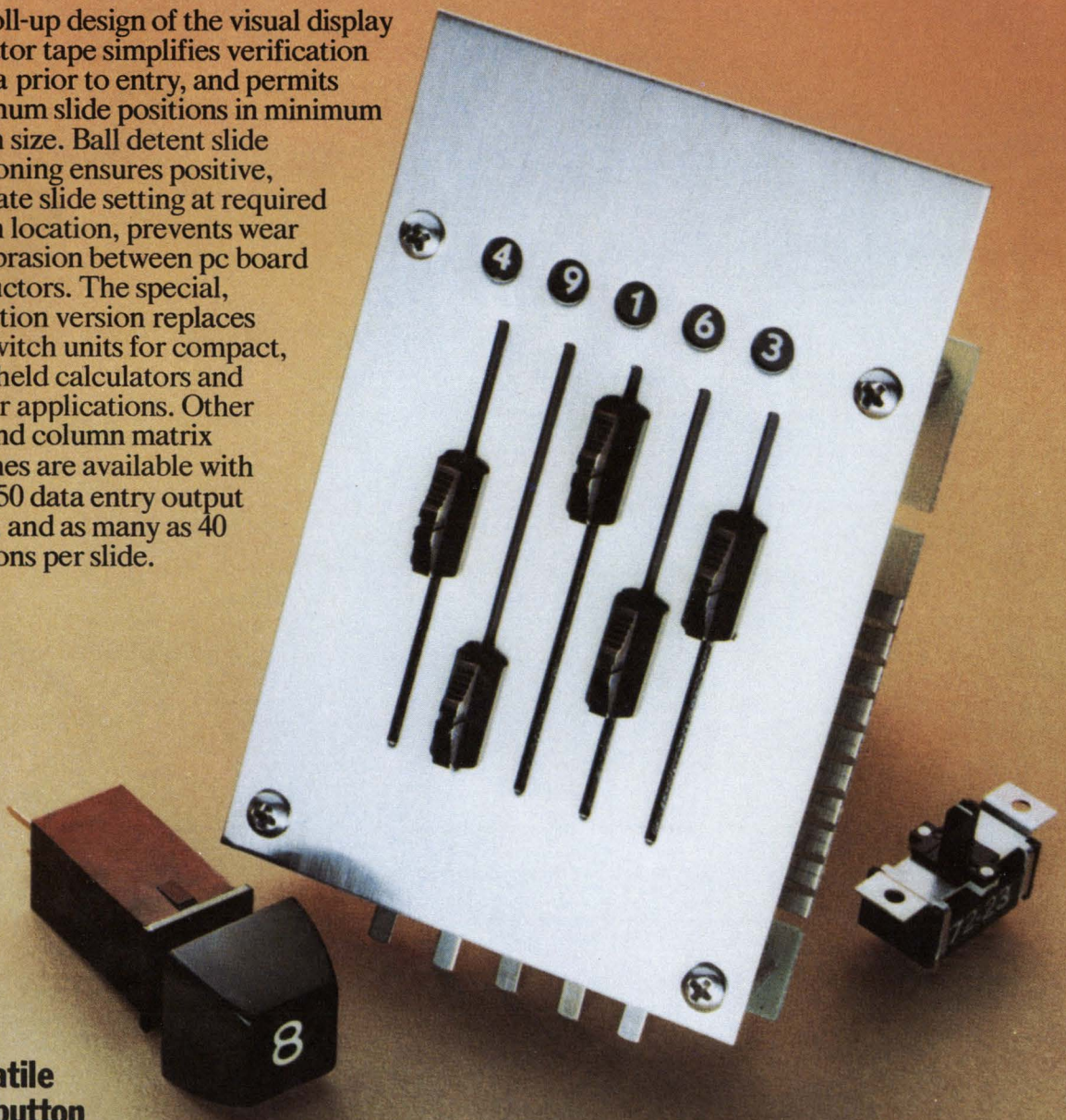
A wide variety of coded outputs are possible in volume requirements by simple substitution of internal pc circuit discs. Output capabilities include decimal, hexadecimal and hexadecimal complement codes with up to 6 contacts and 16 positions per switch layer. Switches are stacked on a common shaft for space-saving installation. Available with post contacts for flow soldering directly to pc board, or with pin type receptacles snapped over posts for terminating to pc board connectors.

your programming needs.

AMP INCORPORATED

Matrix slide switches feature unique visual readout, greater positioning accuracy.

Roll-up design of the visual display indicator tape simplifies verification of data prior to entry, and permits maximum slide positions in minimum switch size. Ball detent slide positioning ensures positive, accurate slide setting at required switch location, prevents wear and abrasion between pc board conductors. The special, 5-position version replaces two switch units for compact, hand held calculators and similar applications. Other row and column matrix switches are available with up to 50 data entry output slides, and as many as 40 positions per slide.



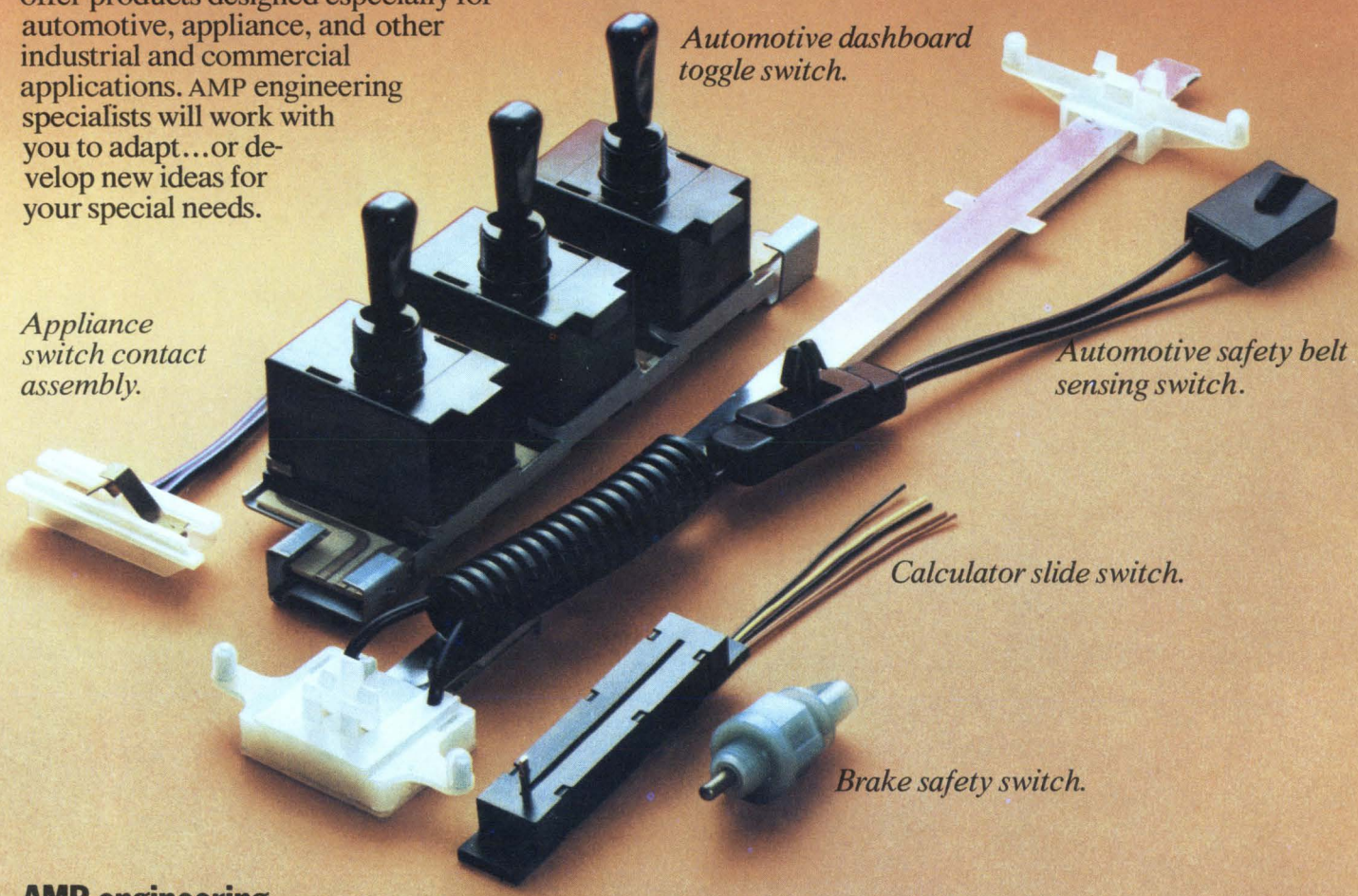
Versatile pushbutton keyboard switch.

Fast acting pushbutton offering a choice of switching functions can be manufactured for specific needs: one SPNO or SPNC; two SPNO or SPNC; one NO and one NC in the same switch.

A contact bounce of less than 1 millisecond makes this the ideal component for momentary switching applications. Gold-over-nickel contacts meet low-level logic current requirements. Pushbutton switches can be snapped into panel cutout or soldered directly to pc board.

AMP also has switch designs for unusual applications.

Developing special products to help individual customers speed production and reduce electrical assembly costs has always set AMP apart. So it is with AMP switches. In addition to our complete line of rotary, slide, rocker, thumbwheel and keyboard switches for electronic packaging, we offer products designed especially for automotive, appliance, and other industrial and commercial applications. AMP engineering specialists will work with you to adapt...or develop new ideas for your special needs.



Automotive dashboard toggle switch.

Appliance switch contact assembly.

Automotive safety belt sensing switch.

Calculator slide switch.

Brake safety switch.

AMP engineering... the key to reliable switch performance. Worldwide.

Standard or special, every AMP switch is backed by the full resources of our engineering and customer services staffs. More than 700 qualified application, sales and service engineers are ready to assist you from the earliest stages of equipment design, to determine the best programming or switching method. AMP products and services are available at AMP plant locations and distribution centers in 16 international markets throughout the world. In United States, district offices are located in California, Georgia, Illinois, Massachusetts, Michigan, Minnesota, New Jersey, Ohio, Pennsylvania, Texas, and the District of Columbia.

For more information on AMP pc board switches, circle reader service number 75, or write AMP Industrial Division, Harrisburg, Pa. 17105.

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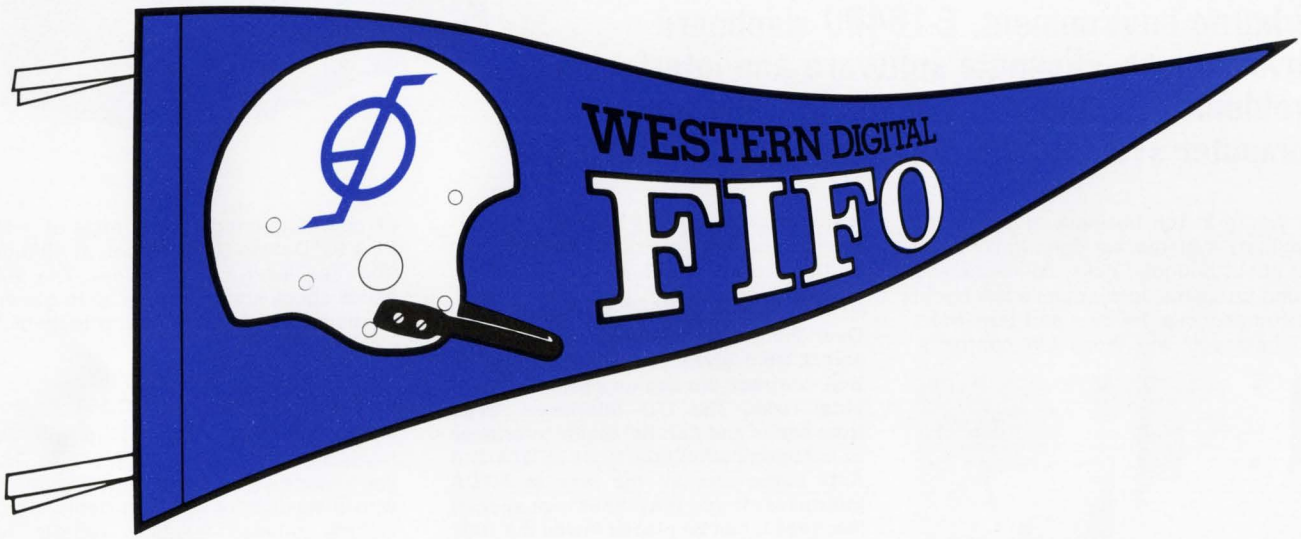
Our FIFO: #1 Draft Choice of the MOS/LSI Pros.



More MOS/LSI engineering pros specify Western Digital's FIFO (First-In First-Out) buffer memory because it's the most cost-effective method of data speed buffering available.

The 40 characters x 9 bit formation matches your data. And you don't have to pay for two devices to tackle the job of one. It's ideal for terminals, computers or data communications systems. For interfacing high and low speed data with synchronous or asynchronous systems. For formatting. Or even as a digital delay line.

Simply insert the FR1502E FIFO into your data stream. Features like full TTL compatability, tri-state data lines, master reset and status flags will make you stand up and cheer.

Order our FIFO in the 1 MHz input/output version. Or now you have the option of half-time at 500 kHz for less price... the FR1502E-01.

There is no industry blackout on delivery at Western Digital. FIFO's are available immediately in 28 pin DIP packages.

Free NFL Pennant

Our FIFO is the winner in the MOS/LSI league. Find out why. Write us on your letterhead and tell us the name of your favorite National Football League team. We will send you a pennant for **your** favorite NFL team, along with data on **our** MOS/LSI favorite. Write Western Digital Corporation, 19242 Redhill Ave., Newport Beach, California 92663. Tel: 714/557-3550. TWX: 910-595-1139.

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Go with the action...Go Western Digital!

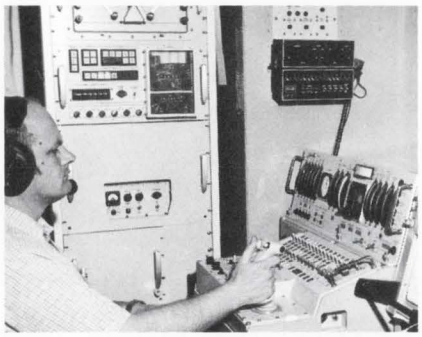
INFORMATION RETRIEVAL NUMBER 141

ATTENTION PROGRAM MANAGERS:

How to win a $10 million government contract with the new $20,250 Rolm Ruggednova:

For $20,250 you can meet Mil Specs E-5400 airborne environment, E-16400 shipboard environment, eliminate software and interfacing problems . . . and still buy the world's toughest computer system with 8K of memory and teletype.

If you're in the business of producing military systems, we don't have to tell you about budgets, risks, deliveries and design problems. Instead, let's talk about the Ruggednova 1602 . . . and how Rolm can help you win those big contracts.



A new technique for armchair control of RPVs (Remotely Piloted Vehicles) has been developed by Motorola Government Electronics Division for the Navy. The Ruggednova in the background helps provide either discrete or proportional control for up to six RPVs of any variety at ranges exceeding 250 nautical miles.

SOFTWARE IS THE FIRST SAVING

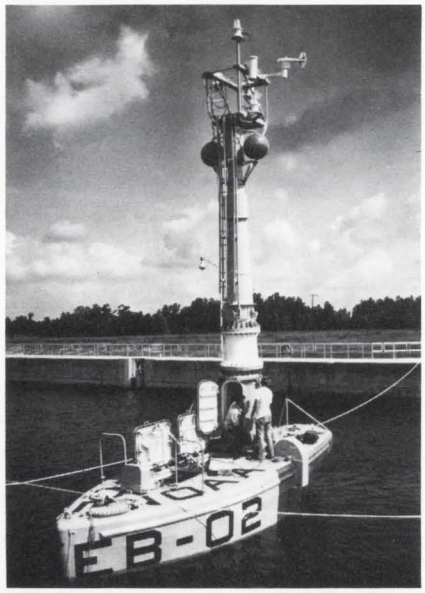
You can effectively reduce the most expensive and longest lead-time item in a system's task with our wide selection of proven and documented software. You'll see your program working on the 1602 in less time because the Rolm software set includes assemblers, compilers, debugging aids, utility routines, math libraries and powerful operating systems. A significant benefit of our system is the availability of a compatible commercial equivalent. Any program written on the Data General Corporation's Nova series will operate on the Ruggednova. Our licensing agreement with Data General allows us to provide more software than any other mil spec computer.

OUR EXPANDED INSTRUCTION SET GIVES GREATER FLEXIBILITY

With the Ruggednova 1602 your applications programming task has been simplified with a new extended instruction set. For example, our file search instruction enables you to do an "in limits / out of limits" comparison on a file up to 64,000 words long with one single instruction. Other examples include 1602's stack processing capability, automatic branching and nesting of interrupts, immediate mode instructions and double precision arithmetic.

INTERFACING IS MADE EASY

Over 30 general purpose interfaces to select from gives you another edge on that contract. No design costs. No technical risks. The I/O interfaces range from series and parallel digital interfaces to communication interfaces to D/A and A/D converters all the way to NTDS interfaces. If you have your own special interface it can be placed inside the 1602 chassis. You save money by not having to design a rugged chassis or rugged power supply.



This new prototype, 30-ton buoy, built by Lockheed Missile & Space Company for the National Oceanic and Atmospheric Administration, has been placed in the Gulf of Mexico to record meteorological and oceanographic data. It is equipped with a Rolm Ruggednova for data acquisition and communications processing.

MIL SPECS ARE ALREADY MET

We supply you with a qualification test report free. You don't have the hassle, risk, or expense of qualification testing. The 1602 meets Mil-E-5400 airborne environments, Class II; Mil-E-16400 shipboard environments, Class I; Mil-Std-461A electromagnetic interference and Mil-S-901 for high impact shock. It has an operating temperature range of −55° to +95°C case temperature, at altitudes from sea level to 80,000 feet. The 1602 meets shock specifications of 15 g's with 11 ms duration and vibration tests of 10 g's, 5 to 2000 Hz.

AND THERE'S A SUPPORT PACKAGE AT NO EXTRA COST

Rolm's program doesn't stop with just hardware and software. We also help you reduce your budget and design risk with a number of back-up items. These include detailed reliability reports, two weeks of training, complete documentation and a 90-day warranty. For software support there's also a "how-to" software manual, individual software write-ups, and full diagnostic software.

NEW DEBUGGING FEATURE

Within the first 15 minutes of loading a program into the 1602 you can localize most program errors. A new "panel breakpoint" switch allows you to execute your program until it hits the address located on the 16 data switches. This allows you to verify good routines and identify program bugs. No more single stepping through 2,000 word subroutines or keying halts. It's a great time-saving software feature.

Now that we've told you about all the ways Rolm can help you get that multi-million dollar contract, there's no space left to describe a host of other features about the Ruggednova 1602. So, drop us a line and we'll send you complete data on the world's toughest computer. If you're interested in getting a head start on that contract . . . give us a call.

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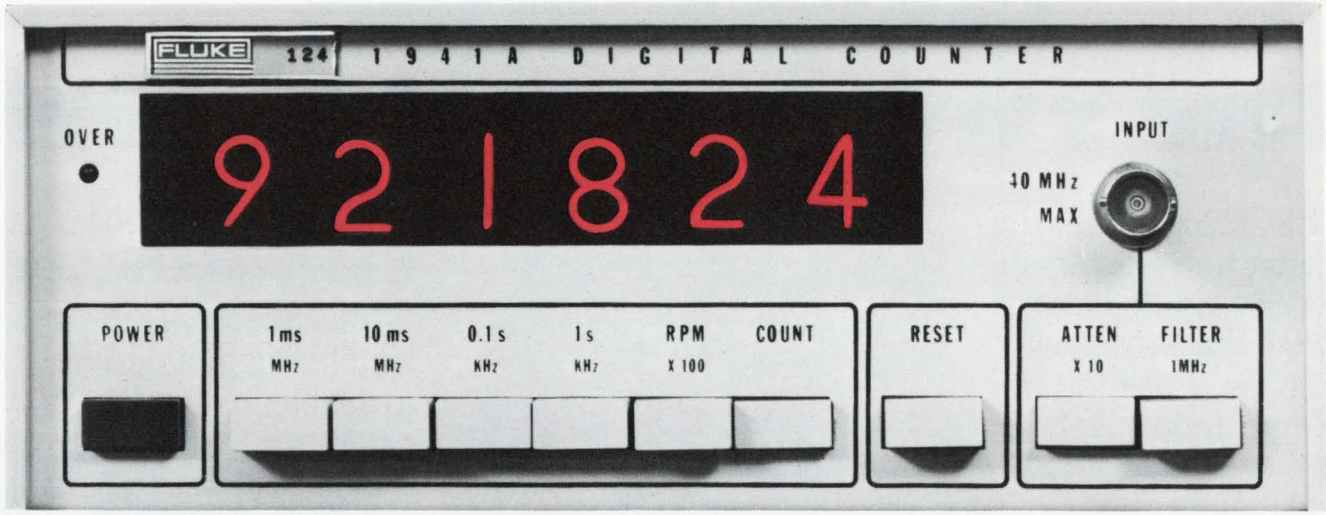


Simply the best low cost counter you can buy.....$299.

Now you can buy an economical counter with noise immunity and programmable offset to measure frequency, read rpm directly, or totalize events.

From lab to the production line, here's a rugged low-cost counter with all the most needed features to make industrial and laboratory measurements.

A unique digital frequency counter, the new Fluke Model 1941A operates over a frequency range of 5 Hz to 40 MHz. It measures frequency, reads rpm directly and totalizes. Sensitivity is better than 40 mV rms. Aging rate is a low 6×10^{-7} /day.

All functions are easily selectable and clearly marked. Read out is a big six-digit display clearly readable from a distance in high ambient light.

Functional "burn-in" eliminates marginal parts.

Options include programmable offset for fast, accurate go-no-go decisions even with an unskilled operator and a four line BCD output to directly drive printers and other peripheral equipment.

Best of all, there's no need to wait to put the 1941A to work. Throughout the U.S., Canada, and western Europe, this counter is in stock and available for immediate demonstration or delivery. A worldwide network of service centers provides 48 hour turnaround repairs.

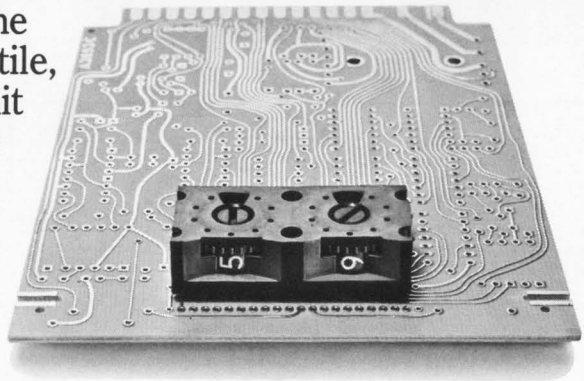
In the continental U.S., dial our toll free number 800-426-0361 for the name and address of your nearest local source. Abroad and in Canada, call or write the office nearest you listed below, John Fluke Mfg. Co., Inc., P.O. Box 7428, Seattle, Washington 98133. Phone (206) 774-2211. TWX: 910-449-2850. In Europe, address Fluke Nederland (B.V.), P.O. Box 5053, Tilburg, The Netherlands. Phone 013-67-3973. Telex: 844-52237. In the U.K., address Fluke International Corp., Garnett Close, Watford, WD2 4TT. Phone, Watford, 33066. Telex: 934583. In Canada, address ACA, Ltd., 6427 Northam Drive, Mississauga, Ontario. Phone 416-678-1500. TWX: 610-492-2119.

FLUKE®

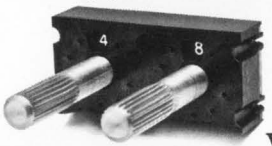
INFORMATION RETRIEVAL NUMBER 143

INTRODUCING THE TWO-FACED SWITCH

EECO introduces the Stripswitch™—a versatile, low cost printed circuit switch that's available in strips of one to eleven stations, for ease of handling and installation.



Because it's two-faced, you can mount it either horizontally or vertically. And you can wave-solder it directly to the printed circuit board.



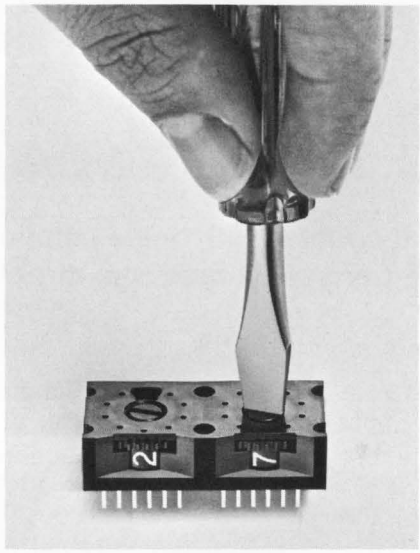
Saves you money

Stripswitch is inexpensive to begin with—less than $1 per station in quantity.

And, because you can wave-solder it directly to the printed circuit board, the need for rivetting, eyeletting, mounting hardware, switch-to-board wiring or expensive special plating is normally eliminated.

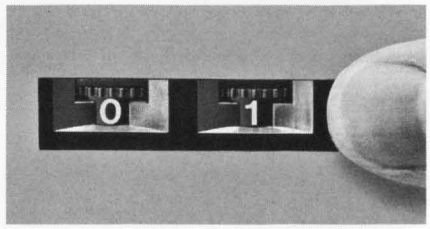
Actuates three ways

You can actuate Stripswitch by means of knurled wheels. Or, if you mount it behind a panel, you can actuate Stripswitch by means of a screwdriver or shaft extension and knobs.



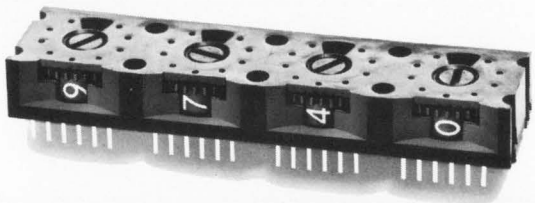
Guaranteed rugged

The Stripswitch is a simple, rugged design available in a variety of codes and switching functions, backed by an exclusive two-year warranty. And it's constructed from materials that can withstand caustic cleaning solutions.



That's the straightforward story of our two-faced switch.

For more information write to Electronic Engineering Company of California, 1441 East Chestnut Ave., Santa Ana, California 90701. Or phone (714) 835-6000.



Stripswitch by EECO

Distributed by Schweber, Hall•Mark and G.S. Marshall

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A MINI-LIBRARY OF SEMICONDUCTOR GUIDES FROM HAYDEN...

THICK FILM TECHNOLOGY

By Jeremy Agnew

This volume constitutes an actual working guide to hybrid circuit manufacture and packaging. It begins with an overview of the processes and equipment used, compares them, and underscores the advantages of each. The book details each processing phase, fully describing what to do and what pitfalls to avoid. Other valuable sections cover packaging schemes and processing hazards and cautions. The volume's abundance of practical advice and data make it ideal as an on-the-job reference. **176 pages, 6 x 9, illus., #5803-9, $8.50**

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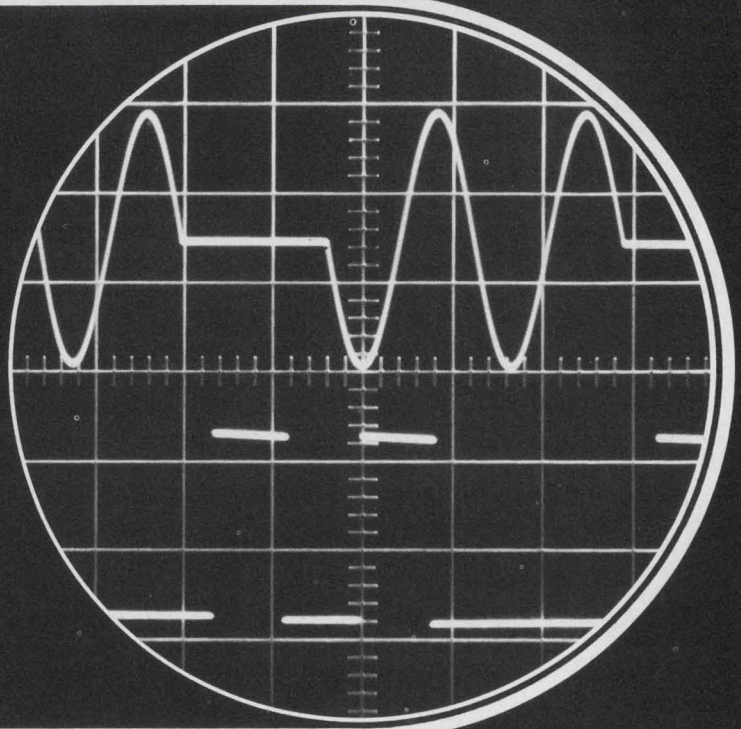

Oscilloscopes for most production, inspection, QC and lab applications are not used to their full capability.

In fact their full capability in bandwidth may even need to be limited by an external bandpass filter for easier trace readability. In one electronics manufacturing facility a survey of 22 applications discovered 19 applications which were appropriately served by our least expensive $179.95 oscilloscope with recurrent sweep and 2MHz bandwidth. A survey of your facility may reveal similar opportunities for saving. Our triggered sweep scopes with 10MHz bandwidth and 35 nanosecond rise time answer the needs of more than 80% of all applications. Sensitivity of 10mV/cm offered by both our single and dual trace triggered sweep scopes is similarly suitable for over 80% of all applications.

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DC to 10MHz at 10mV/cm. Two separate vertical amplifiers. 35 n sec rise time. Six dual pattern modes including chopped, alternate, add and Channel 2 inverted. Auto and triggered sweep 1 usec/cm to 0.1 sec/cm. 5X magnification. **$529.95**

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B&K Model 1431 3" Triggered "Mini-Scope"
As above, but ⅓ the size. **$399.95**

B&K Model 1403 Portable 3" "Mini-Scope"
3" solid state scope only 5¼"x7⅜"x11¼". DC to 2MHz bandwidth and 20mV/cm sensitivity. Recurrent sweep 10Hz to 100kHz. Weighs only 8½ pounds. **$179.95**

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Complete Line of Analog and Digital Multimeters, Oscilloscopes, Signal Generators, Semiconductor Testers, Power Supplies, Probes, Tube Testers and Substitution Boxes.

INFORMATION RETRIEVAL NUMBER 14

Is this another bum wrap?

If you've been getting more than your share of faulty plug-in and wire-wrapped panels lately, you should talk to us: Garry Manufacturing.

At Garry, we take extra care to insure that you get a better wire-wrapped panel. Whether you buy a plug-in panel from us (and wrap it yourself). Or, whether you let us wrap it for you.

Either way, you get a better panel. Because our unwrapped panels are more "wrappable" (squareness, for example, is exactly .025 inch. It never varies). Our precision beryllium spring clip has the most consistent I.C. insertion/withdrawal ratio in the industry. All this because our facilities are among the world's best.

This attention to quality is nothing new to Garry. For 25 years we have been supplying contacts to the connector field. We have the largest facilities for making contacts and do not rely on outside suppliers for our parts. We have plants in the U.S. and Switzerland. And we have a long list of very satisfied customers, including the 5 largest electronics manufacturers in the United States.

Why not find out more about Garry panels? About our ultra-reliable contacts. Our design and engineering service. Our extra-fast delivery/turnaround. And our technically-oriented sales staff.

They just might help you beat a bum wrap.

Garry's panels are available for less cost, with up to three levels of wire wrap*, in any quantity. Get all the details. Send for Garry's literature.

Garry Manufacturing Co.,1010 Jersey Ave., New Brunswick, New Jersey 08902.

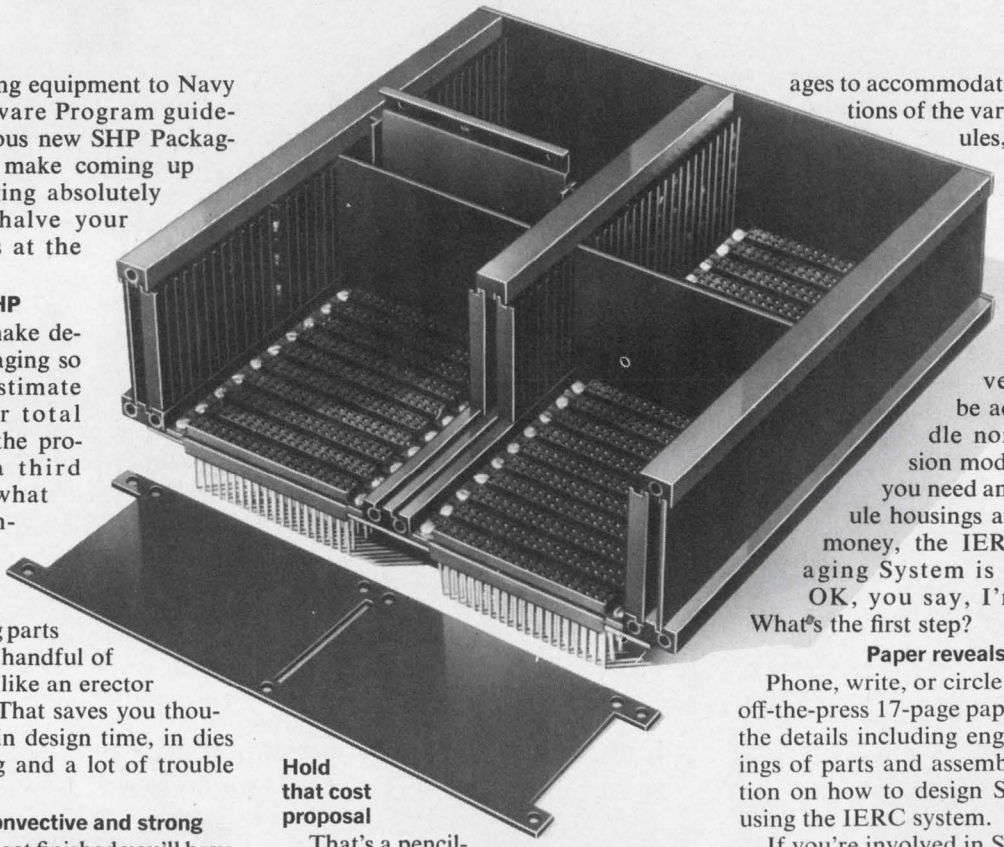
*Gardner-Denver

Garry
Manufacturing Co.

We won't pin a bum wrap on you.

INFORMATION RETRIEVAL NUMBER 15

Navy Standard Hardware Program packaging made easy and profitable



If you're supplying equipment to Navy Standard Hardware Program guidelines, our ingenious new SHP Packaging System will make coming up with the packaging absolutely simplistic and halve your packaging costs at the same time.

No sweat SHP

First off, we make designing the packaging so effortless we estimate you'll cut your total design load for the procurement by a third because that's what our first customers are experiencing.

Production consists of putting parts together — just a handful of different kinds — like an erector set. Only easier. That saves you thousands of dollars in design time, in dies and other tooling and a lot of trouble to boot.

Conductive, convective and strong

And when you get finished you'll have packaging for your circuitry with the high order of thermal efficiency you'd expect from industry's leading manufacturer of circuit heat dissipating devices. Plus mechanical integrity that's ready for the most demanding environments.

Packaging that cannot be individually produced for twice the price.

Hold that cost proposal

That's a pencil-sharpening fact you can ill afford to ignore if you're in the middle of preparing a proposal in response to an RFP that calls out SHP — or if you ever expect to bid an SHP program.

Here's how our new SHP Packaging System works:

We've designed six basic parts — plus a few specials for unusual configurations — with which you can build circuit module housings conforming to Navy Avionics Facility, Indianapolis, guidelines and dimensions for any of the common SHP-defined circuit modules using nothing but a screwdriver.

Ad infinitum

You can build these packages to accommodate any combinations of the various SHP modules, and the potential dimensions of the packaging in span and depth are for practical purposes limitless.

In fact, our system is so versatile it can be adjusted to handle non-SHP-dimension modules as well. If you need any kind of module housings and like to save money, the IERC SHP Packaging System is for you, too.

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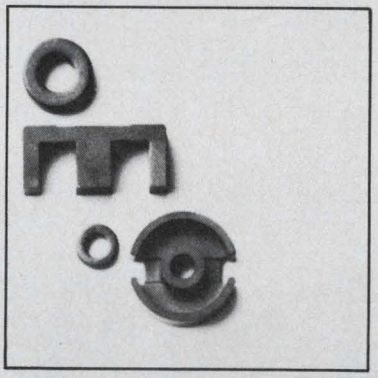

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INFORMATION RETRIEVAL NUMBER 18

news scope

NOVEMBER 8, 1973

U.S. weighs Israeli request for latest ECM equipment

The U.S. State Dept. is studying a request from Israel for first-line American electronic countermeasures equipment. In keeping with Defense Dept. rules, U.S. allies ordinarily are not supplied with first-line weapons, for fear they might fall into the hands of a common enemy.

The Israelis' specific need is for airborne ECM equipment to foil the Soviet-built SA-6 ground-to-air missile radars, which have been used so successfully by the Syrians and Egyptians to shoot down many Israeli planes. The Israeli aircraft carry Sylvania-built ECM packages to cope with the SA-2 and SA-3, but they have nothing to counter the SA-6. The SA-2 uses a slant range of about 20 miles for defense against high-altitude approaches, and the SA-3 slant range of about 17 miles for low-level attacks. Some Israeli planes also carry the passive radar-homing, air-to-surface Shrike missile, built by Texas Instruments.

Most ECM equipment in Israeli aircraft has been of the deceptive type, as opposed to the straightforward noise jammers, which transmit high-powered noise with a gaussian distribution.

Deceptive ECM receives an enemy radar signal, examines it, reorganizes it and sends it back. The result is an erroneous signal on the enemy radar screen. The pulse reorganization may consist of a change in shape, phase or polarization. These changes cause the radar to present a false reading for the aircraft's direction, speed or distance.

Such ECM has been used by Israel rather than noise jammers for a number of reasons:

- It's simple; noise jammers require a separate receiver in addition to the jammer and also a tuning device to find the enemy's frequency.
- The deceptive ECM package is small and does not require the large amount of power the jammer does.
- The jammer can only handle one frequency at a time, whereas the deceptive package can receive 100 signals, each at a different frequency. And
- Since deceptive equipment operates in nanoseconds, it can handle all the signals.
- The deceptive kits can be programmed to deceive a variety of radars.

Israeli units have been effective against SA-2 and SA-3 radars because there is abundant data on the SA-2 and some on the SA-3. U.S. pilots in Vietnam had seven years' experience with the SA-2, and the SA-3 has been in Egypt and elsewhere for several years. Experience with the SA-6, however, has been extremely limited.

The American EA-6B electronic-warfare aircraft, built by Grumman, is equipped to counter the SA-6 missile radar. But, the U.S. has not tested the plane in combat against the SA-6.

"What's needed," says Roger Bush, Grumman, EA-6B business-development manager in Bethpage, N.Y. "is complete data on the SA-6 acquisition radar—operating frequencies, pulse-repetition frequencies, power capabilities and antenna characteristics, like beam width and scan angle.

Bubble-memory material promises faster readout

A new bubble-material compound promises optical readout of bubble memories with low-power light sources and a hundredfold increase in readout speed.

Developed at RCA's Physical Electronics Laboratory in Princeton, N.J., the compound—known as bismuth thulium garnet—could hasten the commercial application of bubble-memory technology to information processing.

Until now, says Dr. George D. Cody, director of the laboratory, bubble-memory technology resisted optical-readout approaches because bulky and expensive, high-powered light sources—such as gas lasers—were required. With bismuth thulium garnet, light sources as low-powered as light-emitting diodes can be used to read out bubble-memory data, he reports.

This is possible, Cody explains, because light interacts with the new compound 10 times more readily than with other garnets previously used for bubble memories. The interaction is called Faraday rotation.

To detect bubbles optically, it's necessary to shine a polarized light through the garnet material onto photodetectors. When bubbles move through the polarized beam, Faraday rotation causes the amount of light that reaches the detector to vary, and a change in signal is produced.

Non-optical techniques—such as magneto-resistive—have been used in the past to read data out of bubble memories. However, these techniques are slow and reduce the inherent data-storage capacity of the bubble memory by as much as 25%. Optical readout techniques are faster. And since the optical-readout technique doesn't take up a lot of real estate, it should be possible to use many detectors—which would increase the readout speed even more.

AF data link to use time-shared system

A time-shared, X-band data-communication system that allows several thousand users to send, receive or share information simultaneously—but doesn't require any message center or switching facility—is under development by the Air Force.

"Information is not switched from point to point, like in conventional communications systems," explains Lt. Col. K. H. Krunlund, project officer at the Air Force

Electronic Systems Div. in Bedford, Mass. Instead, he says, the individual message data bits are broadcast one after another in a periodic sequence of time slots. Every station receives all the data, but the receiver selects only the data addressed to it.

Known as the Seek-Bus program, a prototype was tested successfully in recent military air exercises in Europe and on the West Coast, according to Colonel Krunlund.

Each user's Seek-Bus equipment is synchronized to operate with all other elements in the system on an exact time schedule. Every second is divided into more than 1200 time slots, and each user is allocated as many time slots as he requires.

"For example," Krunlund says, "a flying radar station would be given enough time slots to report the position, speed, heading and identity of all aircraft which it is capable of detecting."

The number of Seek-Bus subscribers is limited only by the number of time slots available and by the user access rate. There is no limit on the number of receivers. The access rate to the system lies anywhere between once every 8 ms and once every 12.8 minutes.

The system has features to ensure that command and control messages are processed only by the addressed receiver.

Users beyond the line of sight can be connected by an airborne relay. Any aircraft or ground unit equipped with a terminal can perform the relay task without added equipment.

Medium-scale computer announced by Univac

A medium-scale, general-purpose computer has been introduced by Univac. Called the 90/60, the processor has an instruction rate that is 60% higher than the IBM 370/135 but costs 6 to 16% less, according to Univac.

The new computer uses semiconductor memories, which represent Univac's complete switch from plated-wire to solid-state technology.

The main memory of the 90/60 is a MOS—made with 1-k RAMs—that operates in a byte-oriented mode. Access occurs with a cycle rate of 600 ns for each full word (four bytes). A writeable control store (microprogram) implements each computer instruction and allows emulation of selected Univac and IBM machines. Memory size is expandable from the initial 131-k bytes to 262 in 32-k steps.

The processor's I/O structure includes a byte-multiplexer channel that can operate at rates up to 175-k bytes and up to three selector channels (for block-data) with 1.1-M byte/s throughputs. And up to 30 phone lines—a capacity of about 100 CRT terminals—can be supported with an external controller.

The computer handles Univac's full peripheral line, which includes 119-M byte disc drives with 30-ms access time. The byte orientation provides compatibility with most data formats.

Acoustic-wave filters studied for TV use

Surface acoustic-wave filters are fast approaching the point where they will be used in common, bandpass applications instead of the discrete-element filters now used, according to Roger H. Tancrell, principal research scientist at Raytheon Research Div., Waltham, Mass. A number of laboratories are working toward this goal, Tancrell says, including Zenith and other TV companies that plan to use lithium niobate acoustic-wave filters for the i-f stages. The problems in producing filters like this were described by Tancrell this week at an IEEE Ultrasonics Symposium, held at the Naval Postgraduate School, Monterey, Calif.

In a paper on "Design Considerations for Surface Acoustic Wave Filters," Tancrell said: "The range we're interested in lies between 0.1% to a 30 or 40% bandwidth, with a center frequency from 10 MHz to as high as 800 MHz."

The latter frequency, he pointed out, is still fairly experimental, whereas the lower-frequency devices are close to mass production. To illustrate the acoustic surface-wave filter design, Tancrell cited a filter centered at 50 MHz with a 17% bandwidth.

"The principal problem in this type of filter," he noted, "is to keep the ripple in the bandpass as low as possible. While we've been able to get the ripple down to ± 0.2 dB, a number of adverse factors have to be overcome. These include triple-transit echo and reflections from the edges of the metalization pattern.

"Triple-transit echo," he explained, "is due to reflections bouncing back and forth between the input and output transducers. A principal means of reducing this echo was the specific use of some 22 dB of insertion loss in the filter design. This loss was obtained by using a multistrip coupler between the two transducers as well as deliberately mismatching the input impedance of the device.

"Reflections off the edges of the metalization pattern were minimized by splitting the electrodes in the transducer, thus changing its mechanical resonance.

A novel use of mass-producible, acoustic surface-wave filters was reported by Paul H. Carr, chief of the microwave acoustics branch of the Air Force Cambridge Research Laboratories, Bedford, Mass. He described the use of 21 filters on a 2-cm-long-by-9/10-cm-wide lithium tantalate slab as a narrowband filter bank.

Carr explained that for the synthesizers, a comb of frequencies ranging between 520 and 650 MHz, with 5.3 MHz between individual frequencies, was generated from a quartz oscillator.

"In our case," he said, "21 discrete outputs are selected by the acoustic filter. The very small, surface-wave filter size as well as the fact that it can be reproduced by standard photolithic techniques, makes the device unique."

"Based upon our experiments," Carr explained, "we can eventually double the frequency of the device. To do this, we are now investigating thin films of aluminum nitride on sapphire, which has roughly twice the velocity of lithium tantalate.

"In developing the synthesizer filter, a basic problem—that of reflections from the hundreds of lines on the filter—was overcome by a technique of "line thinning. "We omitted transducer lines in a regular pattern," he explained.

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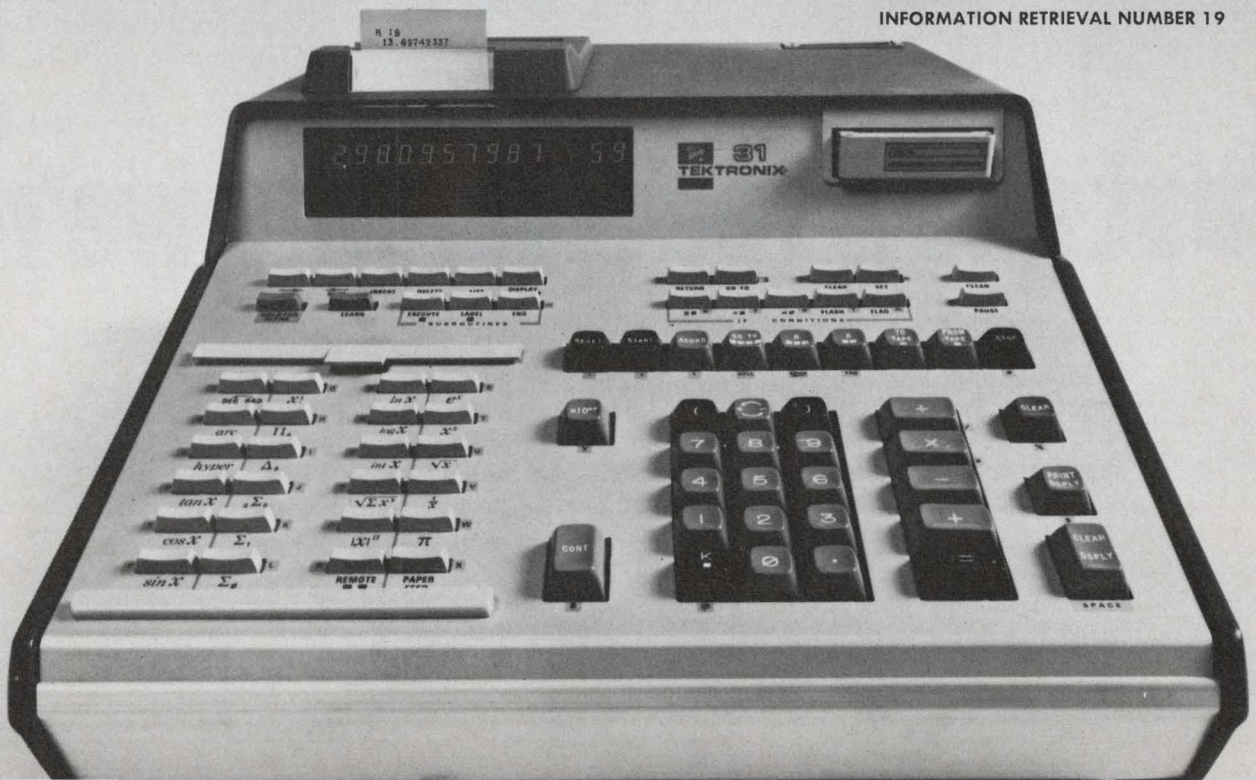

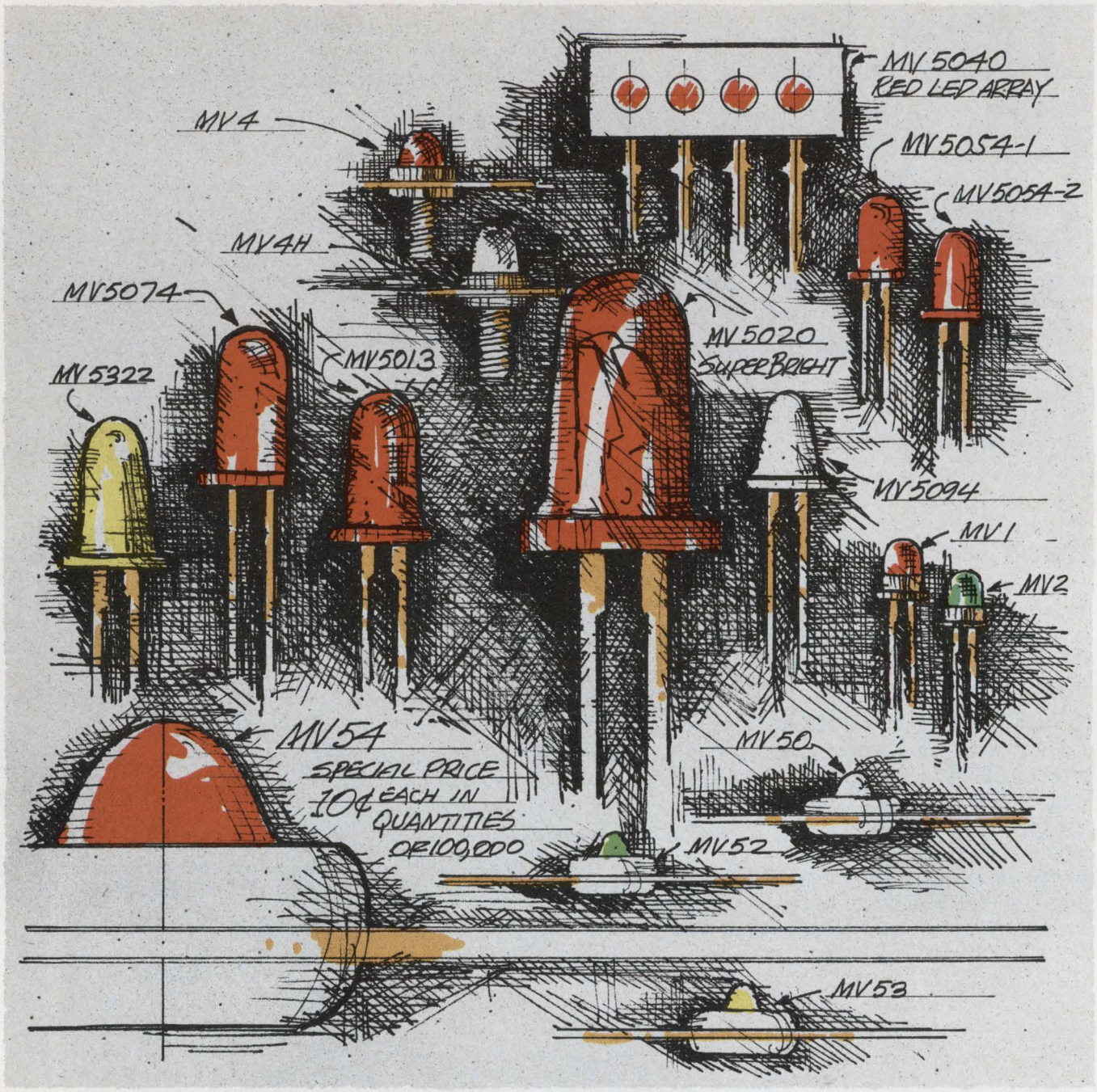

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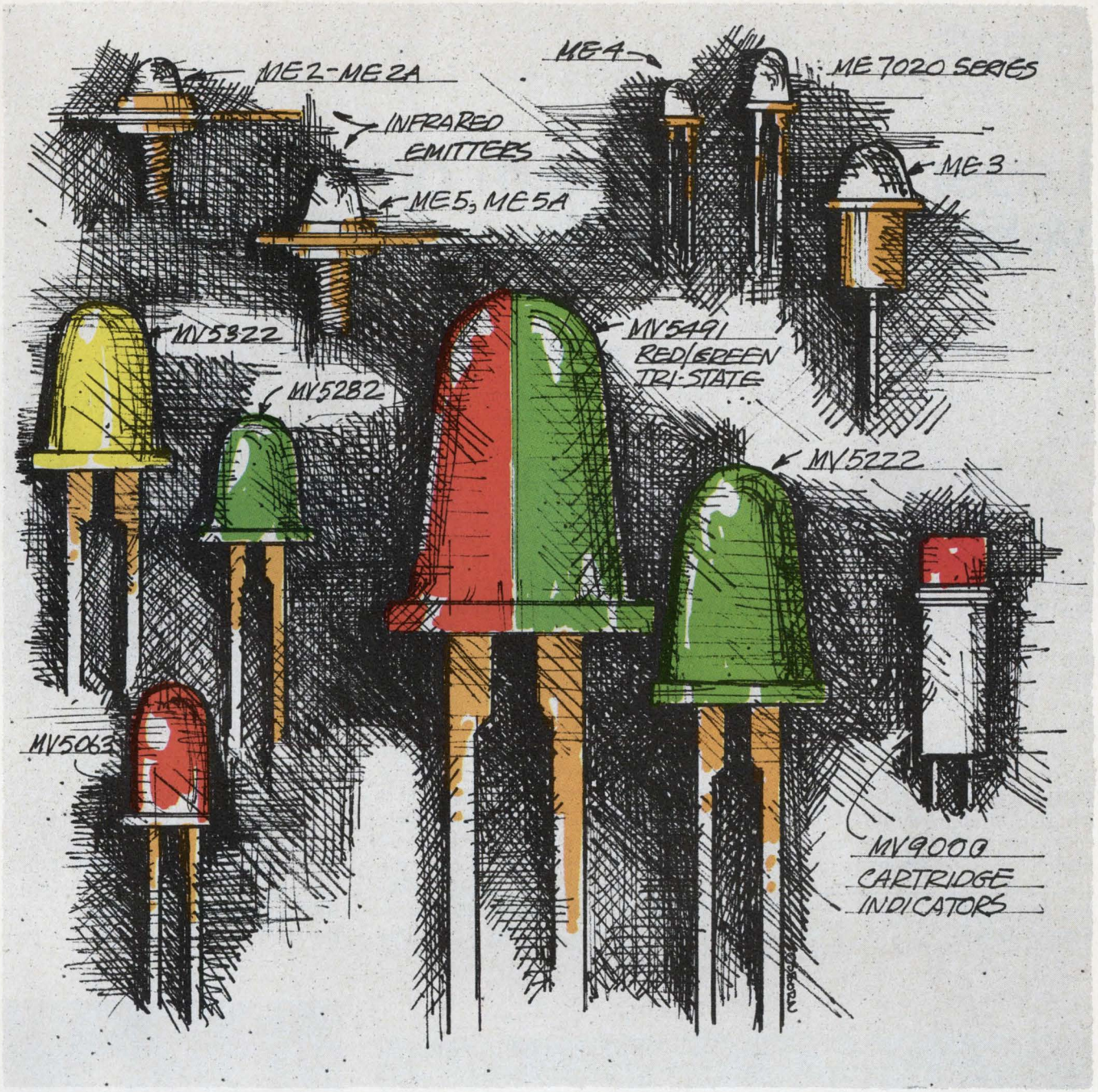

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INFORMATION RETRIEVAL NUMBER 20

news

Laser control system operates vehicles in hazardous areas

A multichannel laser remote control system that can be used to control vehicles and other equipment in hazardous locations has been developed by engineers at NASA's Langley Research Center in Hampton, Va.

The system is said to be particularly useful in areas where radio or hardwire control is unsatisfactory or prohibited. It provides, for example, a means of remotely controlling vehicles vacuuming and removing radioactive debris and waste material from nuclear engine test sites.

Tests have shown the system to be operational over distances greater than 360 feet in direct sunlight.

The over-all system consists of a control station on which is mounted the laser transmitter and a receiving station on the controlled vehicle. A key element in the system, according to E. E. Burcher, one of the developers, is the optical "antenna" located on the vehicle. To capture energy during all vehicle maneuvers the optical antenna accepts a laser signal through an azimuth angle of 360°.

This performance is provided by a "parabocone"—an optically polished conical surface that has a shape defined by rotating one leg of a parabola about an axis through the focus and perpendicular to the parabolic axis (see photo). Incident light from any direction in a plane normal to the parabocone axis is automatically focused on a photosensitive detector.

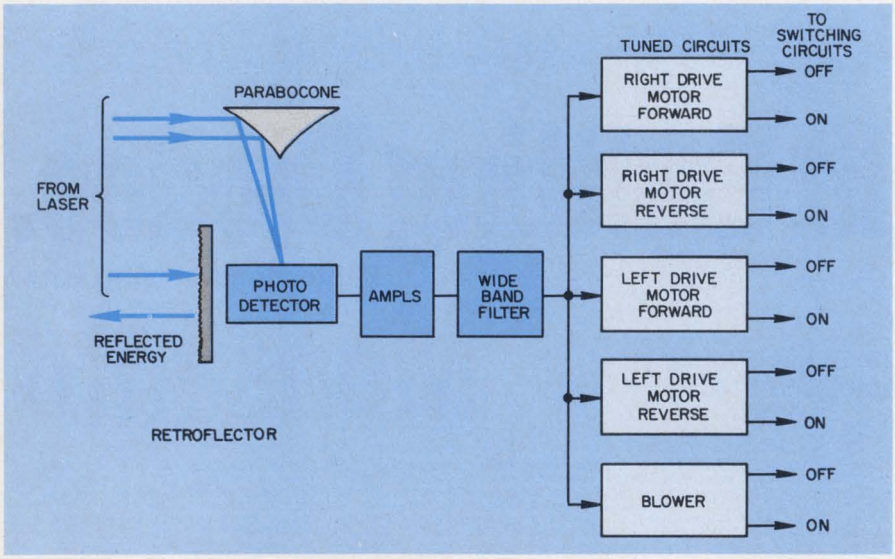
Around the cylindrical base of the parabocone is a strip of "Scotchlite" reflecting tape. This reflects a portion of the laser energy—the beam is deliberately spread for this purpose—back to the transmitter and to a special tracking receiver that keeps the transmitter pointed at the parobocone antenna as the vehicle moves about.

The laser, a 1-mW helium-neon unit that radiates at 0.6328 μm, is amplitude modulated by sine-wave subcarrier oscillators—one for each of the five command channels necessary to control two vehicle propelling motors and a vacuum blower. A sixth subcarrier channel provides a signal that is used in the transmitter-tracking receiver to keep the transmitter aimed at the parabocone. Six widely separated frequencies in a 10 to 200 kHz range of the laser modulator allow sufficient band and harmonic separation.

Receiver tracks vehicle

The tracking receiver is mounted atop the laser on a turntable that rotates in azimuth to follow the vehicle motion. The tracking receiver, which is boresighted with the laser beam, consists of a pair

Jim McDermott
Eastern Editor



Receiving system for laser control reflects beam onto a photodetector. Five subcarrier signals between 10 and 200 kHz are amplified and passed on to tuned circuits that control the switching functions of motors.

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The laser energy reflected from the Scotchlite tape on the parabocone is split in the tracking receiver by an aluminized prism that directs half of the reflected energy onto the face of each phototube. This receiver responds only to the frequency of the sixth subcarrier channel.

The outputs of the phototubes are amplified, filtered, rectified and sent through a nulling circuit that produces a signal when any difference between the outputs occurs, as when the controlled vehicle moves. For such an unbalance, the tracking system output is applied to a dc motor that rotates the turntable until a null position is attained. This keeps the transmitter pointed at the moving vehicle antenna. To reject background noise a narrowband interference filter is employed in the tracking receiver.

To make capture and control of the moving vehicle easy, the laser beam is spread to a 15-inch diameter at the parabocone antenna location. Spreading is accomplished by using a negative lens at the transmitter aperture.

The controlled vehicle station consists of the parabocone, a solid-state detector, a demodulator and switching circuits.

The parabocone collects energy from all directions. The upper support is designed for minimum obscuration, while the lower cylindrical section houses the electronics and also acts as a background-noise shield.

The laser signal from the detector is amplified and fed to the demodulator, which consists of circuits tuned to the individual (five) command functions. When a voltage appears across one of the tuned circuits a field-effect transistor energizes a switching circuit related to that particular command frequency.

The switching circuits control the rotation of the two dc motors that propel the vehicle. A high degree of maneuverability is obtained because both right and left motors may be commanded backward and forward simultaneously.

The system is fail-safe because the presence of a subcarrier is necessary to provide the driving function. Obstruction of the beam or loss of tracking halts the vehicle.

Tracking response of the system is measured by positioning the parabocone Scotchlite area in the center of the laser beam, 45 feet from the transmitter and adjusting the tracker output to zero. The retroflector is then moved laterally until the tracker follows. In the prototype equipment a dead-zone of ± 1.25 minutes of arc was found, that was due to relatively high friction in the prototype turntable. ■■

Mars Photo process finding earth uses

A digital image processing and comparison technique, used to process transmitted images of the surface of Mars, is expected to find eventual application in aerial reconnaissance and topographic mapping.

Developed by Dr. Lynn H. Quam of the Stanford University Artificial Intelligence Laboratory, Palo Alto, Calif., the technique was designed to process the images transmitted by Mariner 9 during its orbits of Mars last year. By processing two overlapping pictures of the same object and normalizing the images to remove the perspective effects of different camera angles and lighting, it is possible to digitally subtract one image from the other. Thus, it is possible to compare pictures of the same feature regardless of when they were taken and under different camera and lighting conditions.

The digitized pictures from Mariner 9 were submitted to the laboratory in the form of magnetic tapes which contained more than 50,000 elements per picture. Each element consisted of a 9-bit word showing 512 possible gray shades. Each photographic frame consisted of an 832-by-700 element array. The information from up to 500 individual frames was stored in two IBM 3330 disc packs. The actual image processing and comparison was done with a PDP-10 computer.

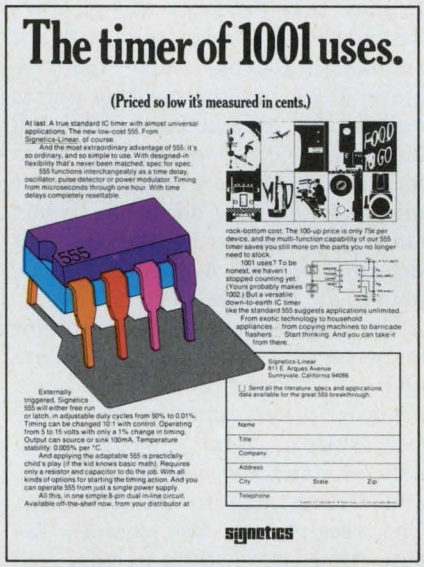
A display is then generated showing all the frames that cover a desired area. Two frames are selected that give the best coverage. By using information about the position of the camera in relation to the surface the computer transforms both pictures to a common scale, as though the two pictures were taken from the same distance and position. Because of uncertainties in the camera-pointing information, the two images must then be brought into registration. This is done by breaking the picture up into 25-by-25 element areas, correlating the required displacements of each element and finally distorting one picture to make it match the other. Finally, one picture is subtracted from the other, leaving only the picture elements which are different.

The new technique makes several important contributions to picture processing technology. It permits accurate geometric registration of two images. Similar techniques have been used in character recognition experiments, but they have never been used to align two complex pictures. Also, normalizing the image illumination permits pictures to be compared without the confusion caused by different lighting levels.

Although the technique was devised for astronomical purposes, Dr. Quam is currently experimenting with other possibilities.

"By matching the areas of two parallax views of a scene, the depth of points in the scene can be located rapidly, practically in real time," according to Quam. This means that by comparing two aerial pictures of an area, the map contours can be generated automatically—and accurately, important for military applications. ■■

556: A real IC two-timer.



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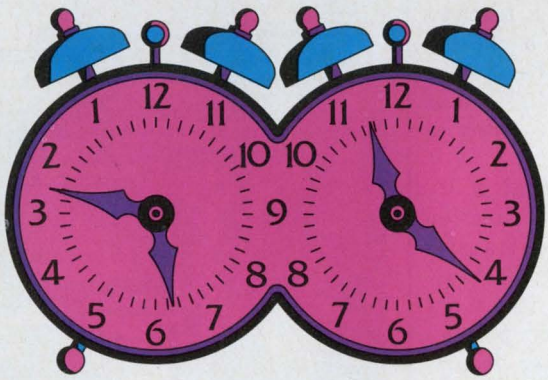
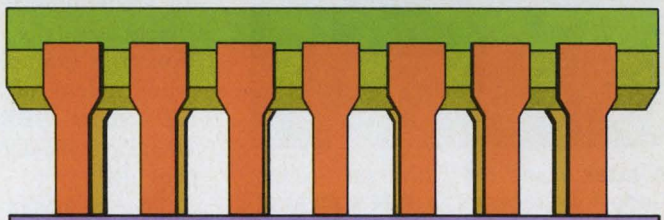
No sweat on power, either. Anywhere from 5 to 15 volts does the job, with only 1% maximum timing change from bottom to top. And what you get out will source or sink 100mA. Temperature stability is instrumentation grade, 0.005%/°C.

Intrigued? Curious? Want to try one for yourself? For our own amazement, send us any application diagram you can think up for the 556 dual timer. We'll reward you with a FREE sample to tinker with. In timely fashion.





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INFORMATION RETRIEVAL NUMBER 22

Laser point-of-sale system speeds checkout

Do you sometimes get nervous watching the checker ring up your grocery bill in the supermarket? Didn't she hold down 79¢ *five* times instead of *four?*

IBM has developed a point-of-sale system that will let a laser do the job without making mistakes—and do it faster than a clerk ever could.

Using a fast, two-handed motion, a single clerk can both check an item—by pulling it across a 6.5-inch scanning window—and bag it at the same time. No special alignment of the code is necessary. The checker merely holds it face down, and the code can be read on items moving as fast as 100 inches per second.

A laser scans the Universal Product Code for groceries in IBM's point-of-sale system for supermarkets.

Called the IBM 3660, the supermarket system consists of a terminal that is equipped with its own buffered storage where scanned or keyed data are entered and checked for accuracy before transmittal to the store controller. When a message is received at the terminal, it is edited and transferred to the unit's display and printer.

Terminal adapters are available for the attachment of electronic scales and dispensers at the checkstand. A high degree of accuracy results when produce and meat are weighed, and when change and trading stamps are issued to customers.

The terminal uses a two-station printer that produces the system's descriptive customer receipt and a summary journal tape for the store. Each printer position prints up to 30 characters with full alphanumeric capability. The journal tape is printed at 50 lines per minute; and the document insert station, which can be used to print information on customer checks, prints at 35 lines per minute.

The comprehensive sales receipt is printed at 80 lines per minute and can contain each item's name or description, number, price and tax status, total amount due, amount tendered and the change and stamps due to the customer. The receipt can also contain the date, time, checkstand number and a promotional statement customized for each store.

A character-display panel shows an alphanumeric message up to 22 characters long. During a transaction, for example, when a checker scans a loaf of bread, the display will show "BREAD .42"; thus visual verification of the entry is provided.

The keyboard consists of a 10-key numeric pad and 25 function keys. These keys are for transactions in which the checker must enter information about items not marked with the grocery product code—for example, item or department number, price, quantity or weight—as well as when the checker must issue a refund, handle a check, food stamps or coupons.

A system that includes a terminal station and a terminal control unit can be bought for $5800. The terminal station alone costs $2700. The scanner will cost $4000. First shipments are scheduled to begin in the third quarter of 1974. ■■

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For full details on the NAKED MINI/LSI (or its stand-alone counterpart, ALPHA/LSI), write Computer Automation, Inc., 18651 Von Karman, Irvine, Calif. 92664. Or call: (714) 833-8830. TWX 910-595-1767.

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INFORMATION RETRIEVAL NUMBER 24

LEDs check transient response of sensors

The light output from a LED array is used in a new test system for measuring the transient response of sensors such as charge-coupled devices, and television camera tubes.

The fast response of the LEDs —in the order of a few nanoseconds—allows a single horizontal line of a TV tube to be checked, according to James M. Moore, system designer. In the test setup, the camera is focused on the output of the LED array.

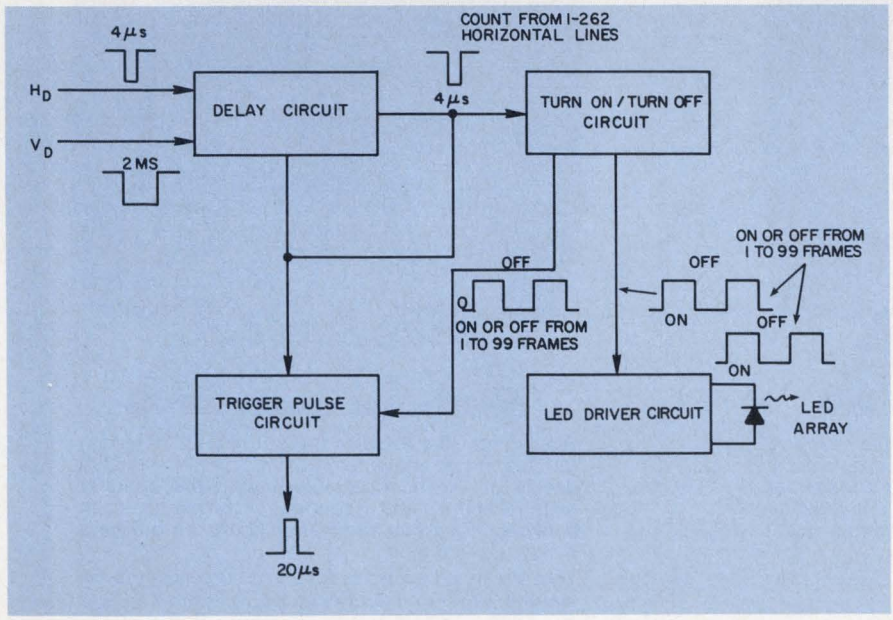
Developed at the Naval Air Development Center, Warminster, Pa., the system is used to check the transient response, or lag, of TV tubes, which has an important effect on the dynamic resolution and image quality.

Previous equipment built for this purpose has been cumbersome and somewhat unreliable, says Moore. Such data, he notes, is normally obtained from the video waveform displayed on an oscilloscope and covers one or more fields at a time. The accuracy of this data is limited by distortion of the waveform due to preamplifier noise, 60-Hz hum and shading and shifting of the clamping levels.

Several desirable features are incorporated in the new equipment:

- The on and off periods of the LEDs are independently adjustable. Long periods are provided to check for tube hysteresis and overload recovery.
- A method of measuring lag as a function of position on the raster is incorporated.
- Special triggering signals are generated to provide stable, repetitive waveforms on the oscilloscope. A triggering function is included that permits the selection of any single line for viewing, thereby obtaining a high degree of accuracy in measuring the data.
- A means for presenting the total buildup and decay lag is designed into the equipment.
- The driving pulses for the LEDs are adjustable in magnitude to permit measuring tube output levels over the operating range of the tube.

A delay circuit provides the main timing pulses for the unit. A vertical sweep drive input initiates a gate that allows programmable counters to count the number of horizontal drive pulses. ■■



Horizontal and vertical drive signals control the circuits of the tester for measuring lag in TV camera tubes and other image devices. The output of a LED array is pulsed to provide a fast light source for the camera.

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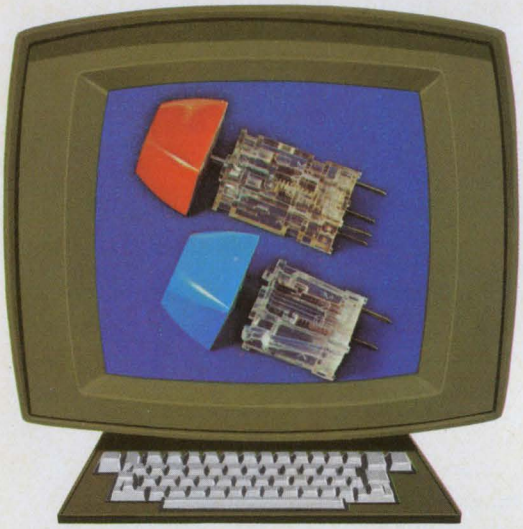

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INFORMATION RETRIEVAL NUMBER 25

Energy meter improves aircraft performance

A new type of electronic aircraft instrument called an energy meter has been developed for use in high-performance aircraft. The instrument promises to substantially improve a pilot's flight efficiency and aircraft performance.

Developed by Honeywell, Inc., Minneapolis, Minn., the device provides the pilot with new parameters that have not been directly monitored before in flight operations. These parameters are: the potential energy of the aircraft due to its height above ground, and the rate at which the aircraft's potential energy is being exchanged with kinetic energy during climbs, dives or turns.

Use of this meter permits the pilot to rapidly and accurately set up optimum flight conditions for a variety of maneuvers, including:

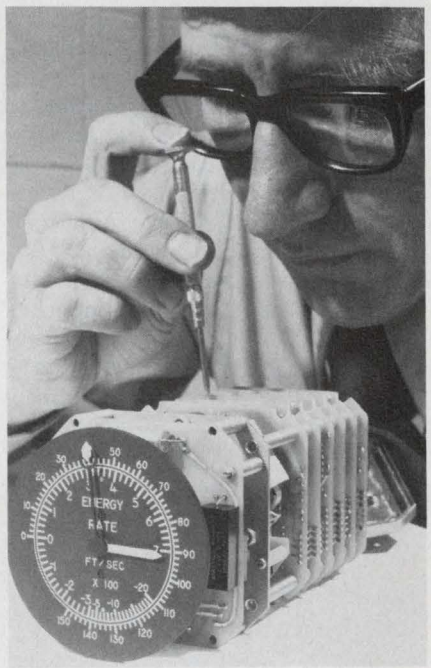
- A minimum-time climb to a given altitude.
- A minimum use of fuel during a climb or during a mission.
- A minimum loss of energy during turns.

The meter is packaged in a standard 3-1/8-inch panel-instrument case and is solid state, according to Nelson R. Zagalsky, project program manager. Both thick and thin-film circuits were investigated, but lowest cost and minimum design time was provided with the thick-film circuitry.

Nine printed-circuit cards plus two needle-driving servos are combined in the instrument, Zagalsky explains.

Two energies are computed and displayed in the energy meter: specific total energy (outside scale) and the rate of energy exchange (inner scale). The dynamic ranges of the scales were selected by analysis and simulation in F-4J aircraft.

The dial and servo assembly use three of the nine PC cards consisting of an unregulated power supply, a transformer and motor mounting plate and an interconnect card. The latter mates with the first of a series of six PC cards containing the analog computer circuits. These cards include the following: dc inverter supply and voltage regulators for positive and negative supplies; true-airspeed squaring circuit and instrument servo drivers; energy rate computation, including angle of attack sine and cosine function generation; angle of attack and altitude interfaces; and true airspeed and accelerometer interfaces.



Adjustments are being made to Honeywell energy meter by Nelson Zagalsky, program manager of instrument development.

There is some initial concern regarding the signal-to-noise ratios that could be expected in the accelerometer outputs. But the initial flight test results indicated that additional filtering was not needed and also verified the suitability of equations.

The initial investigation of the energy meter concept was funded by Honeywell's Internal Investment Program for the development of new ideas. ■■

Ten-year chemical battery could power future heart pacemakers

The answer to the problem of providing a long-life power source for heart pacemakers lies in the chemical battery and not in nuclear power or even rechargeable cells.

This is the finding of Arthur M. Bueche, vice president for research and development at the General Electric Research and Development Center in Syracuse, N.Y.

The most promising answer to this old and vital problem, he says, is a sodium-bromine battery the company is developing that will operate continuously for 10 years. The battery is already being tested by GE in animals and will ultimately be implanted in humans.

Besides lasting as long as nuclear batteries do, and without the hazard associated with radioactivity, the chemical battery is expected to be "a fraction of the cost of nuclear pacemakers, which are now estimated to be $4800," GE says.

The sodium-bromine battery is only half the size and a quarter the weight of mercury-zinc chemical cells now used to power conventional pacemakers, which have to be replaced every 24 to 36 months. In addition its voltage (3.6 V) is nearly three times that developed by mercury-zinc cells.

The sodium-bromine battery is the size of five stacked fifty-cent pieces (1.25 inches in diameter and 3/8 inch high), and weighs about one ounce. It consists of a bromine cathode, a sodium-amalgam anode, and a beta alumina ceramic electrolyte.

Unlike the liquid electrolyte in conventional batteries, the solid ceramic membrane prevents the growth of metal dendrites and thus prevents contact between the reactive materials. This eliminates the self-discharge and cell shorting that reduces the life of today's chemical batteries.

Sodium-bromine battery for heart pacemakers has a life expectancy of 10 years, equivalent to that predicted for nuclear sources.

Ceramic membrane a key feature

The solid ceramic membrane, which is only 2 mm thick (0.008 inch), is a key factor in the battery design, according to one of the developers, Fritz G. Will. Besides preventing shorts, the membrane prevents the formation of gas found in liquid electrolytes. Another advantage is that shelf life is virtually unlimited.

When the sodium-bromine battery is used in a heart pacemaker, sodium ions travel through the ceramic electrolyte and react with the bromine, forming sodium bromide salt. The anode transmits electrons to the pacemaker, producing electrical impulses which are delivered to the heart by wires forcing the heart to contract.

The new cell can store as much as 170 watt-hours of energy per pound, or 15 watt-hours per cubic inch. By comparison, the energy density of a mercury-zinc battery is about 8 watt-hours per cubic inch, and the nickel cadmium battery—being developed by at least two organizations as rechargeable batteries—can store 1 watt-hour per cubic inch.

An estimated 50,000 to 60,000 people in the United States use conventional battery-powered pacemakers, with some 25,000 more expected to receive them annually. Conventional devices sell for about $1000 to $1500 including the required mercury-zinc battery.

Meanwhile, GE has also announced a new pulse generator—a ventricular inhibited pacemaker, called the Sentry 75, which uses an improved mercury-zinc battery. The battery life has been lengthened from two years to five. ■■

Plug this High-Speed Digital Cassette Tiger into your punched tape system

New Remex Punched Tape Emulator boosts speed four times, storage capacity ten times!

Fully interchangeable with punched tape units, this new P.T.E. digital cassette system now offers added speed, capacity and convenience, with absolutely no change in interface equipment or software programming. It can turn any punched tape system into a digital tiger!

The Remex P.T.E. offers simultaneous read/write capability in a two-drive system, with completely asynchronous operation from 0 to 300 cps. Storage capacity is 1.6 million bits per cassette, the equivalent of ten 130-foot punched tapes.

Built-in microprocessor adds flexibility. A microprocessor functions as a small computer in the control logic. This permits program stacking with a dial-in automatic file search, TTY or RS-232-C capability and internal automatic tape duplication. It also offers off-line capabilities, allowing key-to-cassette, cassette-to-printer, and punched tape-to-cassette operation.

Reliability plus convenience. The Remex P.T.E. assures high data reliability, with less than one error per 10^8 bits. Designed to the new proposed ANSI and ECMA standards, it can be used with minicomputers, data communications terminals, NC, communications and test equipment to enhance the performance of a data system. Automatic tape rewind before unload assures maximum data protection.

For details on performance and low price of this new Punched Tape Emulator, contact REMEX, 1733 Alton St., Santa Ana, Calif. 92705. Call (714) 557-6860. In Europe, contact S.P.A. Microtecnica, Torino, Italy.

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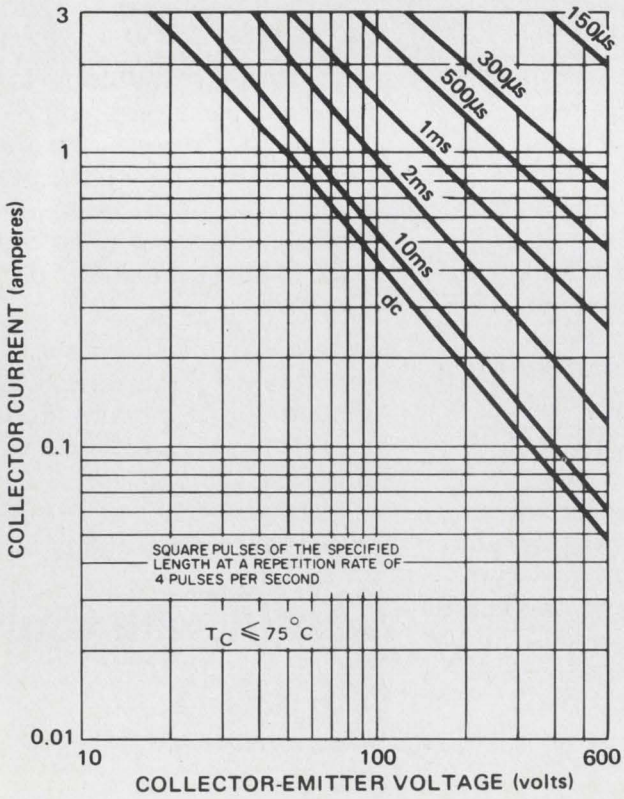

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INFORMATION RETRIEVAL NUMBER 28

washington report

Heather M. David
Washington Bureau

Mideast war may block defense cuts

As the U.S.-Soviet detente strains under pressure of the Mideast war, there is less talk on Capitol Hill of massive cuts of the defense budget by the Appropriations Committees. The committees are getting ready to act on the appropriations bill now that the conferees of the House and Senate Armed Service Committees have reported a military authorization bill totalling $21,299,520,000 covering procurement and R&D funding. The bill includes almost the full funding requested by the Defense Dept. for the F-14 ($693.1-million) and F-15 ($918.5-million) fighter aircraft program.

The conferees voted to cut the $8.5-billion R&D budget by $363-million. As part of that funding they voted $13.5-million for a start on a reoriented, three-service strategic cruise missile program. This would permit development of components and subsystems, including terrain contour-matching guidance.

The conferees also approved $135-million for a prototype antiballistic missile system for Minuteman sites and $5-million for improvements on the Maverick air-to-ground missile. Of the missile money $3-million is to be spent to adapt for Maverick the laser seeker developed for the Bulldog missile and $2-million for further improvements on Maverick's TV guidance system. Maverick will have two distinct guidance systems.

B-1 employment protected by Congress

Congress has voted special protection against the firing of Rockwell International employees who are working on the B-1 bomber program. The brunt of a $25-million reduction that Congress made in the B-1 program, therefore, will be borne by electronics contractors and subcontractors. The bill stipulated that the reduction be achieved partly by a delay in the award of a contract for defensive avionics and partly by a reduction in the effort on offensive electronics.

White House organizes Federal communications

Industry should get some beneficial fallout in the form of better design and market planning information in the Government communications field as a result of a plan by the White House Office of Telecommunications Policy to tighten the management of Government communications systems.

The plan calls for long-range planning (annual and five-year programs) and for management of specific functions by experts in the field. For

example, the Defense Dept. has responsibility for the national security of all Government communications systems. Transportation involved in Government communications will be the responsibility of the Transportation Dept., and environment, that of the Dept. of Commerce, law enforcement by the Justice Dept., and Government administrative communications by the General Services Administration.

OTP hopes that supervision by categories by agencies with experience in the particular field will eventually trim 20% from the annual $6-billion spent for Government communications.

Air Force looking for cheap missile

The Air Force plans to develop a new dog-fight air-to-air missile, guidance system unspecified. One thing the Air Force does specify, however, is that it will be cheap, the exact figure to be in black and white in the design contract. The contractor who wins the award will design, develop, fabricate and flight test 30 missiles—extensively—before the service will consider production.

Capital Capsules: The Defense Dept. is proposing an amendment to the Armed Service Procurement Regulations **to protect contractors who use software developed at company expense** in a subsequent Government contract. The proposed regulation recognizes that software is "much more easily duplicated than hardware" and present rules do not afford adequate protection to contractors. . . . Fairchild Industries vice president Dr. Wernher von Braun told the Senate Space Committee that **NASA's move out of the communications satellite field was a bad one.** This, he said, could "give the game back to the established monopolies, who, in view of their vast investments in old fashioned wire communications, never had much of an incentive to explore the satellite potential in the first place". . . . The National Science Foundation has awarded **three contracts to industry/university teams to explore the feasibility of using solar energy to heat,** cool and provide hot water for buildings. Winners are General Electric/University of Pennsylvania; TRW, Inc./Arizona State; Westinghouse Electric/Colorado State University/Carnegie-Mellon University. . . . The Senate Aeronautical and Space Sciences Committee has published a **199-page booklet entitled "Toward a Better Tomorrow With Aeronautical and Space Technology."** It describes applications and potential achievements for technology developed by NASA. The booklet is available from the committee, Room 231, Russell Senate Office Building, Washington, D.C. 20515. . . . Another useful publication available is a **"Printer on Government Contract Claims,"** by the Senate Small Business Committee. The aim is to aid small-business contractors, who accounted for $12.5-billion in Government procurement in 1972. Copies are available from the committee, Room 424, Russell Senate Office Building, Washington, D.C. 20515. . . . The U.S. Postal Service has asked seven companies to bid on a contract for development of **a five-year master plan for using information systems technology throughout the Postal Service.** Other requests for proposals have gone to IBM, Holmes and Narver, Inc., and Computer Sciences for a systems analysis of the National Bulk Mail System now being installed in 33 centers. . . . The Defense Dept. has asked Congress for **$5.5-million for engineering development of two over-the-horizon backscatter radars**—one in Maine facing east and one in the state of Washington facing west. They will be used for aircraft detection.

an unbeatable combination... 350 MHz and 1ns/div in a portable!

Dual trace, 350 MHz bandpass, high writing speed, 5 mV/div to full bandwidth and 1 ns/div sweep together with many operator conveniences assure fast accurate high-speed oscilloscope measurements. This combination is now available in a portable—the 485 from Tektronix. It weighs just 24 pounds, allowing you to move it in the lab and shop, or you easily take it with you on installation and repair jobs.

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BONUS FEATURES

Some of the operator conveniences are: A-external trigger view, delayed sweep, automatic scale factor readout, horizontal sweep switching, A-trigger hold-off, bandwidth limit, beam finder, frequency selectable fast-rise calibrator, automatic focus, and battery operation with the TEKTRONIX 1105.

Full realization of these many ease-of-operation features can only be gained through actual hands-on experience. Your local Tektronix field engineer has a 485. Call him for a personal demonstration.

If you'd like additional literature, write Tektronix, Inc., P.O. Box 500, Beaverton, Oregon 97005. In Europe, write Tektronix Ltd., P.O. Box 36, St. Peter Port, Guernsey, C.I., U.K.

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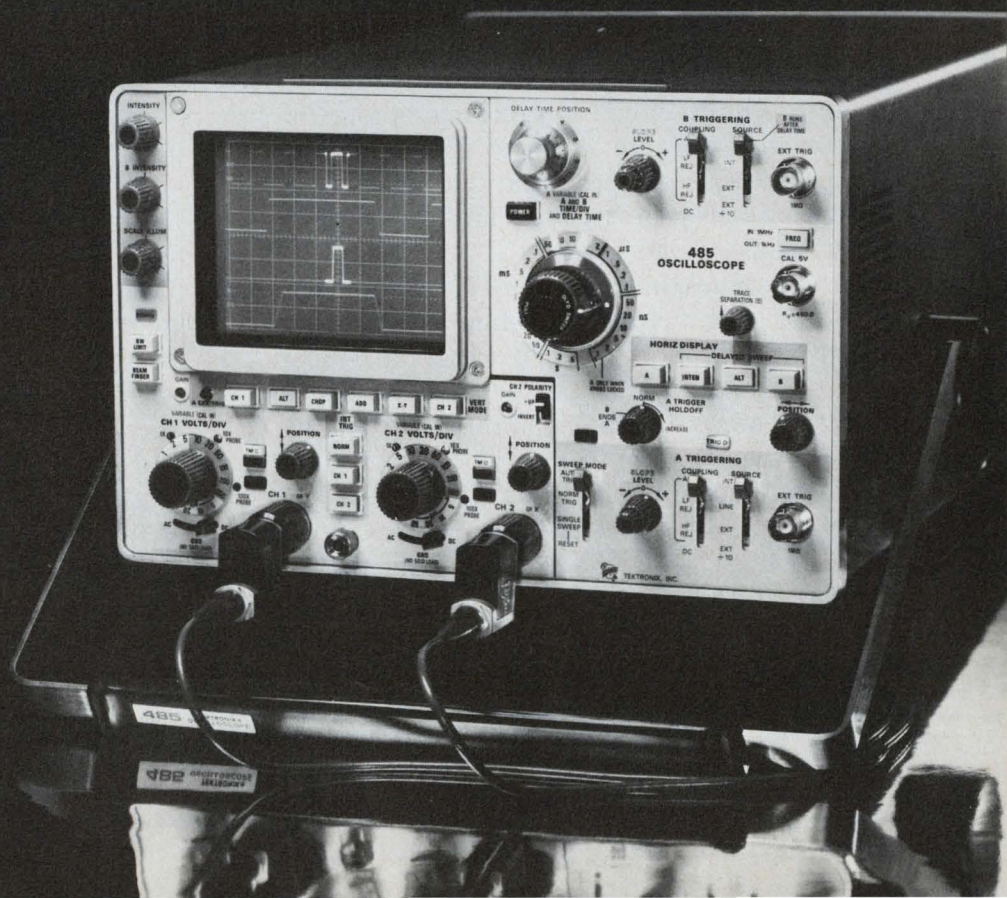
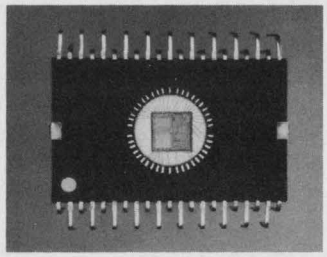


Our microelectronic business has grown in two directions.



So now we have two divisions:

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If you need help in designing or building microelectronic circuits for your product, read here. We've formed a separate division with separate engineering staff to serve you.

Our product line now includes a family of powerful one-chip calculator and slide rule circuits, a multi-circuit four-bit microprocessor system with software for microprogramming by equipment manufacturers and telephone frequency tone generation circuits—all at more-functions-per-dollar prices.

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Rockwell International

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INFORMATION RETRIEVAL NUMBER 30

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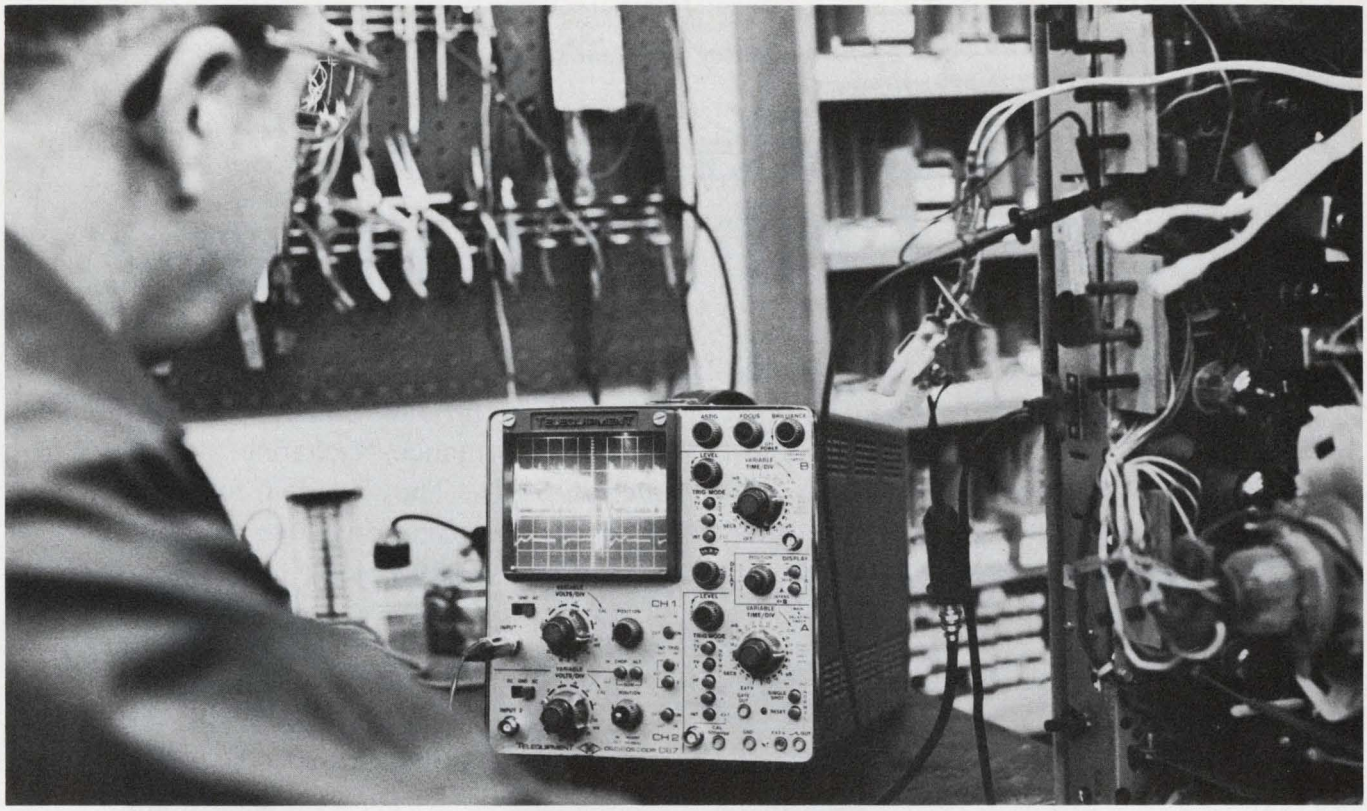
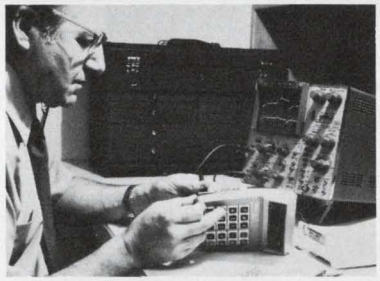


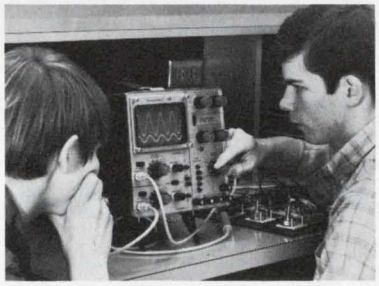
The D67 ends troubleshooting guesswork in complex TV and audio circuits—at a low price.

TV and audio equipment servicing is outdistancing the capabilities of older test instruments. Also, greater use of electronics in consumer products (pocket calculators, microwave ovens, digital clocks, home intruder alarms, etc.) is opening up new service opportunities. Telequipment offers you the high performance you need in a low-cost scope for this new service business.

The D67 combines dual-trace, delayed sweep, and 25 MHz bandwidth, at a very low price. Non-delayed sweep scopes just can't compete with the D67's delayed sweep measurement flexibility. It allows quick, accurate troubleshooting of IF tuning and color bandpass problems. You can also see fast circuit conditions after relatively long time delays.



If you don't require delayed sweep but need dual trace at 25 MHz, here's another economical, quality scope—the D66. Troubleshooting consumer digital products such as mini-calculators is made easier by using dual trace. Also a "SUM" mode with normal-invert capability makes it possible to look at small signals in the presence of common mode noise—such as power supply hum.



This simple to use, dual trace, 10 MHz D54 gives you low-cost, dependable performance in a wide variety of applications. Like all Telequipment scopes, it is light weight, easy to carry and is backed by Tektronix' warranty and reputation for quality. Students shown are testing amplifier circuit by measuring the gain between input and output signals.

Dual-trace waveforms displayed on a bright CRT are essential for servicing TV and high quality audio systems, where time and phase relationships between signals are critical. Whatever the consumer's electronic service problem, 25 MHz is probably all the bandwidth you will need.

Telequipment products are marketed and supported in the U.S. through the Tektronix network of 52 Field Offices and 35 Service Centers. Telequipment prices range from $245 to $1495. For a Telequipment catalog, and a reprint of the ET/D review of the D67, write: Tektronix, Inc., Box 500, Beaverton, Oregon 97005

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TELEQUIPMENT

INFORMATION RETRIEVAL NUMBER 31
FOR DEMONSTRATION, CIRCLE 162

Meet our new series of
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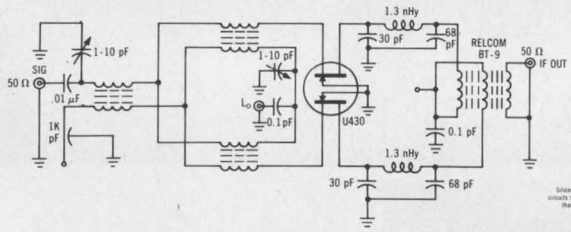
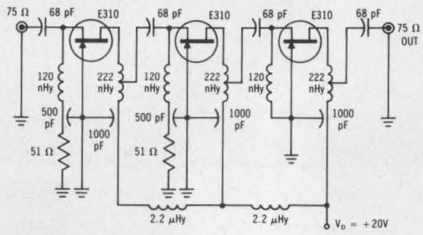
High-Performance VHF/UHF FET Family

Remember the U310? Some people call it the SuperFET. We introduced it a year ago: worst-case 75Ω input match VSWR of 1.25:1. Figure of merit 2.35×10^9 typical. Third order intercept point of +29 dBm.

Now we've extended the U310 technology to produce an entire family of high-performance N-channel junction FETs. They're ideal for VHF/UHF applications such as the two circuits shown below:



Single-balanced active mixer — 100 dB dynamic range, +2.5 dB conversion gain, +32 dBm intercept point, 50-250 MHz.



Wideband amplifier — 225 MHz center frequency, 1 dB bandwidth of 50 MHz, 24 dB gain.

U310 family characteristics include:

- High power gain (common gate)— 16 dB at 100 MHz, 11 dB at 450 MHz.
- Noise figure = 3 dB typical at 450 MHz.
- High transconductance = 10,000 to 20,000 μmhos.

Select the right FET for your application from this array:

Type	Package	Feature	Applications	Price (1K units)
E308	Epoxy TO-106	$V_P = -1.0$ to -6.0 V, $I_{DSS} = 12$ to 60 mA	High-frequency, small signal VHF or UHF source followers, amplifiers, mixers, or oscillators	$ 0.57
U308	Metal TO-52			$ 3.70
E309	Epoxy TO-106	$V_P = -1.0$ to -4.0 V, $I_{DSS} = 12$ to 30 mA		$ 0.75
U309	Metal TO-52			$ 4.45
E310	Epoxy TO-106	$V_P = -2.0$ to -6.0 V, $I_{DSS} = 24$ to 60 mA		$ 0.75
U310	Metal TO-52			$ 4.45
U310 family dual FETs have V_P, I_{DSS}, and g_{fs} parameters matched to 10%. Packages designed for easy insertion into printed circuit boards.				
E430 Dual	Epoxy Si-105	$V_P = -1.0$ to -4.0 V, $I_{DSS} = 12$ to 30 mA, $g_{fs} = 10$ to 20 mmho	VHF/UHF balanced mixers and cascode amplifiers	$ 1.70
U430 Dual	Metal TO-99			$ 9.95
E431 Dual	Epoxy Si-105	$V_P = -2.0$ to -6.0 V, $I_{DSS} = 24$ to 60 mA, $g_{fs} = 10$ to 20 mmho		$ 1.70
U431 Dual	Metal TO-99			$ 9.95

Get the complete story on this advanced high-frequency FET family.
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editorial

Can designers be goaded to innovate? Let's try it

The National Bureau of Standards is about to conduct an unusual experimental program that could have far-reaching effects on the electronics industry. The objective is to spur the pace of technological innovation.

Under the Experimental Technology Incentive Program, the bureau—in conjunction with industry—will issue periodically specifications on consumer products to stimulate companies to introduce product innovations. These specs will not be forced on industry. Instead, the Government—particularly the General Services Administration—hopes to use them to set bidding standards for its equipment purchases. In this way, instead of providing seed money to industry for product development, the Government hopes that the GSA's $2-billion annual purchasing budget will stimulate manufacturers to innovate. It is also hoped that these improvements will gradually move into the consumer marketplace as well as the export market, thereby helping the balance of payments.

Sometime this month the NBS Institute for Applied Technology, which is overseeing the new program, will release the first series of production specs on air-conditioners and power mowers. The specs will ask that the energy-efficiency ratio for air-conditioners be raised from seven times the cooling power per watt to 11 times. They will also ask that the power-mower noise level be reduced from 72 to 62 decibels. Government scientists believe that both goals are technically feasible in the industry today.

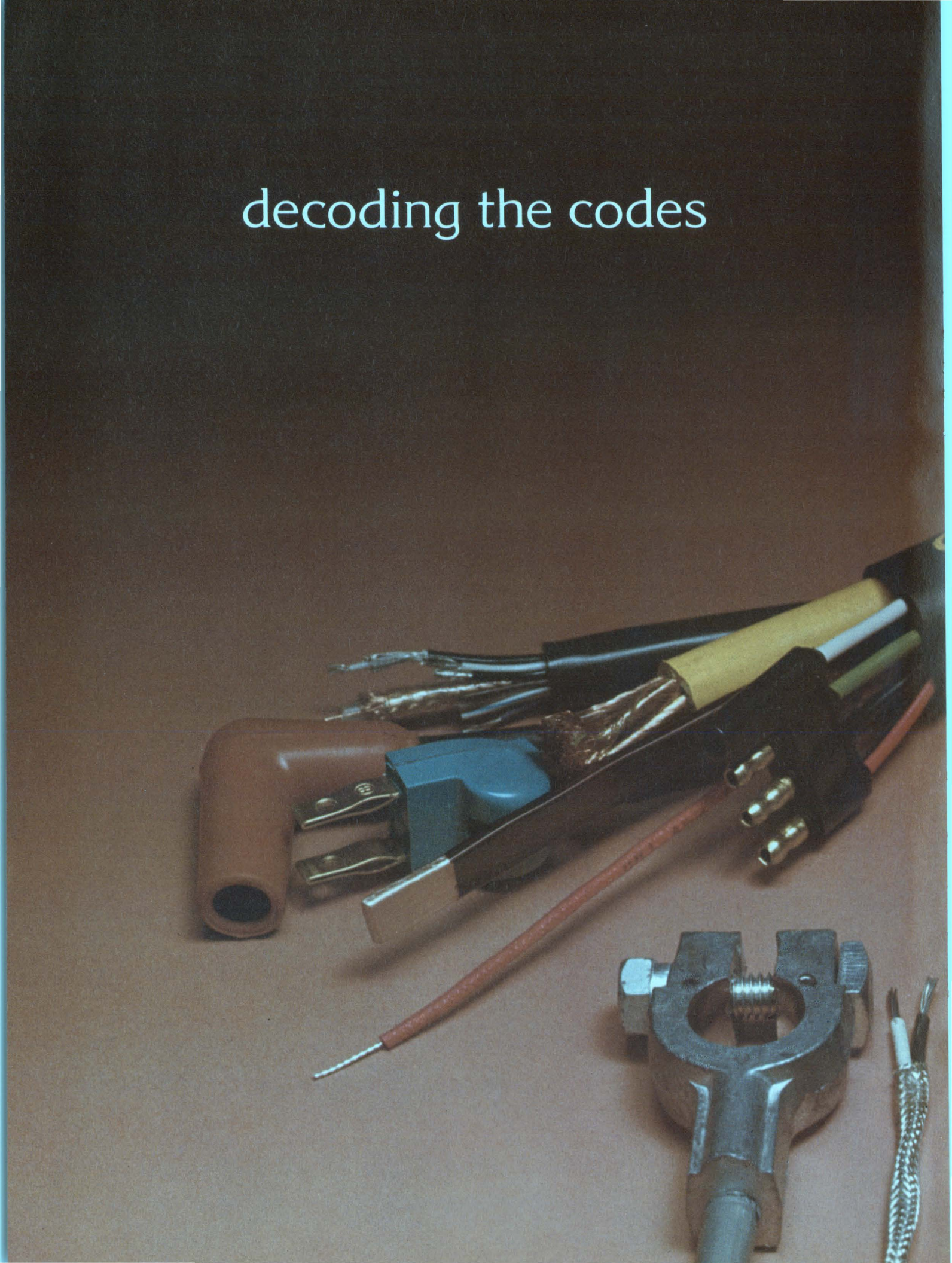
Manufacturers and Government officials have some valid fears about the program: Will the innovations make the products too expensive and thereby noncompetitive? Will the specs be so tight that one company could become the sole source of supply to the Government? How can the technical requirements be set so that equal competition is maintained among companies?

Since the program is still experimental, the real answers to questions like these may not be clear for three or four years. Meanwhile why anticipate abuses? Although we don't believe it's possible to legislate innovation, we do applaud the Government's attempt to speed technological improvements. In the long run we'll all benefit, if it's done right. The designer will be challenged to come up with new ideas, the public will get a better product and industry will profit.

Ralph Dobriner

RALPH DOBRINER
Managing Editor

decoding the codes



With ever-changing technology and increasing demands for innovative products, more precise safety guidelines are a must.

Belden knows the codes, standards, requirements and limits of acceptability in the wide world of industrial wire, cable and cord. As supplier of thousands of standard items for electrical, electronic and automotive needs we can readily help you select the right product for the job. Belden products meet or exceed industry code needs. And we can custom design and manufacture complex cable configurations to meet the most demanding specifications. If a code is puzzling you, or you have an application where you're not sure what the standards are, check with Belden. We cope with codes every day.

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H-3-3

BELDEN

INFORMATION RETRIEVAL NUMBER 234

FOCUS on Power semiconductors

How do you know when to choose a power transistor and when to choose a thyristor? In many applications the choice is easy. For low power dc you usually choose transistors, while for very-high-power applications, thyristors are most commonly selected. There is, however, an increasing grey area between these two extremes where the newer high power transistors and Darlingtons are replacing thyristors. At the same time low-current thyristors are being used instead of power transistors in many applications.

Choosing between power transistors and thyristors is only part of the problem. Once you've decided on one, you must select a specific device to use. This is not always easy, especially if you rely heavily on the data sheets for help. They don't always give the full story of device capabilities, and often they are deceptive, misleading or ambiguous.

JEDEC devices have problems, too

Pay particular attention to devices registered by the Electronic Industries Association's Joint Electron Device Engineering Council (JEDEC). Such devices are assigned 2N numbers and must meet a JEDEC spec, but the specs don't always give enough information.

Since JEDEC is composed of representatives of the different semiconductor manufacturers and must be approved by them, its specs are necessarily broad. The result is that two transistors from different manufacturers can have the same number and quite different characteristics. One reason for this is that the manufacturing process is not specified.

And in the last few years, notes Herbert Roth, president of Power Designs, a power-supply manufacturer in Westbury, N.Y., semiconductor manufacturers have found a new game: Find a home for the overrun device. It is not unusual for a manufacturer to ship you, under the same part number, devices with chip size, geometry and electrical characteristics that are substantially different from those of the basic device. A good example is the 2N3055, one of the most widely used power transistors.

"It is common knowledge among semiconductor manufacturers," says Roth, "that the 2N3055 is the garbage dump for everything that falls off of every other line. It is not the least bit unusual to get chip sizes ranging from 65 mils to 240 mils."

Since f_t is always specified as a minimum and never as a maximum, it can vary so widely that devices with the same JEDEC number will have completely different high-frequency characteristics, even though they will be similar for low frequencies.

Differences in the device characteristics are related to the different processes used in production. The 2N3055 has been produced by at least three different methods; single-diffused, triple-diffused and epi-base.

The single-diffused technique was used on the original 2N3055 registered by RCA. It led to a rugged device with an excellent safe operating area—a measure of its power handling capability. Then a triple-diffused version came out, with a decreased safe operating area. An epi-base version followed, and while smaller and therefore cheaper than the two other versions, it had a different high-frequency characteristic.

Is anything being done about improving power-transistor spec sheets. Yes, but progress

Jules H. Gilder
Associate Editor

is slow. After the introduction of the 2N3055, RCA attempted to improve the device's JEDEC specs by adding a spec for safe operating area. But there was intense resistance from other manufacturers and the attempt to update the data sheets failed. For new devices, however, improvements are being made. Devices now being registered have spec sheets that are much better than those of the older devices. These devices, in the 2N5000 and 2N6000 series, have safe-operating-area specs, data for switching applications, fewer typical specs and more min/max.

If you must use the older, inadequately specified devices, evaluate your application and the devices thoroughly.

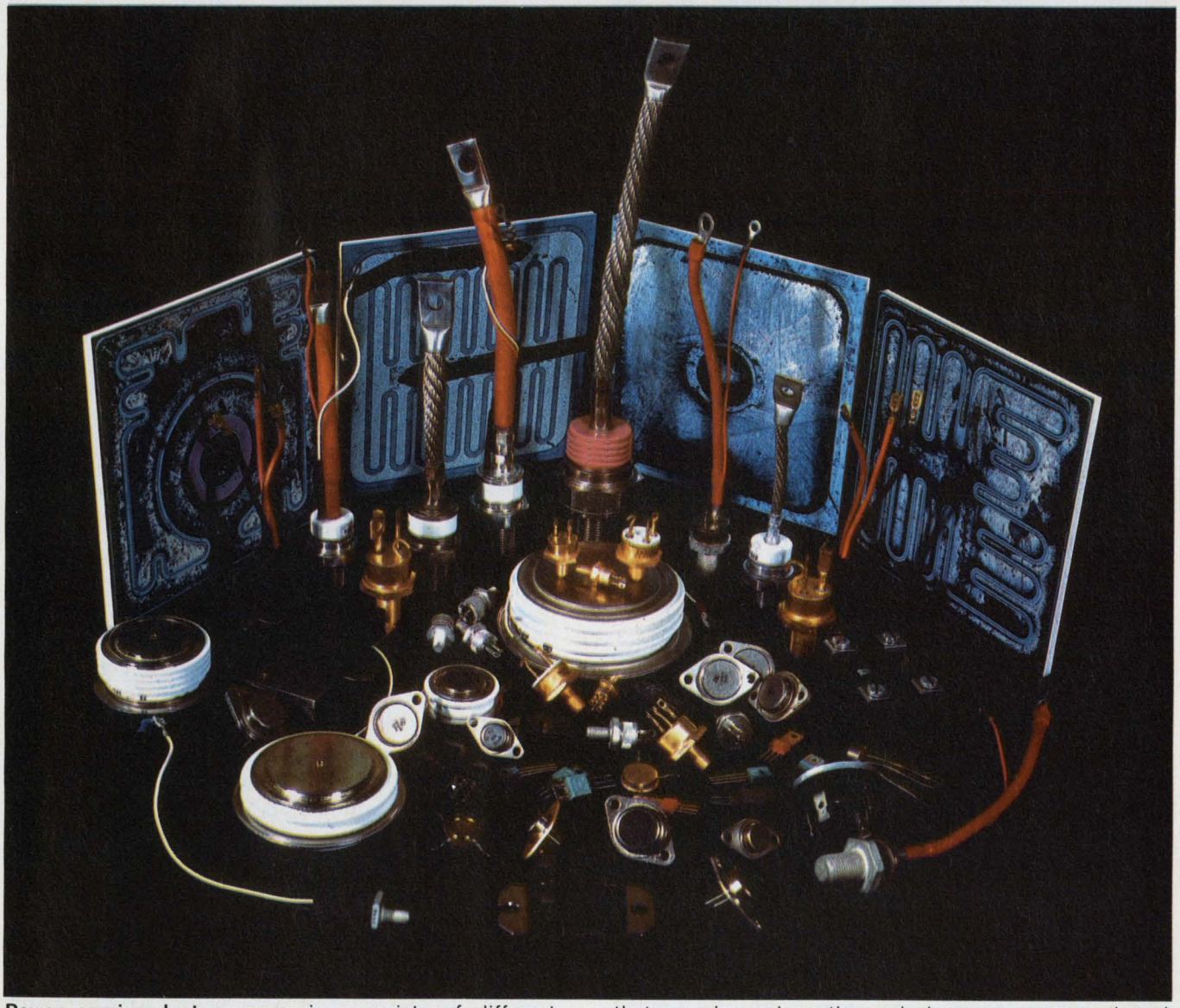
Look out for those deceptive specs!

Deceptive specs often found on power semiconductor data sheets include unrealistic operating conditions. For example, a current or power rating for a device is generally given at a case temperature of 25 C. This is an unrealistic rating; as one user put it, the only way you can hold the device at that temperature is to mount it on the side of a battleship in the Arctic Ocean.

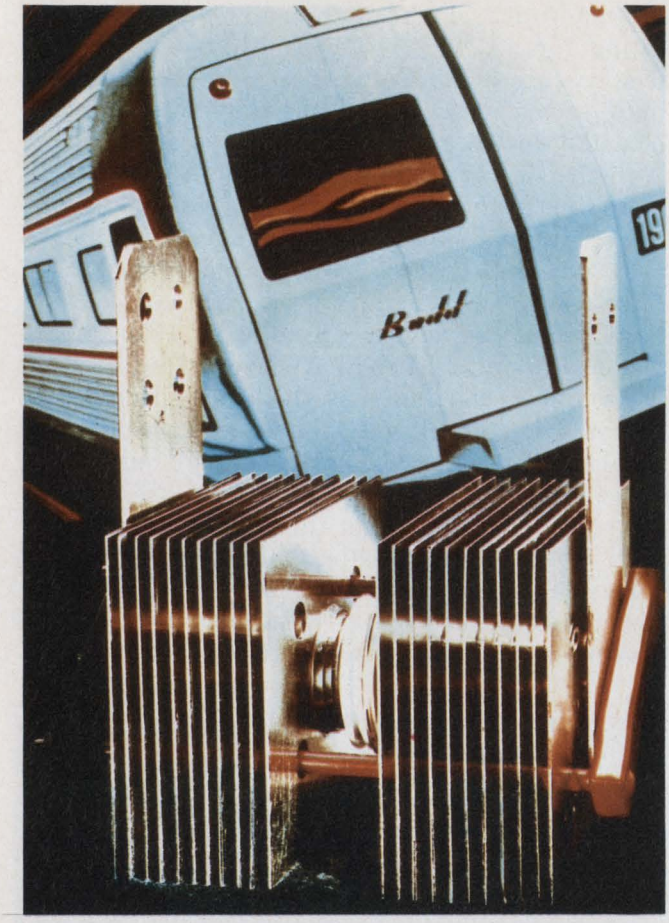
Adding to the problem of semiconductor-device power ratings is the practice of rating diodes and thyristors by both average and rms current. A so-called 1800-A rating for such a device is meaningless. A device can be rated 1800 A rms and have only a 1100-A average rating.

Assuming you know if the rating is average or rms, you've still got trouble. You will never be able to get the full rated current out of the device.

Engineers often forget that the maximum current, voltage and dissipation ratings may not correspond. Some manufacturers list these parameters separately, and when you multiply the maximum voltage drop by the maximum load



Power semiconductors come in a variety of different shapes and sizes. Selection of the right device requires that you know how these devices are processed and packaged as well as how they are going to be used.



High power thyristors, like this one from Westinghouse, are finding increasing use in transportation systems.

current, you may find that the maximum allowable dissipation has been exceeded. The solution is to do some cross-checking to find out the allowable load current.

Realizing that current ratings are confusing to the designer, at least one manufacturer, Power Semiconductors, Inc., of Devon, Conn., has added to the traditional average and rms ratings a third value—usable current. This tells the engineer how much current he can expect under typical conditions of ambient temperature, coolant flow, practical heat sinks, conduction angles, etc.

If you take a device with an average rating of 1100 A and an rms rating of 1800 A, you'll find that the usable current is only 450 A when forced-air cooling is used and the air is at 50 C. That's a far cry from 1800 A.

Another thing to watch out for is a spec that gives the operating current capability for an inverter device at a very low frequency—say, 60 Hz—while at the same time the device is advertised as operating at 5 to 10 kHz. The current looks terrific at low frequency, but wait until you get to the higher region.

An ambiguity found with many power semis is that devices are specified at current levels that require larger wire sizes than the device terminals can accommodate. For example, many devices are rated at currents that require a No. 8 wire or larger. The terminal eyelets, however, can only accept No. 12 or 14 wires.

Typical specs are anything but

Data sheets, particularly the older ones, contain typical parameter values in addition to some min/max values. The designer's assumption—and one that many manufacturers try to foster—is that "typical" means that a majority of devices in the shipment will approximate the typical value.

The assumption may be true at times for one of many specific parameters, but it is decidedly not true for all parameters all of the time. Typical values will fluctuate with the variation in the intrinsic characteristics of the raw silicon wafer, with the thickness and parallelism of the wafer, and with different diffusion runs—which themselves depend on temperature, gas density contamination level, cooling slope, etc. Another factor affecting typical values is that manufacturers screen out various device types from a single wafer diffusion. This causes a highly skewed distribution that will vary from one side of the norm to the other as different types are drawn from the over-all yield. It is for this reason that manufacturers do not guarantee that some specified percentage of the yield will be within, say, 10% of the so-called typical value.

It's unwise to design for volume production using typical values of power semiconductors without allowance for the *worst* worst-case conditions—minimum and maximum values at temperature extremes. There is a serious risk of receiving devices that meet the letter of the specification but do not function in the system.

Surface contamination can cause failures

Often unexplained device failures can be attributed to surface contamination. Most power semiconductors are made in open air instead of clean rooms, thus the junction is exposed to all sorts of dirt. Though manufacturers clean and passivate the chips, there is always the danger that passivation will seal in contaminants. The contaminants can degrade or even destroy the junction in time.

A controversy exists as to the affect, if any, of surface contamination. Vendors claim that while contamination often occurs, it is nondestructive. Some users, however, disagree.

One method suggested for detecting the presence of surface contamination in a power transistor is to test the device on a curve tracer and bring either the base-emitter or base-collector junction to the point of avalanche. At that point the junction is stressed to its maximum potential,

and any stray materials or contaminants will tend to ionize and form leakage paths, which will make the avalanche breakdown characteristic unstable, soft or even resistive.

Once the contaminated devices have been detected, it may be wise to store them for one to three years. Where contamination degrades the junction, one user—Roth of Power Designs—has found, it will destroy 20% of the junctions after the first year and 10 to 15% more in the second and third years. After storage, the devices should be inspected and the bad ones pulled out. Those that show no change can be used, the assumption being that if the junctions haven't degraded by then, they're okay.

What are the tradeoffs?

There are numerous tradeoffs an engineer must make when choosing a power semiconductor. Just how the tradeoffs are made depends on the application. One fundamental one is price vs performance. You cannot expect to pay 50 cents for a high-reliability power device with burn-in and data logging. Other economic tradeoffs include reliability vs cost and size and weight vs cost.

On the technical side there are more tradeoffs. Generally larger chips can handle higher maximum currents and provide greater pulse-power capability, but these are at the expense of larger capacitance and slower switching speeds.

For thyristors, there is a tradeoff between the current rating, the turn-off time and the blocking voltage. For example, if the turn-off time of a thyristor is reduced from 40 μs to 10 μs either the blocking voltage rating must be decreased from 1200 V to 600 V for the same current or the current rating must be substantially reduced to maintain the 1200-V blocking voltage.

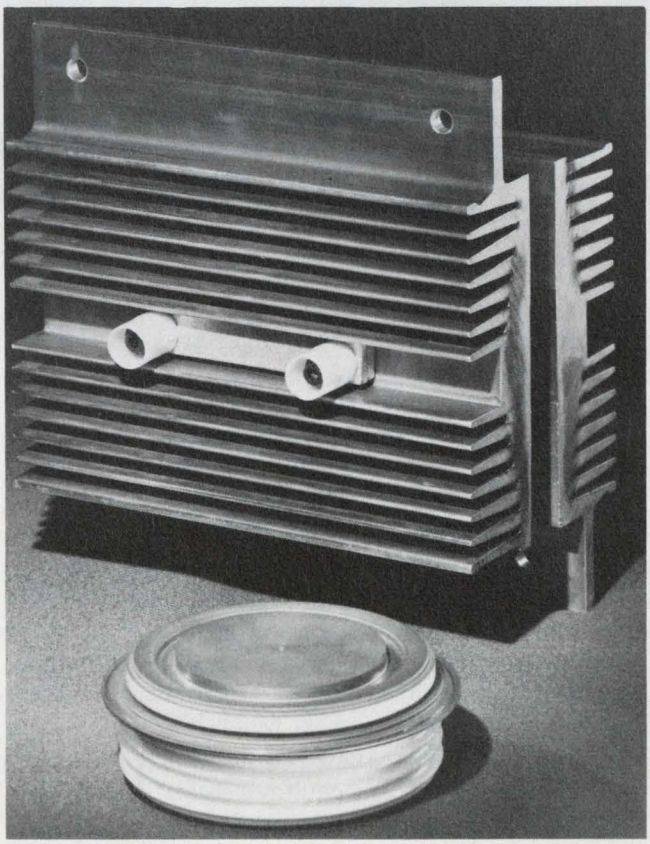
A tradeoff frequently encountered in high-power rectifiers involves junction temperature, current rating and the voltage rating. If the voltage rating is to be increased, the junction temperature must be derated and the current rating must decrease.

Power transistor vs thyristor

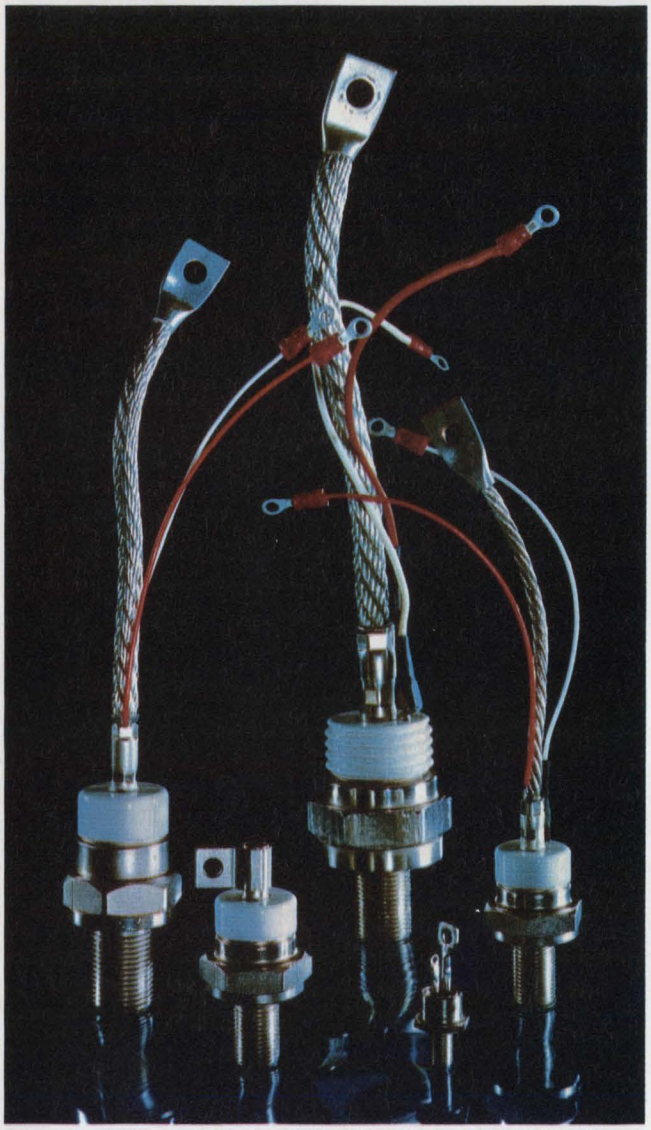
One of the big advantages of power transistors is that their switching characteristics are easy to control. Since transistor switching is controlled by base current, a transistor can be turned off simply by removal of its base current. Silicon-controlled rectifiers, on the other hand, require more complex circuitry to turn off the device.

Another advantage of the transistor is that it operates at much higher frequencies than the thyristor and thus can provide quieter operation, higher efficiency and lower output ripple. In ad-

Silicon power transistors from Unitrode come in a variety of current ratings ranging from 0.5 A to 20 A.



Disc packages, like the one used for Power Semiconductors' 6000-A diode, permit double-sided cooling.



Thyristors that operate at 25 kHz and at a di/dt as high as 2000 A/μs, are the result of recent advances in technology.

dition transistors have superior operating temperatures and, unlike thyristors, are not subject to accidental turn-on by a high dv/dt.

Power transistors are the best choice for dc circuits that require precise control, for self-oscillating low-power inverters and for high-frequency pulse shapers. Also, the new high-voltage devices are especially suitable for automobile ignition systems, TV deflection circuits, choppers and medium-power, high-frequency regulator and inverter circuits.

Thyristors are generally chosen when ac phase-control systems or control of high-power systems are needed. They have a much higher control gain than power transistors and are generally less susceptible to overvoltage transients. Also, because of the latching capability of thyristors, they don't require a constant gate current—unlike transistors which require constant base

Darlington devices are gaining ground in applications formerly restricted to thyristors. Newer Darlingtons bring out the second base to form a 4-terminal device.

current. In general, thyristors are superior to power transistors in ac applications.

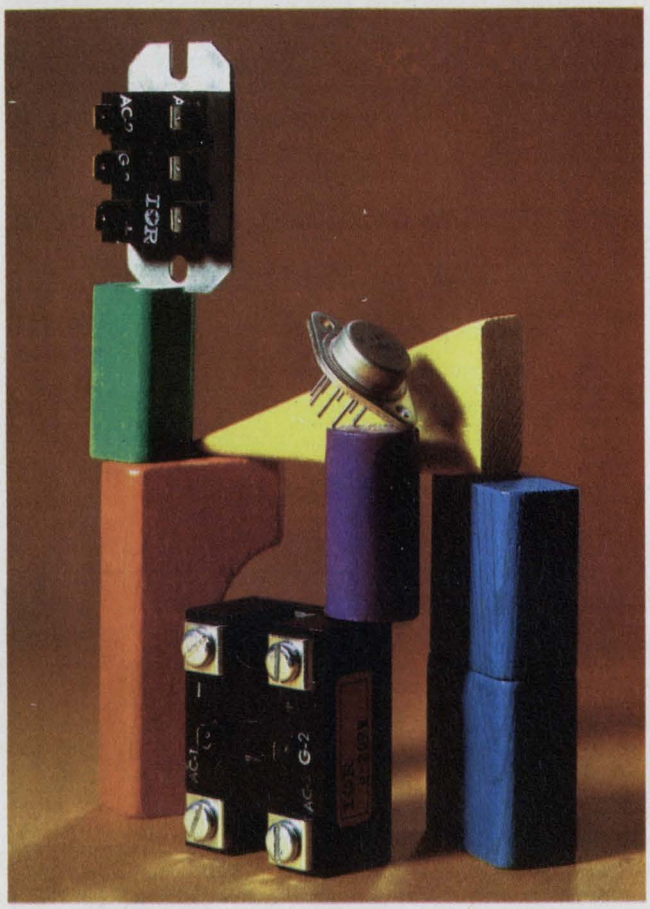
Understanding the safe operating area

Quite often one of the most significant specs for power transistors—the safe operating area—is completely ignored. This is a family of curves that indicate the peak watts, at a given collector-to-emitter voltage, that the device can dissipate for some specific time, ranging from seconds to microseconds.

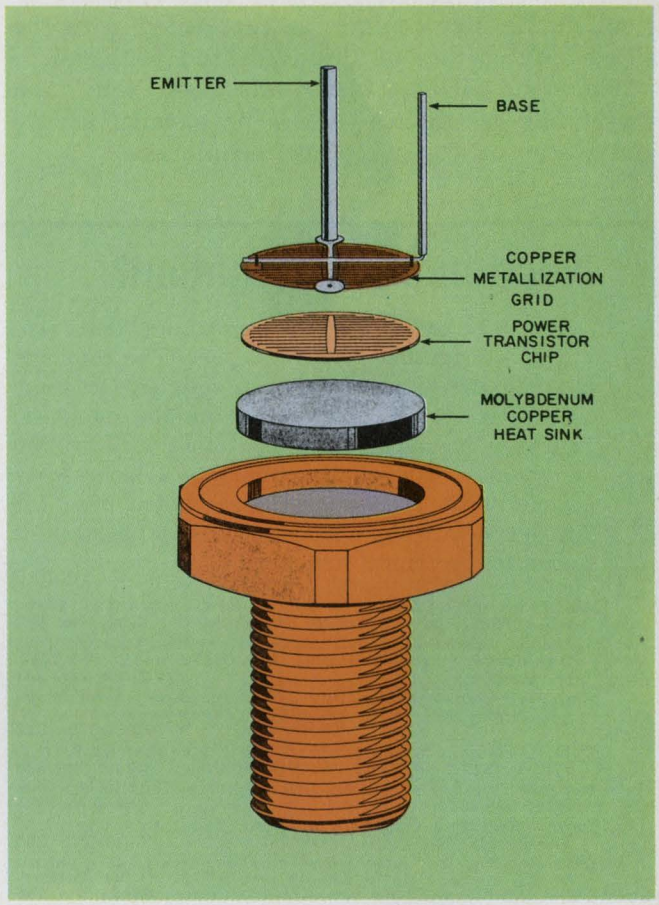
The safe-operating-area spec is important because no matter how uniformly the junction is manufactured, it is possible to get nonhomogeneity of collector current. This lack of uniformity causes the collector current to flow through only a portion of the junction, thus creating local overheating. Since the thermal time constant for the junction is slow and the peak wattage is very high, one area of the junction can actually explode, thus destroying the device.

Sometimes the peak power conditions don't destroy the junction; they just damage it surreptitiously. This damage can be cumulative, and you wind up unexpectedly with reduced life for the device.

Mistakes commonly made in specifying power semiconductors run a wide gamut. Perhaps the



Power modules that contain several thyristors and diodes in various circuit configurations are available from International Rectifier.



The power transistor with the highest current capability is PowerTech's new 500-A device. The chip is almost an inch in diameter and has a voltage rating of 80 V.

most common is overreliance on the spec sheets, making assumptions about parameter distributions and limits that may not be valid and failing to employ the product and application services of the manufacturer.

Another common mistake engineers make is using a manufacturer's data sheet as a specification rather than the actual operating conditions imposed upon the device by the circuit.

Sometimes a designer severely limits his sources of supply by marking up a manufacturer's data sheet rather than starting from the external constraints placed on the device. The remedy: Talk to the manufacturer about your application and let him suggest the best device.

Overspecification is another big problem. Engineers often add too much of a voltage safety factor without informing the manufacturer. Consequently they pay dearly for an overrated device that isn't really needed.

Suppression of voltage spikes and current surges is all too often neglected by designers. Device breakdown caused by these surges must be prevented to achieve reliable operation.

The increasing demand for power commonly results in a need to connect devices in series and parallel. This calls for special device testing and matching to ensure proper blocking-voltage division, and matching of turn-on delays, forward voltage drops, etc.

The latest trends in power semiconductors are toward devices that can handle larger powers. These newer devices simplify circuit design and eliminate the need to connect devices in parallel for higher current or in series for higher voltage.

The transistor with highest current capability will be announced this month. PowerTech, Inc., of Clifton, N.J., is introducing a 500-A, single-diffused transistor intended for application in high-current inverters, switching regulators and motor controllers. The device is fabricated on a 0.825-inch chip and has a voltage rating of 500 A at 80 V.

In thyristors, the device with the highest current appears to be one developed by Power Semiconductors, Inc., of Devon, Conn. It is a 4000-A device fabricated on a 102-mm chip. Since the newer thyristors are handling larger power loads, their packages must be designed for good thermal dissipation. Nearly all employ the flatpack, or

disc, pressure package, which allows more efficient double-side cooling, as contrasted with the single-side cooling of threaded stud packages.

The disc package also lends itself well to a variety of assemblies—series or parallel arrays and water or vapor-cooling techniques.

Another trend in power devices is toward faster-switching and higher-voltage monolithic Darlington transistors. Four terminal Darlington devices are being developed. They would enable the designer to customize the Darlington device to his needs. ■■

Need more information?

We wish to thank the companies that provided information for this report. The products cited in the report have been selected for their illustrative, or in some cases, unique qualities. However, manufacturers not mentioned in the report may offer similar products. Readers may consult with the manufacturers listed here for further details by circling the appropriate information retrieval number.

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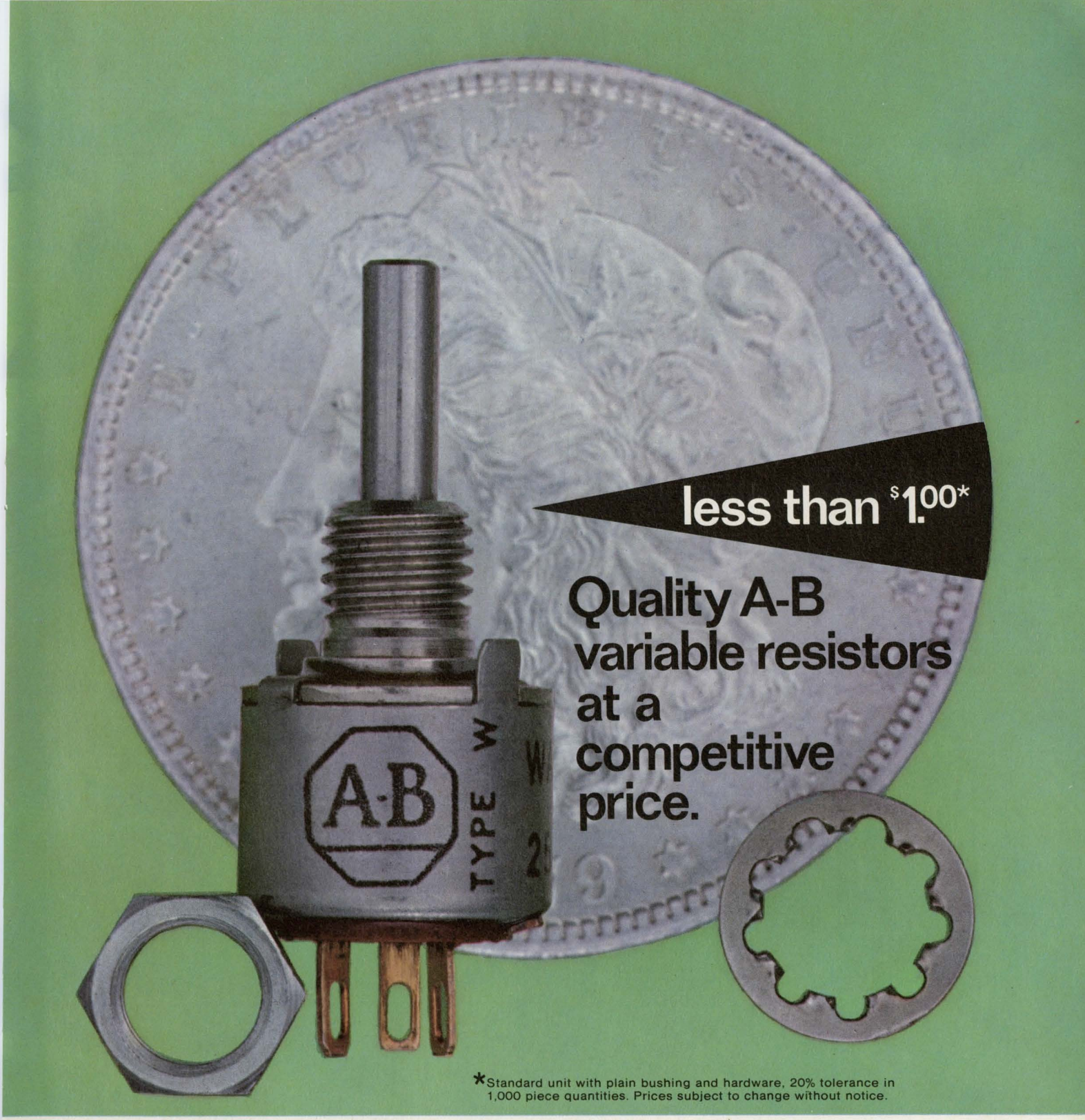

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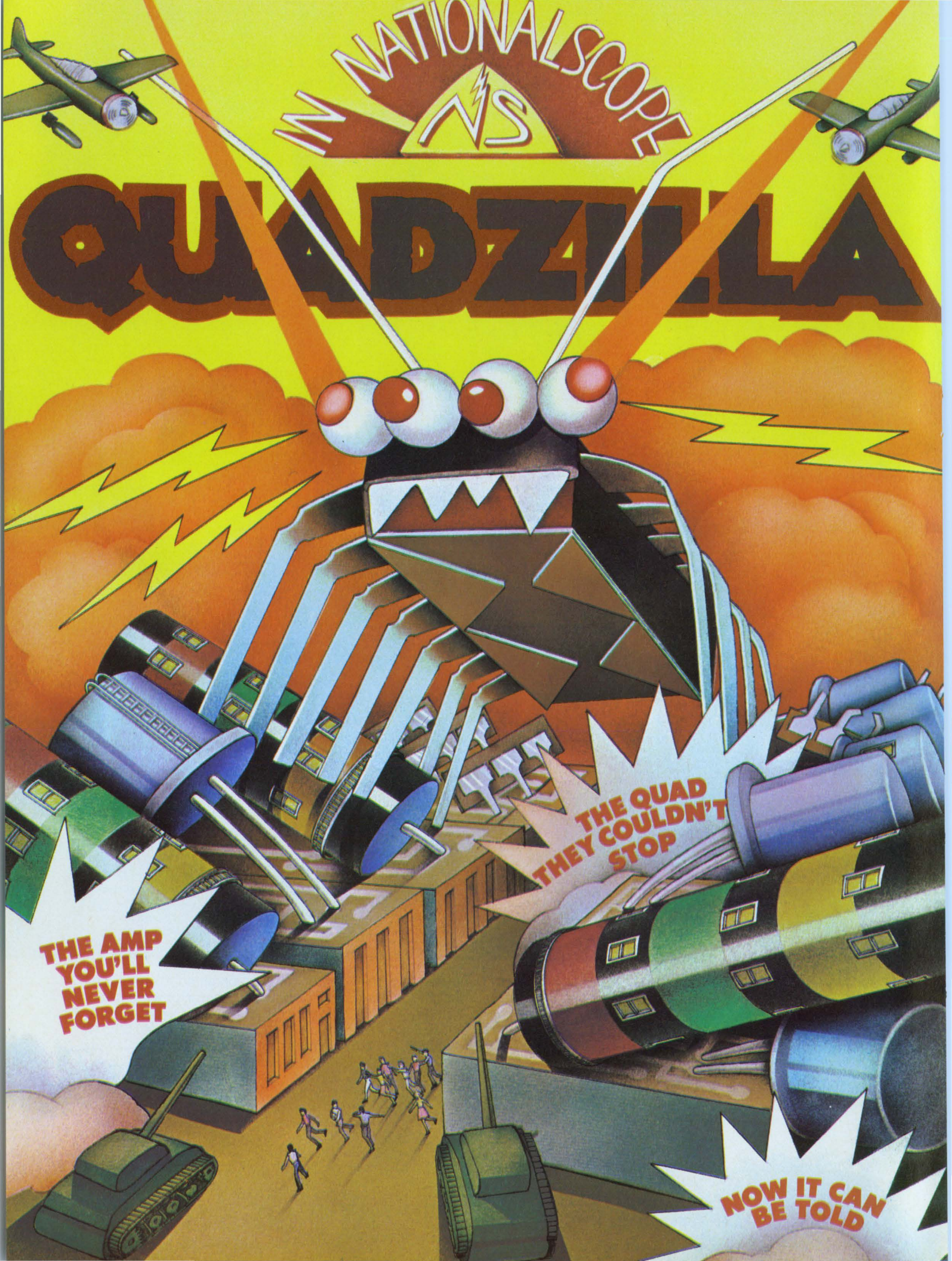
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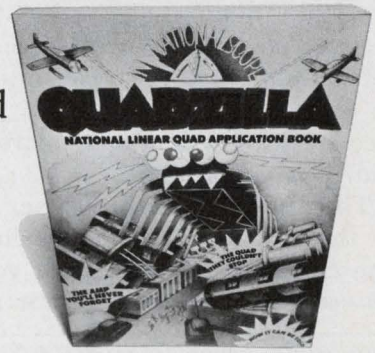

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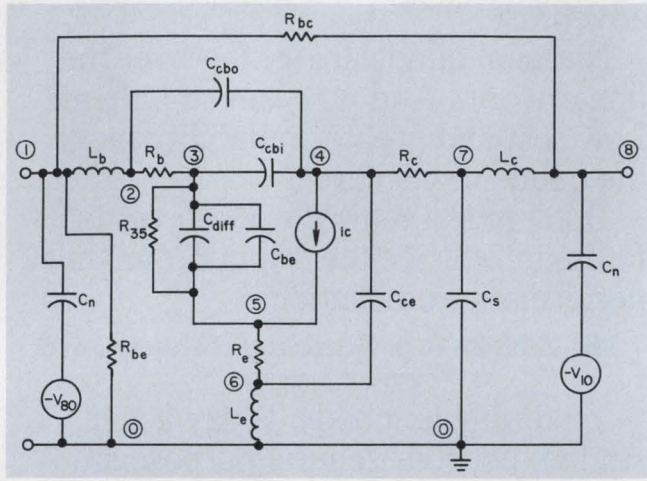
Calculate large-signal behavior of rf power transistors using an equivalent circuit and equations that provide more information than can be obtained from Y or S parameters.

A complete analysis of rf-transistor performance requires a comprehensive equivalent circuit and formulas for large-signal behavior. In addition to large-signal applications, the circuit and formulas permit calculations to determine a variety of functions, ranging from precise, narrowband performance to a check on the accuracy of test measurements.

The usual approach—calculating S parameters—can be used only for small-signal applications. And while wideband information can be obtained, the use of S parameters isn't suitable for the investigation of such problems as unwanted resonances. The comprehensive equivalent circuit can handle all such cases.

Most spec sheets don't list all the characteristics for the equivalent circuit, but the information can be obtained from the device manufacturer or by making your own simple measurements (see box "Transistor Parameters"). One bonus with the equivalent-circuit approach: The formulas are easily handled by a computer.



1. **An rf-transistor equivalent circuit** can be used for large-signal analysis or a precise determination of narrowband performance. Components R_{be}, R_{bc} and C_n permit the handling of a wide variety of applications.

The equivalent circuit

The equivalent circuit (Fig. 1) includes three external components—R_{be}, R_{bc} and C_n—that allow for a wide variety of applications.

The external base-emitter, R_{be}, provides stabilization in Class C amplifiers at relatively low frequencies. Without this resistor, drive power and input resistance of the transistor may become negative, which would lead to instability.

In wideband amplifiers for ssb operation, the collector-base feedback resistor, R_{bc}, reduces the variation in gain and the input impedance.

Cross-neutralization is accomplished in push-pull amplifiers by two capacitors, C_n (for which an approximate value is $C_{cbi} + C_{cbo}$). At high frequencies this gives an increase of power gain and input impedance.

The analysis is entirely ac, and the amplitude of the fundamental component is always used. The calculation begins with voltage and current between the internal collector and emitter points 4 and 5 in Fig. 1. From there, the calculation is made outward in both directions until voltage and current are known at both input and output.

When making a choice of voltage and current between points 4 and 5 you must distinguish between linear operation—as in a Class AB amplifier—or nonlinear—as in Class B or C.

The linear Class AB amplifier

In the Class AB amplifier the collector current source, i_c, is loaded with a real impedance. This means that the shift between the internal collector-emitter voltage, v_{45}, and i_c can be equal to 180°. For linear operation ϕ is 0°. The amplitude of v_{45} is approximately 10 to 20% below the collector-emitter dc voltage, based on linearity considerations.

The following problem exists when the output power is calculated: In general, power is specified between points 8 and 0, not between 4 and 5. But you need the 4-to-5 power for the calculation.

To get around this problem, begin by choosing the power between points 4 and 5 so that it is equal to the specified power. Account for the difference by a ratio of the two powers. In a suc-

A. H. Hilbers and M. H. Burden, Amperex, Hicksville, N.Y. 11802.

ceeding calculation use the ratio as a correction factor for the power between points 4 and 5. Generally only one iteration is sufficient to approach the desired output power to within 1%.

In a Class AB amplifier a positive-bias voltage of approximately 0.6 to 0.7 V is applied between base and emitter. This voltage source has, of course, an internal resistance also (Fig. 2). Both are important for the required ac voltage between points 3 and 5.

The Class B/C amplifier

Most Class B/C amplifiers are of the narrow-band, tuned type. The matching network at the output is chosen so that the output power, and consequently the gain, is maximum. The phase angle ϕ, as previously defined, will certainly not be equal to zero.

In this type of amplifier v_{45} takes the highest possible amplitude. This value depends on the ratio of the operating frequency and the maximum frequency that can be handled by the transistor with reasonable gain. However v_{45} is always higher than the collector-emitter dc voltage. This seems to be unlikely, but it isn't if we consider the following phenomena:

First, at high frequencies the harmonic content of the collector current is small. This is not so for the collector voltage, because of the nonlinear behavior of the collector capacitance. The phase of the second harmonic is such in this case that the amplitude of the fundamental component will rise approximately 10 to 20% above the collector supply voltage (Fig. 3).

Secondly, at low frequencies the influence of the nonlinear collector capacitance is relatively small, because rather big external capacitors are used from collector to ground. The Class C adjustment applied in this case is, however, responsible for a strong harmonic content of the collector current. Since the reactance of the collector-ground capacitance for the second harmonic can certainly not be neglected, a large second-harmonic component in the collector voltage can be expected. In practice it appears that the phase angle preferred by the transistor for maximum gain, together with the present second harmonic voltage, make possible a strong increase of the fundamental voltage. Measurements

Transistor Parameters

- f — frequency of operation, $\omega = 2\pi f$.
- f_T — transition frequency. Available from the spec sheet. Depending on the amount of fall-off of f_T at high collector currents, a somewhat lower value than the maximum must be used for the calculation. Usually this will be approximately 90% of the maximum f_T, $\omega_T = 2\pi f_T$.
- h_{FE} — dc current gain. Given by transistor manufacturer.
- R_b — base resistance. Derived from $R_b + R_e$ measurement at 100 MHz with suitable impedance bridge.
- R_e — emitter resistance. Given by transistor manufacturer or derived from $V_{CE\ floating}$ measurement.
- R_c — collector series resistance. Derived from $V_{CE\ sat}$ measurement.
- L_b — base inductance. Available from manufacturer.
- L_e — emitter inductance. Available from manufacturer.
- L_c — collector inductance. Available from manufacturer.
- C_{be} — base-emitter depletion capacitance. Can be measured at a low frequency and zero-volt bias. The ac measuring voltage has to be sufficiently small—less than 100 mV.
- C_{diff} — base-emitter diffusion capacitor. Available from manufacturer.
- C_{cbi} — internal part of collector-base capacitance (the part that is physically under the emitter). This capacitance is a part of the total collector capacitance, which can be measured directly. The division must be derived from the mask drawings of the transistor.
- C_{cbo} — external part of the collector-base capacitance. See remark for C_{cbi}.
- C_{ce} — collector-emitter capacitance. Formed by emitter resistance and metallization. See remark for C_{cbi}.
- C_s — collector-stud capacitance. Available from manufacturer, or can be measured on an empty encapsulation.
- V_{bo} — external dc bias voltage between base and emitter.
- R_{bo} — dc resistance in base circuit.
- ϕ — phase angle between v_{45} and i_c minus 180°; thus the real loading of i_c gives $\phi = 0$.
- R_{35} — base-emitter internal resistance. Available from manufacturer.
- P_{01} — Output power between internal collector and emitter (points 4 and 5). Dependent on output power.
- V_c — Amplitude of internal collector-emitter voltage between points 4 and 5. It is 10 to 20% below collector-emitter dc voltage for linear operation and 10 to 20% above for Class B or C operation.

have shown increases of over 50%.

Since the analysis is exclusively based on fundamental components, an approximate value of v_{45} must be introduced.

In a Class C amplifier negative-bias voltage between base and emitter is often applied by a base resistor. This, of course, influences the required ac voltage between the internal base and emitter points 3 and 5.

Calculate power and impedance

The final equations for the calculation of power and impedance at both the input and output of the transistor seem straightforward, but many other calculations must be made first to determine the input voltages and currents (see box "Required Equations").

Note the use of the subscripts r and i to designate the real and imaginary parts of the currents and voltages. This breakdown is useful if the calculations are performed by a computer with a language that cannot handle complex numbers.

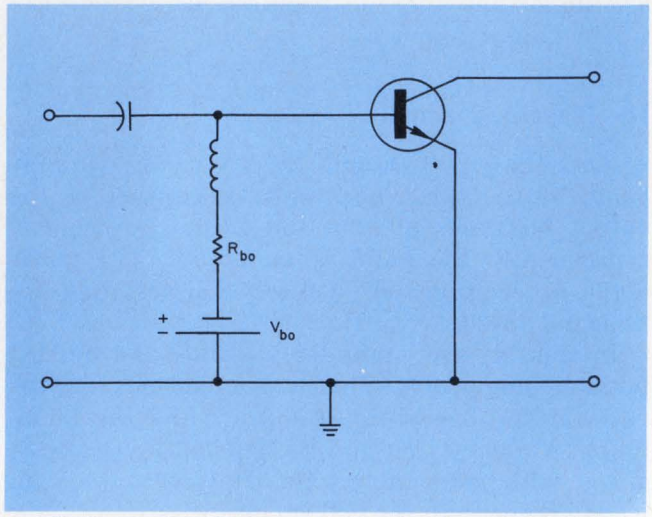
With i_s as the total current flowing out of the transistor at point 1, the drive power is equal to

$$P_i = \frac{v_{10r}\, i_{1r} + v_{10i}\, i_{1i}}{2}.$$

The input impedance is represented by resistance R_i in series with reactance X_i:

$$R_i = \frac{v_{10r}\, i_{1r} + v_{10i}\, i_{1i}}{i_{1r}^2 + i_{1i}^2},$$

$$X_i = \frac{v_{10i}\, i_{1r} - v_{10r}\, i_{1i}}{i_{1r}^2 + i_{1i}^2}.$$



2. **The internal resistance of a real voltage source** must be considered, along with the voltage, to determine Class AB amplifier performance.

Required Equations

The equations for calculating input and output power and impedance are derived from the known data between the internal collector and emitter points 4 and 5.

If between points 4 and 5, P_{oi}, V_c and ϕ are known, the amplitude of the collector current source can be determined with the formula

$$i_c = \frac{2\, P_{oi}}{v_c \cos \phi}.$$

The voltage required between the internal base and emitter points 3 and 5, v_{35}, is approximately 0.8 to 0.9 V for all transistors in the vicinity of their maximum power level. This holds when there is no external or internal dc bias voltage between base and emitter. However, if a bias voltage is present, this voltage has to be subtracted from the 0.9 V. Assuming an external voltage source V_{bo}, an external base resistance R_{bo} (only active for dc) and the internal emitter resistor R_e, we get:

$$v_{35} = 0.9 - V_{bo} + I_e R_e + I_b (R_{bo} + R_b) \approx$$

$$0.9 - V_{bo} + I_c \left(R_e + \frac{R_{bo} + R_b}{h_{FE}} \right).$$

In this equation I_e, I_b and I_c are direct currents. Depending on the angle of collector current flow, i_c will be between I_c (Class A) and $2I_c$ (Class C with very small angle of current flow). The geometric mean value will be used in all cases, so

$$i_c = 1.4\, I_c.$$

From this it follows that

$$v_{35} = 0.9 - V_{bo} + \frac{i_c}{1.4} \left(R_e + \frac{R_{bo} + R_b}{h_{FE}} \right).$$

The parts of the collector capacitance—C_{cbi}, C_{cbo} and C_{ce}—are voltage-dependent. Consequently these capacitances will increase when there is an ac voltage across them in addition to the collector supply voltage. Theoretically the maximum increase for a pure abrupt junction is equal to $\sqrt{1.5} = 1.225$. As practical junctions are between abrupt and graded ones, a factor of 1.15 is used.

Then we get

$$C_{34} = 1.15\, C_{cbi},$$
$$C_{24} = 1.15\, C_{cbo},$$
$$C_{46} = 1.15\, C_{ce}.$$

Capacitance C_{be} is also voltage-dependent. However, with a negative bias voltage across R_e, this capacitance will decrease approximately as much as it is increased by an ac voltage. Therefore no correction factor is applied in this case.

Voltage v_{35} has been chosen as a phase reference in this system. This means that the phase angle of this voltage is 0. The same holds for the collector current source i_c when it takes the direction indicated in Fig. 1.

With I_8 as the total current flowing out of the transistor at point 8, the output power is equal to

$$P_o = \frac{v_{80r}\, i_{8r} + v_{80i}\, i_{8i}}{2}.$$

The load impedance is presented by the parallel connection of a resistance R_L and capacitance C_L, which will be negative in most cases:

$$R_L = \frac{v_{80r}^2 + v_{80i}^2}{v_{80r}\, i_{8r} + v_{80i}\, i_{8i}},$$

$$C_L = \frac{v_{80r}\, i_{8i} - v_{80i}\, i_{8r}}{\omega\,(v_{80r}^2 + v_{80i}^2)}.$$

To calculate the effect of external feedback networks, it is necessary to know, also, the phase difference between the collector voltage and the base voltage, ϕ_{vcb}:

$$\phi_{vcb} = \arctan\frac{v_{80i}}{v_{80r}} - \arctan\frac{v_{10i}}{v_{10r}}.$$

For verification of calculations by measurements, it is sometimes useful to know the amplitude of the output voltage:

$$v_o = \sqrt{v_{80r}^2 + v_{80i}^2}.$$

How well do the equations work?

Two examples, one linear and one Class C, show that the calculated values are in a close agreement with measured values. A BLX14 vhf power transistor is used for both examples. The transistor data follow:

$f_T = 300$ MHz;	$L_b = 2$ nH,	$C_{cbo} = 31.9$ pF,
$h_{FE} = 50$,	$L_e = 1$ nH,	$C_{be} = 26.3$ pF,
$R_b = 0.4\ \Omega$,	$L_c = 0$,	$C_s = 3.5$ pF.
$R_e = 0.33\ \Omega$,	$C_{be} = 2300$ pF,	
$R_c = 0.165\ \Omega$,	$C_{cbi} = 61.9$ pF,	

Inductance L_c has been set equal to zero because its influence at 7 MHz can be neglected.

Operating data for a linear amplifier are

$f = 7$ MHz,	$V_{bo} = 0.72$ V,	$R_{bc} = \infty$,
$P_o = 50$ W,	$R_{bo} = 2.8\ \Omega$,	$\phi = 0$,
$v_o = 27$ V,	$R_{be} = \infty$,	$C_n = 0$.

Voltage v_o has been chosen so that the load resistance becomes 6.25 Ω. This results in a v_o of 25 V. Accordingly the load resistance in the test circuit has been adjusted to 6.25 Ω. The collector supply voltage is 28 V. The base-bias voltage is delivered by a resistor-diode potentiometer and adjusted for a collector quiescent current (collector dc current without drive power) of 100 mA. These adjustments yield the required V_{bo} and R_{bo} values.

Calculations produce the following results:

$R_L = 6.25\ \Omega$,	$R_i = 2.59\ \Omega$,	$P_i = 0.173$ W,
$C_L = -124$ pF,	$X_i = 6.76\ \Omega$,	$G = 24.6$ dB.

Then,

$$v_{35r} = v_{35}, \qquad v_{35i} = 0.$$

According to definitions given before:

$$v_{45r} = -v_c \cos\phi \qquad v_{45i} = -v_c \sin\phi$$

$$i_{35r} = \frac{i_c}{h_{FE}}$$

$$i_{35i} = \omega\left(\frac{i_c}{\omega_T} + v_{35}\, C_{be}\right)$$

$$i_{34r} = \omega\, C_{34}\, v_{45i} \qquad i_{34i} = \omega\, C_{34}\,(v_{35r} - v_{45r})$$

$$v_{23r} = R_b\,(i_{35r} + i_{34r}) \qquad v_{23i} = R_b\,(i_{35i} + i_{34i})$$

$$v_{25r} = v_{23r} + v_{35r} \qquad v_{25i} = v_{23i}$$

$$v_{24r} = v_{25r} - v_{45r} \qquad v_{24i} = v_{25i} - v_{45i}$$

$$i_{24r} = -\omega\, C_{24}\, v_{24i} \qquad i_{24i} = \omega\, C_{24}\, v_{24r}$$

$$v_{12r} = -\omega\, L_b\,(i_{24i} + i_{34i} + i_{35i}) \qquad v_{12i} = \omega\, L_b\,(i_{24r} + i_{34r} + i_{35r})$$

$$V_{56r} = R_e\,(i_c + i_{35r}) \qquad v_{56i} = R_e\, i_{35i}$$

$$i_{46r} = \omega\, C_{46}\,(v_{45i} + v_{56i}) \qquad i_{46i} = \omega\, C_{46}\,(v_{45r} + v_{56r})$$

$$v_{60r} = -\omega\, L_e\,(i_{46i} + i_{35i}) \qquad v_{60i} = \omega\, L_e\,(i_{46r} + i_{35r} + i_c)$$

$$i_{47r} = -i_c + i_{34r} + i_{24r} - i_{46r} \qquad i_{47i} = i_{34i} + i_{24i} - i_{46i}$$

$$v_{74r} = -R_c\, i_{47r} \qquad v_{74i} = -R_c\, i_{47i}$$

$$v_{70r} = v_{74r} + v_{45r} + v_{56r} + v_{60r} \qquad v_{70i} = v_{74i} + v_{45i} + v_{56i} + v_{60i}$$

$$i_{70r} = -\omega\, C_s\, v_{70i} \qquad i_{70i} = \omega\, C_s\, v_{70r}$$

$$i_{78r} = i_{47r} - i_{70r} \qquad i_{78i} = i_{47i} - i_{70i}$$

$$v_{87r} = \omega\, L_c\, i_{78i} \qquad v_{87i} = -\omega\, L_c\, i_{78r}$$

$$i_{18r} = \frac{v_{12r} + v_{24r} - v_{74r} - v_{87r}}{R_{bc}} \qquad i_{18i} = \frac{v_{12i} + v_{24i} - v_{74i} - v_{87i}}{R_{bc}}$$

$$v_{10r} = v_{12r} + v_{23r} + v_{35r} + v_{56r} + v_{60r} \qquad v_{10i} = v_{12i} + v_{23i} + v_{56i} + v_{60i}$$

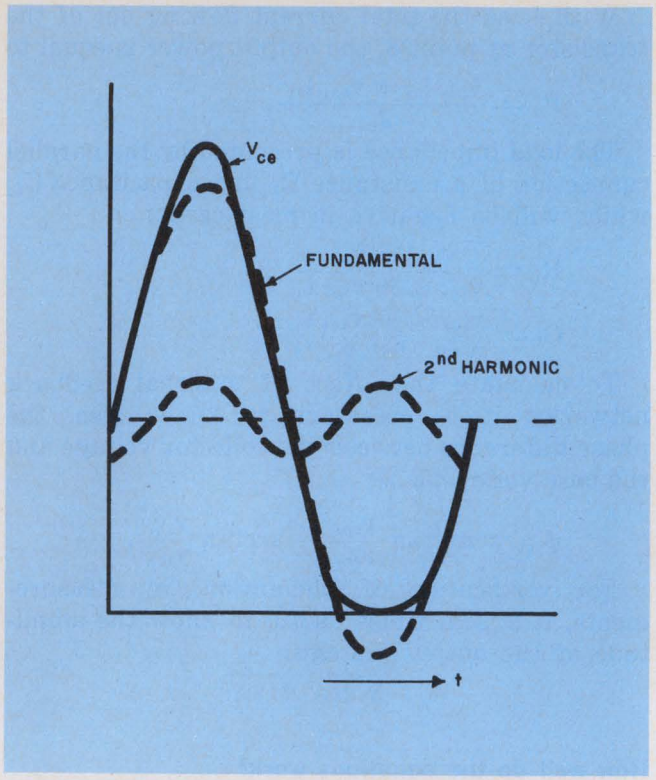
$$v_{80r} = v_{70r} + v_{87r} \qquad v_{80i} = v_{70i} + v_{87i}$$

$$i_{10r} = \frac{v_{10r}}{R_{be}} \qquad i_{10i} = \frac{v_{10i}}{R_{be}}$$

$$i_{nr} = -\omega\, C_n\,(v_{10i} + v_{80i}) \qquad i_{ni} = \omega\, C_n\,(v_{10r} + v_{80r})$$

$$i_{1r} = i_{24r} + i_{34r} + i_{35r} + i_{10r} + i_{18r} + i_{nr} \qquad i_{1i} = i_{24i} + i_{34i} + i_{35i} + i_{10i} + i_{18i} + i_{ni}$$

$$i_{8r} = i_{78r} + i_{18r} - i_{nr} \qquad i_{8i} = i_{78i} + i_{18i} - i_{ni}$$



3. **Harmonics can affect calculations** based on the fundamental frequency, especially when an harmonic and fundamental are in phase.

The measured values are

$R_L = 6.25\ \Omega$, $R_i = 2.61\ \Omega$, $P_i = 0.178$ W,
$C_L = 0$, $X_i = -6.86\ \Omega$, $G = 24.5$ dB.

The differences in complex quantities can be evaluated from absolute values and phase angles. For the load impedance, this becomes

$$\Delta|Z_L| = 0.06\%, \qquad \Delta\phi_L = 1.9°.$$

And for the input impedance:

$$\Delta|Z_i| = 1.4\%, \qquad \Delta\phi_i = 0.13°.$$

The deviation of drive power is $\Delta P_i = 2.8\%$, corresponding to $\Delta G \approx 0.1$ dB.

For this example, the agreement between calculation and measurement is extremely good.

For Class C amplifier operation, the transistor data are, of course, the same as in the previous example. The operating data become

$f = 7$ MHz, $V_{bo} = 0$, $R_{bc} = \infty$,
$P_o = 50$ W, $R_{bo} = 0$, ϕ = optimum,
$v_c = 43.4$ V, $R_{be} = 27\ \Omega$, $C_n = 0$.

The value of v_c is chosen to equal the measured value of the output voltage.

The value of $R_{be} = 27\ \Omega$ is chosen to achieve stable operation. With this resistor value, we avoid a negative drive power and a negative real part of the input impedance.

Calculations yield the following results:

$R_L = 17.7\ \Omega$, $R_i = 1.29\ \Omega$, $P_i = 0.114$ W,
$C_L = -1303$ pF, $X_i = -6.29\ \Omega$, $G = 26.4$ dB.

The results for these two examples cannot be obtained using S-parameter techniques. ■■

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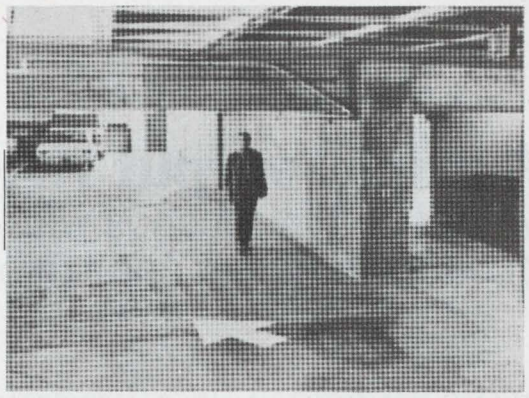
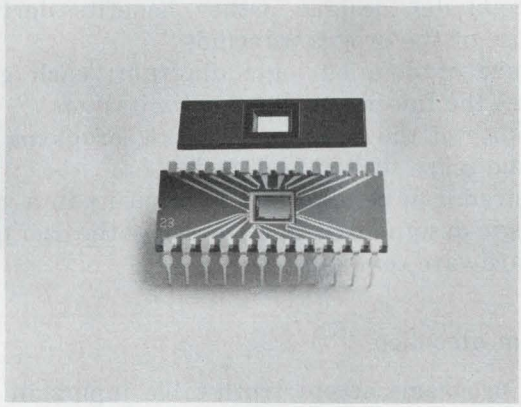
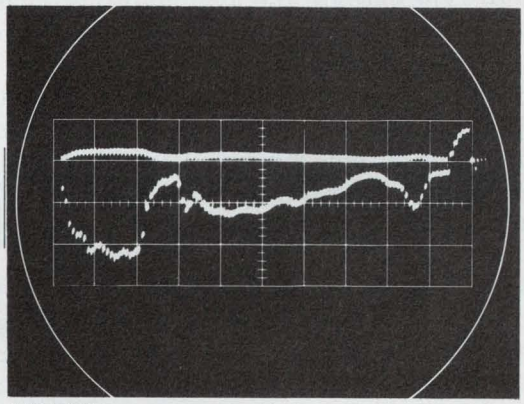


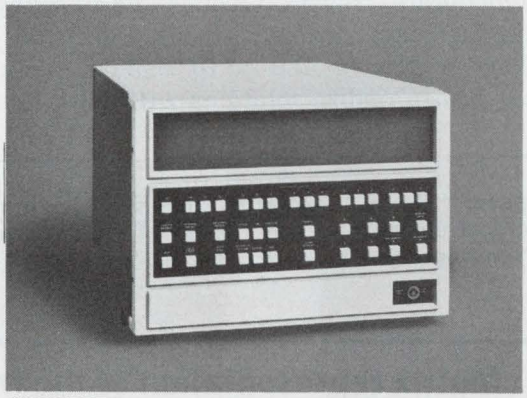
TV MONITOR



SENSOR



A-SCOPE



COMPUTER

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INFORMATION RETRIEVAL NUMBER 37

Multiple-output NAND networks

synthesized in seconds with computer program that accounts for fan-in and fan-out limits.

NAND and NOR gates find wide use in logic design. Yet, despite the availability of computer-aided circuit-design techniques, much of the logic design used continues to be performed by hand. Recently, however, Su and Nam[1] presented an efficient computer algorithm for the synthesis of multiple-output, multiple-level NAND (NOR) combinational networks that accounts for the practical fan-in and fan-out limits of these logic gates.

The algorithm, programmed in Fortran on the CDC-6400 computer, provides efficient logic design for truth tables or function-arrays that have up to 75 variables (the sum of the input and output variables). Requirements of time and storage are moderate—several seconds and 51.2 kbytes of main memory.

The program's ability to handle many variables and to realize solutions with near minimum numbers of gates makes it ideally suited for practical computer designs. Other benefits derived from use of the program include:

- Output of detailed logic diagram; each gate satisfies the fan-in and fan-out limitations.
- Ability of the designer to tackle problems beyond the scope of hand methods.
- Program can be used as a subroutine in a general logic-design program (logic-synthesizer) or as a hardware compiler.

Stephen Y.H. Su, Associate Professor, Department of Electrical Engineering, City College of the City University of New York, New York, N.Y. 10031.

Program execution

The programs accept truth-table inputs in cubic notation[2]—a compact notation for Boolean products (see Box 1)—along with specifications for the following integer variables:

- NC — no. of cubes (rows)
- NV — no. of input variables
- NVO — no. of output variables
- IFI — NAND gate fan-in limit
- IFO — NAND gate fan-out limit
- IWFI — fan-in weight
- IFWFO — fan-out weight

Matrix representation of the truth table

Cubic notation permits compact matrix representation of a given truth table. To convert to this type of notation, express each output as the sum of Boolean products, then reserve a matrix in which the number of rows equals the total number of products—one row (cube) for each distinct product. Reserve one column for each input variable X_i and one column for each output Z_j.

Proceed column-by-column with each row; place a 1 if X_i appears in the product; a 0 if the complement appears, or an X if the literal does not appear in the product.

In the output columns, use 0 and 1 to represent on and off, respectively; use D to indicate a "don't care" condition. For example, the logic equations

$$Z_1 = X_1X_2X_3 + \overline{X}_1\overline{X}_2\overline{X}_3 + (X_1X_2\overline{X}_3 + X_1\overline{X}_2X_3)$$
$$Z_2 = \overline{X}_1\overline{X}_2X_3 + X_1X_2\overline{X}_3 + (X_1X_2X_3),$$

where the parenthesized terms are "don't cares," are represented as shown in the table. The input combinations $\overline{X}_1\ X_2\ \overline{X}_3$, $\overline{X}_1\ X_2\ X_3$ and $X_1\ \overline{X}_2\ X_3$ correspond to $Z_1 = 0$ and $Z_2 = 0$ and needn't be shown in the array.

Array representation for Z_1 and Z_2 outputs

Cube* number	Input variables			Output variables	
	X_1	X_2	X_3	Z_1	Z_2
1	0	0	0	1	0
2	0	0	1	0	1
3	1	0	1	D	0
4	1	1	0	D	1
5	1	1	1	1	D

*Not part of array representation

where the fan-in and fan-out weights determine the relative importance of fan-in and fan-out reduction. For example,

$$\text{IWFI} = 2 \text{ and } \text{IWFO} = 1$$

mean that it is twice as important to solve fan-in than fan-out problems.

Data inputs for a job consist of a card in 7I5 format that contains the seven integer variables, followed by cards for the truth table or function-array. Array data are in row-by-row order; each array element occupies one space on the card. One space is to be left between input and output variables, and each row of the matrix begins on a new card. A given row may occupy a total of 75 card-columns—on successive cards.

More than one problem can be done at each execution of the program, provided the data cards for each problem are placed behind one another. A blank card placed after one or more data decks terminates the run. Computer output for each problem consists of a recapitulation of the input data (Fig. 1a) and a cryptic description of the detailed logic diagram (Fig. 1b).

The example shown has 10 inputs, six outputs, and the truth table contains 13 rows. The printout of the truth table follows the format described in the box.

The solution to the problem contains 44 NAND gates (Fig. 1b). Six gates, numbered 39 through 44, respectively, generate the six output-variables, Z_1 through Z_6. Inputs to the gates are defined as follows: a number signifies input from a like-numbered gate; symbols such X1, X9, X10 denote input literals X_1, X_9 and X_{10}; a Γ-like symbol preceding the X indicates use of the complement of variable X. Commas separate the individual inputs.

Other than elimination of rows for which there are no ONEs in the output columns, the eighth row in the sample case, the program does not simplify the given truth table or function-array. But the NAND-gate count is often less if such a reduction or simplification is made before this program is run. Programs that reduce the truth table may be found in appendices I and H of Ref. 3. These use the reduction algorithms of Su and Dietmeyer.[3,4,5]

```
NO. OF CUBES             =  13
NO. OF INPUT VARIABLES   =  10
NO. OF OUTPUT VARIABLES  =   6
FANIN LIMIT              =   5
FANOUT LIMIT             =   3
FANIN WEIGHT             =   1
FANOUT WEIGHT            =   1


     INPUT       OUTPUT
      X       1 Z
     1234567890 123456                                   (a)

C 1   11111XXX10 1011D1
C 2   111XX11001 11011D
C 3   1110000XXX 010DD1
C 4   0XXX00010X D11D11
C 5   X0XX000X10 001111
C 6   00000X10X1 111001
C 7   00000X1X00 010D10
C 8   1110XX11X0 DD00DD
C 9   0X1X011X01 1100DD
C10   011X01111X 01111D
C11   1X110X1X1X D10111
C12   0000X000X1 1D0111
C13   00000XX111 D00011

DELETED CUBES
C 8

        1  NAND    X9
        2  NAND    1
        3  NAND    X10
        4  NAND    3
        5  NAND    ¬X1,¬X2,¬X3,¬X4
        6  NAND    5
        7  NAND    X1,X2,X3
        8  NAND    7
        9  NAND    X3,¬X5,X7
       10  NAND    9
       11  NAND    ¬X5,¬X6,¬X7
       12  NAND    11
       13  NAND    X7,X10
       14  NAND    13
       15  NAND    ¬X5,6
       16  NAND    15
       17  NAND    ¬X1,¬X9
       18  NAND    17                                   (b)
       19  NAND    X4,X5,X9,¬X10,8
       20  NAND    X6,¬X8,¬X9,8,14
       21  NAND    ¬X4,8,12
       22  NAND    X8,12,18
       23  NAND    ¬X2,X9,¬X10,12
       24  NAND    ¬X8,14,16
       25  NAND    X7,¬X9,¬X10,16
       26  NAND    X6,4,10,18
       27  NAND    ¬X1,X2,X6,X8,2
       28  NAND    27
       29  NAND    28,10
       30  NAND    X1,X4,2,10
       31  NAND    ¬X6,¬X7,¬X8,4,6
       32  NAND    X8,2,4,16
       33  NAND    24
       34  NAND    33
       35  NAND    20,22,29,30
       36  NAND    35
       37  NAND    19,23,31,36
       38  NAND    37
Z 1    39  NAND    19,20,24,26,31
Z 2    40  NAND    21,34,25,26,36
Z 3    41  NAND    19,22,23,34,29
Z 4    42  NAND    38
Z 5    43  NAND    25,32,38
Z 6    44  NAND    21,34,32,38

Note: ¬Xn denotes the complement of the variable; Xn the variable itself.
```

1. **Program output consists** of a recapitulation of input data as well as the completed NAND network design. The program accepts truth-table inputs in the form of matrix notation (a) along with fan-in and fan-out limits. Symbols containing X's indicate input variables or their complement (b); numbers refer to inputs from other NAND gates.

Table 1. Functional breakdown of program, LOGIC

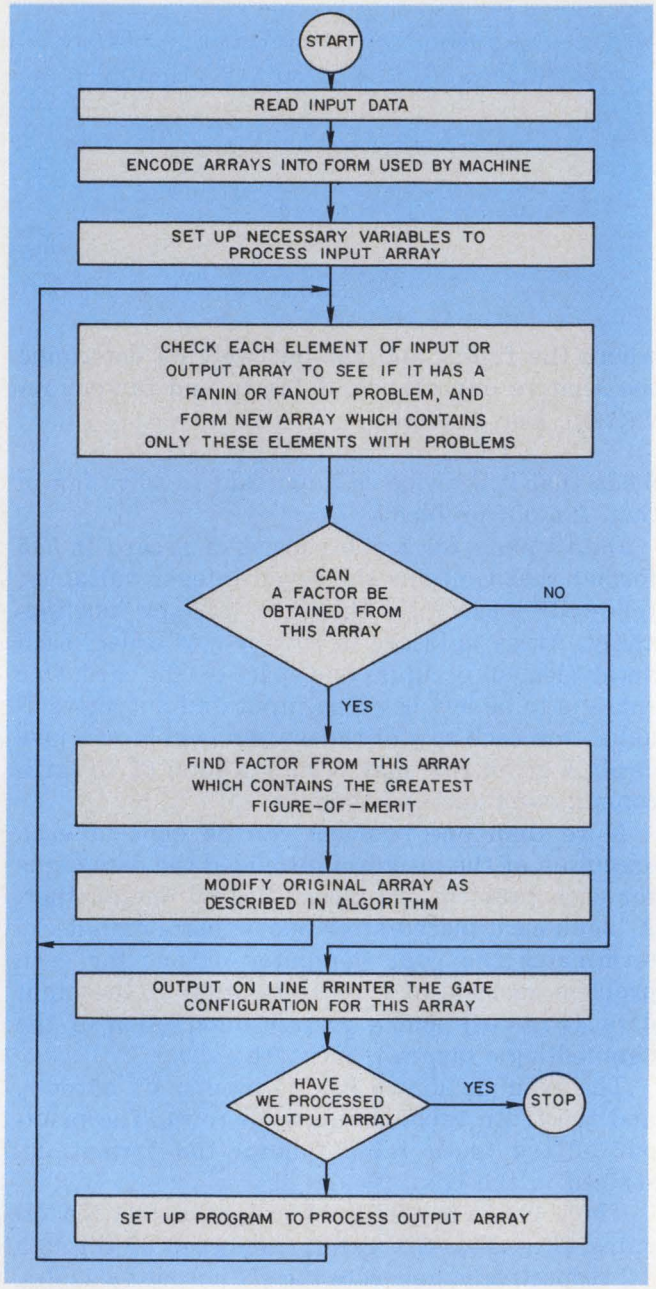
Section	Tasks performed
1	Print headers; read and print input data; encode and store input-data arrays; check for input errors.
2	Count the number of 0's and 1's in each row and column of ICUBE.
3	Check output array for rows with only 0 or X elements; if any exist, delete the entire row from the input and output arrays; print list of deleted rows.
4	Check output array for fan-in or fan-out problems; form array IW that contains only elements with this problem.
5	Do same as in section 4 with the input array.
6	Form the factors of rows in IW; store pointers to these rows in IM.
7	Call subroutines for further array processing.
8	Set up to process output array.

LOGIC, the main program, controls the flow of operations (Fig. 2). The program's functions are to read and to print input data, to encode the incoming arrays, to prepare them then for processing by the subroutines and to call these subroutines.

Procedural subdivisions

Functionally, LOGIC is divided into eight sections, which perform eight tasks (Table 1). Processing begins with section 1. All input information is printed out as a check to the programmer. Array rows are read with a DO loop. The input information is encoded to occupy two bits of the CDC-6400, 60-bit word. Input characters are checked against IRCL for error. IRCL contains only five elements: 0, 1, 2, X and D. If the input contains any other elements there is an error and an error message is printed. The program continues to check the remaining rows for errors, then terminates. At the end of this section the output array (the Z's) are stored in ICUBE and ISTORE; the input array in IM.

Then program execution proceeds to section 2 to count 0's and 1's in the output array—contained in ICUBE—and continues to the third section. The third section is used only once. At completion of section 3, the input array is stored in ICUBE; the output array remains in ISTORE.



2. **Over-all program flow.** The mainline program controls the operations, reads input data, encodes the arrays and then forwards them for processing by subroutines.

This completes preliminary processing.

Processing of the input array according to the algorithm begins. The program returns to section 2, then to sections 5, 6 and 7. LOGIC calls subroutines IFACT and CUBE in section 7. The program keeps cycling—section 2, 5, 6 and 7—until no additional factors can be found in section 6. At this point, section 7 is entered and subroutine OUTPUT is called to produce the necessary gate connections for the input array.

When processing of the input array is completed, control goes to section 8, where the variables necessary to process the output array are set.

The output array previously stored in ISTORE is placed in ICUBE.

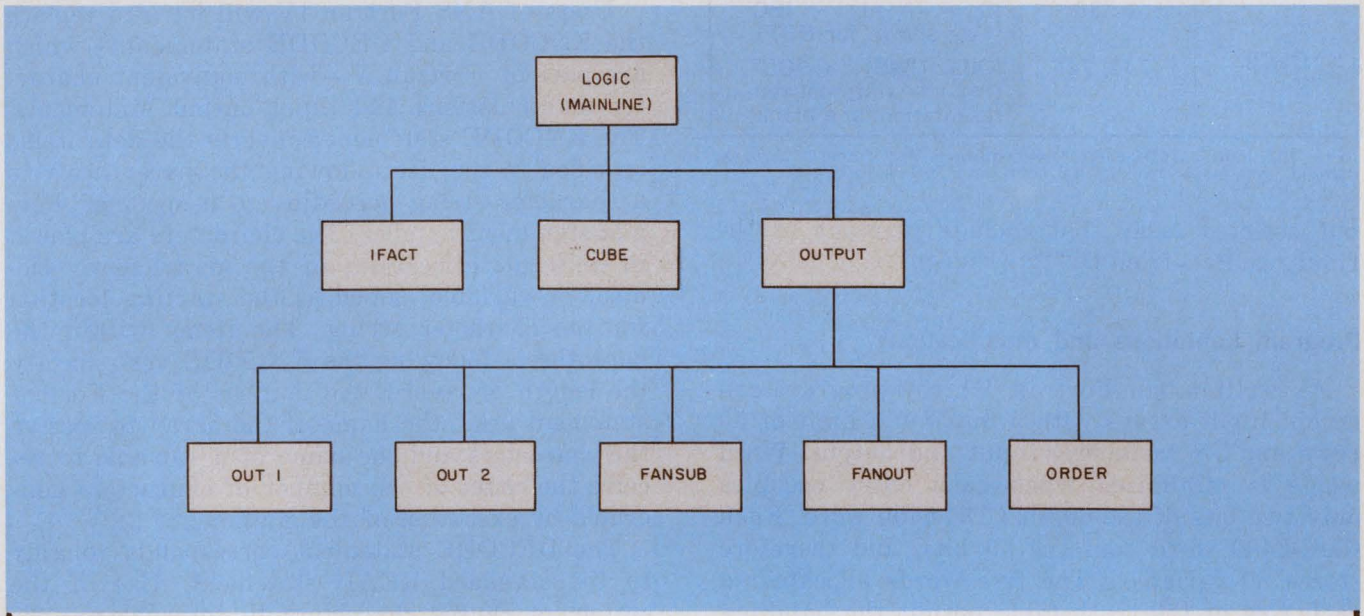
A cycle similar to the one used to process the input array occurs that involves sections 2, 4, 6 and 7. Once again, when no additional factors are found in section 6, subroutine OUTPUT is called to post the output-array information. The program is now completed, so it terminates. A number of important functions are performed by subroutines (Fig. 3). LOGIC, the mainline program, calls the three major subroutines—IFACT, CUBE and OUTPUT. In turn, OUTPUT calls on five minor subroutines—OUT1, OUT2, FANSUB, FANOUT and ORDER.

Subroutine IFACT finds the common factor with the largest figure-of-merit that can reduce fan-in or fan-out problems. The program consists of three sections as follows:

Section 1 — finds factors to be tested.
Section 2 — calculates figures-of-merit for the input array.
Section 3 — calculates figures-of-merit for the output array.

According to the algorithm, an auxiliary row and variable must be added to ICUBE for each term found with IFACT. Elements in ICUBE covered by the factor must be replaced by "don't-care" elements. Both tasks are performed by CUBE.

When LOGIC, IFACT and ICUBE complete the processing of either the input or output array, the array is passed to OUTPUT to produce the necessary gate connections. OUTPUT examines the variables contained in each row, locates fan-in or fan-out problems and keeps track of the gate numbers. Calls to the minor subroutines carry



Major subroutines	Function	Minor subroutines	Subtask performed
IFACT	Finds factor in ICUBE with greatest figure-of-merit.	OUT1	Pads characters for gate connections in IOUT with 6-bit BCD code.
CUBE	Adds auxiliary row and variable for each factor found in ICUBE. Deletes elements in ICUBE covered by that factor and replaces them with "don't care" elements for the output array and X's for the input array.	OUT2	Prints gate connections formed in other subroutines.
		FANSUB	Stores pertinent information on fan-out problems in any row or variable.
OUTPUT	Generates gate connections for input or output arrays. Calls on five additional subroutines for selected subtasks.	FANOUT	Determines if fan-out problem exists and if so, which gate should receive the connection. Uses mostly information processed in FANSUB.
		ORDER	Assures proper processing sequence of auxiliary terms or variables to avoid use of undefined variables in the algorithm.

3. **Subroutines play an important role** in the execution of the algorithm. IFACT and CUBE embody the iterative portions of the algorithm. Once processing by LOGIC, IFACT and CUBE is completed, OUTPUT generates gate connections, keeps track of gate numbers and locates fan-in and fan-out problems.

Table 2. Computer-dependent program changes

Sub-routine	Statement or line no.	Statement or variable change
OUT1	1	IH = (Internal representation of numeral zero) + ICHAR/100
	1, 3	ICOMMA = (Internal representation for a comma)
	3	IPACK = (Symbol to denote a complemented variable)
	4	IPACK = (Internal representation of an "X")
	3, 9	IBC = IBC-N* (IBC/N), where N = no. of characters that can be stored in the computer word. For the CDC-6400, N = 60 bits/word ÷ 6 bits/char.
OUT2	738	IS = (N−1) − IBC; N as shown for OUT1
	741, 744	IOUT (IWC) = IOUT (IWC) + (Internal representation for a blank)

Note: The internal CDC-6400 representations for numeral zero, X, comma, and blank are 27, 30B, 56B and 55B, respectively.

out selected tasks that include printout of the final results—from OUT2 (Fig. 3).

Program limitations and modifications

As written (in Fortran V) the program can accept input arrays with a maximum limit of 50 rows and 75 variables—input and output. Word usage is minimized when each entry occupies only two bits of the 60-bit CDC-6400 word. Each CDC-6400 word contains 60 bits, and therefore stores 30 variables. The five words allocated to each row of the truth table permit the handling of up to 150 variables. More words can be allocated—to handle more variables—but the number of allowable rows is reduced. Each matrix row is stored in successive elements of array ICUBE, such as ICUBE (I, 1), ICUBE (I, 2), etc.

Variables in labelled-common occupy about 50% of the total memory space used. Consider the following dimensioned variables in COMMON: ICUBE (100, 5) IM (50, 200) ISTORE (50, 5) and IW (100, 5). To reduce memory requirements—as well as the capacity of the program—certain relations must be maintained between the size parameters, that are defined by writing ICUBE (I, J), IM (L, M), ISTORE (K, J) and IW (I, J). The meaning of the dimensional parameters I, J, K, L and M is as follows:

I — total number of rows which the program can process;

J — varies with I, increases by one for every 30 variables or part thereof processed;

K — maximum number of rows that can be read into the program;

L — largest number of elements in a factor;

M — largest number of factors that can have the same number of elements.

And the following relationships must be satisfied:

$$K < I$$
$$L \geq K$$
$$M \geq K \text{ and } \geq 2 \cdot \text{Max } (I, J).$$

To have the program occupy more or less memory space, modify the dimension statements for IC0 (I), IC1 (I), ICC1 (I), ICC (I), IM (L, M), IMU (L), IORDER (K), ISAVE (K), IKEEP (I), IKEEPI (I), ISTORE (K, J) and IW (I, J). Use of larger arrays necessitates program changes along with changes to the field lengths specified to the program.

Users of ANS Fortran IV will have to replace the ENCODE and DECODE statements—which are part of Fortran V—with equivalent character manipulations and input/output statements. The ENCODE statement converts the data items specified in the list following the parenthesis to a character string according to a specified Format-statement number. The characters are placed in consecutive locations of the array, array element or variable named as the starting location for the character string. The items within the parenthesis following the ENCODE verb specify the length of record, the number of the Format statement used, the name of the array to receive the characters and the name of a variable to receive the count of the number of characters generated by execution of the statement.

The DECODE statement corresponds roughly to the standard READ statement. Use of the statement causes characters in internal records to be converted to data items. The list portion specifies the items to be decoded as in the READ statement. The items in the parenthesis specify the number of characters to generate per record, the Format statement used, the name of an array, array element or variable that is the starting location for data and the name of a variable to receive a count of the number of characters scanned during the execution of the statement.

In all cases the following Fortran statements in the program listing must be changed to conform to the values selected for these dimensional parameters: Line nos. 24, 26, 214, 450, 523, 524, 532 and 804.

Certain changes must also be made in the program depending on the computer you are using. These changes depend on the number of bits in a

(continued on page 105)

Program listing of NAND synthesis algorithm

Mainline program for data input and control

```
@DATA,IL OF.
DATA005-08/31-14:48
000001          PROGRAM LOGIC (INPUT,OUTPUT)
000002          DIMENSION ICO(100),IC1(100),ICC1(100),ICC(100),MASK(20),MASK1(20),
000003         1 MASK2(20),ICUBE(100,5),IW(100,5),IMU(50),IM(50,200),IO(100),
000004         2IRCL(5),ISTORE(50,5),RU(5)/FMT(3)
000005          COMMON /A/ NC,NV,ICO,IC1,ICC,ICUBE,ISET1,IFI,IFO
000006          COMMON /B/ MASK,MASK1,MASK2
000007          COMMON /C/ IM,IW,IMU
000008          COMMON /D/ IWFO,IWFI
000009          COMMON /E/ ICC1
000010          COMMON /G/ IO,IBIT
000011          DATA IRCL/ 1H0,1H1,1H2,1HX,1HD/
000012      C   THE VALUE OF IBIT = NUMBER OF BITS IN COMPUTER WORD
000013          DATA IBIT/60/
000014          IBIT = IBIT/2
000015          MASK(IBIT) = 3
000016          MASK1(IBIT) = 1
000017          MASK2(IBIT) = 2
000018          IBIT1 = IBIT - 1
000019          DO 120 I = 1,IBIT1
000020          J = IBIT - I
000021          MASK(J) = 4*MASK(J+1)+3
000022          MASK1(J) = 4*MASK1(J+1)+1
000023      120 MASK2(J) = 4*MASK2(J+1)+2
000024      110 DO 1 I=1,50
000025          II = 2*I
000026          DO 1 J=1,5
000027          ICUBE(II-1) = 0
000028          ICUBE(II) = 0
000029          ISTORE(I,J) = 0
000030        1 IM(I,J) = 0
000031          READ 1000, NC,NA,NVO,IFI,IFO,IWFI,IWFO
000032     1000 FORMAT(10I5)
000033          IF(NC .EQ. 0) GO TO 100
000034          PRINT 1001, NC,NA,NVO,IFI,IFO,IWFI,IWFO
000035     1001 FORMAT(*1NO. OF CUBES                = *I3/* NO. OF INPUT VARIABLES  =
000036         1 *I3/* NO. OF OUTPUT VARIABLES = *I3/* FANIN LIMIT              = *
000037         2 I3/* FANOUT LIMIT              = *I3/* FANIN WEIGHT             = *
000038         3 I3/* FANOUT WEIGHT             = *I3///)
000039          ISET = 1
000040          IERROR = 1
000041          NV5 = NA
000042          NA2 = 1+NA/2
000043          NV2 = (NA+NVO)/2)-1
000044          IF(NVO .LE. 6) NV2 = 2+NA/2
000045          ENCODE(30,1002,FMT)NA2,NV2
000046     1002 FORMAT(1H(I3,8HX=INPUT*I3,10HX=OUTPUT*))
000047          PRINT FMT
000048          IP = 1+MAX0(NA,NVO)/10
000049          DO 2 I=2,IP
000050        2 IO(I) = I-1
000051          IP = 1+NA/10
000052          IO(1) = 1HX
000053          PRINT 1003, (IO(I), I=1,IP)
000054     1003 FORMAT(7X,A1,I9,*110)
000055          NV2 = 7+NA
000056          IO(1) = 1HZ
000057          ENCODE(30,1004,FMT) NV2
000058     1004 FORMAT(9H(**I3,13HX,A1,I9,4I10))
000059          IP = 1+NVO/10
000060          PRINT FMT,(IO(I), I=1,IP)
000061          IP = MAX0(NA,NVO)
000062          DO 3 I=1,IP
000063        3 IO(I) = I-(I/10)*10
000064          PRINT 1005, (IO(I), I=1,NA)
000065     1005 FORMAT(7X,50I1)
000066          ENCODE(30,1006,FMT) NV2
000067     1006 FORMAT(9H(**I3,7HX,50I1))
000068          PRINT FMT, (IO(I), I=1,NVO)
000069          NR = NA*NVO+1
000070          PRINT 1007
000071     1007 FORMAT(* *)
000072          DO 22 I=1,NC
000073          NN = NA+2
000074          MM = NR
000075          NV = NVO
000076          READ 1008, (IO(J),J=1,NR)
000077     1008 FORMAT(80A1)
000078          PRINT 1009, I,(IO(J), J=1,NR)
000079     1009 FORMAT(* C*,I2,3X,101A1)
000080       10 DO 16 N=NN,MM
000081          J=N
000082          IF(J .GT. NA) J = J-NA-1
000083          IJ = 1 + (J-I)/IBIT
000084          DO 11 IC=1,2
000085       11 IM(I,IJ) = IM(I,IJ)+1M(I,IJ)
000086          K=0
000087          DO 12 L=1,5
000088          IF(IO(N) .EQ. IRCL(L)) GO TO (13,14,15,15,15), L
000089       12 CONTINUE
000090          PRINT 1011
000091     1011 FORMAT(/ * ERROR IN INPUT DATA, CHECK LAST PRINTED LINE FOR INVAL
000092         1ID CHARACTER*/35X*PROGRAM WILL TERMINATE AFTER ALL INPUT DATA IS C
000093         2HECKED FOR ERRORS*/)
000094          IERROR = 2
000095       13 K=1
000096          GO TO 15
000097       14 K=2
000098       15 IM(I,IJ) = IM(I,IJ)+K
000099       16 CONTINUE
000100          GO TO (17,19), IERROR
000101       17 IUP = 1+(NV-1)/IBIT
000102          IS = 2*(IBIT-NV+IBIT*(IUP-1))
000103          IF(IS .EQ. 0) GO TO 19
000104          DO 18 IC=1,IS
000105       18 IM(I,IJ) = IM(I,IJ) +IM(I,IJ)
000106       19 IF(N .LE. NA) GO TO 22
000107          NN = 1
000108          MM = NA
000109          NV = NA
000110          GO TO (20,10), IERROR
000111       20 DO 21 IJ = 1,IUP
000112          ISTORE(I,IJ) = IM(I,IJ)
000113          ICUBE(I,IJ) = IM(I,IJ)
000114       21 IM(I,IJ) = 0
000115          GO TO 10
000116       22 CONTINUE
000117          NV = NVO
000118          GO TO (30,100), IERROR
000119       30 DO 31 I=1,100
000120          ICC1(I) = 0
000121          ICO(I) = 0
000122          IC1(I) = 0
000123       31 ICC(I) = 0
000124          DO 35 I=1,NC
000125          DO 34 JJ=1,NV
000126          JJJ = (JJ-1)/IBIT
000127          J = JJ-IBIT*JJJ
000128          IJ = 1+JJJ
000129          INM = ICUBE(I,IJ) .AND. MASK(J)
000130          IF(INM-MASK1(J)) 34,32,33
000131       32 ICO(JJ) = ICO(JJ)+1
000132          ICC(I) = ICC(I) +1
000133          GO TO 34
000134       33 IC1(JJ) = IC1(JJ)+1
000135          ICC1(I) = ICC1(I)+1
000136       34 CONTINUE
000137          ICC(I) = ICC(I)+ICC1(I)
000138       35 CONTINUE
000139          IUP = 1+(NV-1)/IBIT
000140          GO TO (40,50,60), ISET
000141       40 II=0
000142          NOUT = 0
000143          NV = NA
000144          NM = MAX0(NA,NVO)
000145          IUP = 1+(NM-1)/IBIT
000146          DO 44 I=1,NC
000147          IF(ICC1(I) .EQ. 0) GO TO 42
000148          II = II+1
000149          DO 41 IJ=1,IUP
000150          ICUBE(II,IJ) = IM(I,IJ)
000151       41 ISTORE(II,IJ) = ISTORE(I,IJ)
000152          GO TO 44
000153       42 IF(NOUT .NE. 0) GO TO 43
000154          NOUT = 1
000155          PRINT 1012
000156     1012 FORMAT(//* DELETED CUBES*)
000157       43 PRINT 1013, I
000158     1013 FORMAT(* C*12)
000159       44 CONTINUE
000160          NCS = II
000161          NC = II
000162          ISET = 3
000163          PRINT 1014
000164     1014 FORMAT(//)
000165          GO TO 30
000166       50 DO 59 II=1,NC
000167          DO 51 IJ=1,IUP
000168       51 IW(II,IJ) = 0
000169          IOC = 0
000170          DO 52 JJ=1,NV
000171          IF(IC1(JJ) .LE. IFI) GO TO 52
000172          IWORD = 1+(JJ-1)/IBIT
000173          J = JJ-(IWORD-1)*IBIT
000174          ICM = ICUBE(II,IWORD) .AND. MASK2(J)
000175          IF(ICM .NE. 0) IOC = IOC+1
000176          IW(II,IWORD) = IW(II,IWORD) .OR. ICM
000177       52 CONTINUE
000178          IZ = 7777777777777777778
000179          IF(ICC1(II) .GT. IFO) GO TO 55
000180          IF(IOC .GT. 1) GO TO 54
000181          DO 53 IJ=1,IUP
000182       53 IW(II,IJ) = 0
000183          GO TO 59
000184       54 IZ=0
000185       55 DO 58 JJ=1,NV
000186          IWORD = 1+(JJ-1)/IBIT
000187          J = JJ-(IWORD-1)*IBIT
000188          MUU = ICUBE(II,IWORD) .AND. MASK(J)
000189          IF(MUU-MASK1(J)) 57,58,56
000190       56 IH = IW(II,IWORD) .OR. MASK2(J)
000191          IW(II,IWORD) = (IH .AND. IZ) .OR. IW(II,IWORD)
000192          GO TO 58
000193       57 IW(II,IWORD) = IW(II,IWORD) .OR. MASK2(J)
000194       58 CONTINUE
000195       59 CONTINUE
000196          GO TO 70
000197       60 DO 86 II = 1,NC
000198          DO 61 IJ=1,IUP
000199       61 IW(II,IJ) = 0
000200          IF(ICC(II) .LE. IFI) GO TO 63
000201          DO 62 IJ=1,IUP
000202       62 IW(II,IJ) = ICUBE(II,IJ)
000203          GO TO 66
000204       63 DO 65 JJ=1,NV
000205          IWORD = (JJ-1)/IBIT
000206          J = JJ-IWORD*IBIT
000207          IF(ICO(JJ) .LE. IFO) GO TO 64
000208          IW(II,IWORD+1) = IW(II,IWORD+1)+(ICUBE(II,IWORD+1) .AND. MASK1(J))
000209       64 IF(IC1(JJ) .LE. IFO) GO TO 65
000210          IW(II,IWORD+1) = IW(II,IWORD+1)+(ICUBE(II,IWORD+1) .AND. MASK2(J))
000211       65 CONTINUE
000212       66 CONTINUE
000213       70 NCC = NC-1
000214          DO 71 M=1,50
000215       71 IMU(M) = 0
000216          MAX = 0
000217          DO 77 II=1,NCC
000218          III = II+1
000219          DO 76 JJ=III,NC
000220          DO 72 IJ=1,IUP
000221       72 MU(IJ) = IW(II,IJ) .AND. IW(JJ,IJ)
000222          IF(ISET .EQ. 3) GO TO 74
000223          INDI = 0
000224          INDJ = 0
000225          DO 73 LL=1,NV
000226          IK = 1+(LL-1)/IBIT
000227          L = LL-IBIT*(IK-1)
000228          MFACI = (MU(IK) .AND. ICUBE(II,IK)) .AND. MASK2(L)
000229          MFACJ = (MU(IK) .AND. ICUBE(JJ,IK)) .AND. MASK2(L)
000230          IF(MFACI .EQ. MASK2(L)) INDI = INDI+1
000231          IF(MFACJ .EQ. MASK2(L)) INDJ = INDJ+1
000232          IF((INDI .GE. 2) .AND. (INDJ .GE. 2)) GO TO 74
000233       73 CONTINUE
000234          GO TO 76
000235       74 M=-1
000236          DO 75 KK=1,NV
000237          IJ = 1+(KK-1)/IBIT
000238          K = KK-(IJ-1)*IBIT
000239          IF((MU(IJ) .AND. MASK(K)) .EQ. 0) GO TO 75
000240          M = M+1
000241       75 CONTINUE
000242          IF(M .LE. 0) GO TO 76
000243          IMU(M) = IMU(M)+1
000244          IMUC = IMU(M)
000245          IM(M,IMUC) = 1000*II+JJ
000246          IF(M .GT. MAX) MAX = M
000247       76 CONTINUE
000248       77 CONTINUE
000249          ISET1 = ISET-1
000250          IF(MAX .LE. 0) GO TO 80
000251          CALL IFACT(MAX)
000252          CALL CUBE
000253          GO TO 30
000254       80 CALL OUTPUT(NCS,NVS)
000255          IF(ISET .EQ. 2) GO TO 110
000256          ISET = 2
000257          NC = NCS
000258          NV = NVO
000259          NVS = NVO
000260          DO 90 I=1,NCS
000261          DO 90 IJ=1,IUP
000262       90 ICUBE(I+IJ) = ISTORE(I+IJ)
000263          GO TO 30
000264      100 STOP
000265          END
```

Major Subroutines

```
000266          SUBROUTINE IFACT(MAX)
000267          DIMENSION ICO(100),IC1(100),ICC1(100),ICC(100),MASK(20),MASK1(20),
000268         1 MASK2(20),ICUBE(100,5),IW(100,5),IMU(50),IM(50,200),IST(100,2),
000269         2 IV(2),MUA(5),MUU(5),IA(5),IO(100)
000270          COMMON /A/ NC,NV,ICO,IC1,ICC,ICUBE,ISET1,IFI,IFO
000271          COMMON /B/ MASK,MASK1,MASK2
000272          COMMON /C/ IM,IW,IMU
000273          COMMON /D/ IWFO,IWFI
000274          COMMON /E/ ICC1
000275          COMMON /F/ IST,MUU,IVV,N
000276          COMMON /G/ IO,IBIT
000277          IV = 1
000278          INDI = 2
000279          INDJ = 2
000280          N=1
000281          ISAVE = 1
000282          IR = 1
000283          MX = MAX
000284          IMM = IMU(MAX)
000285          IF(MAX-2) 4,1,2
000286        1 IF(IMU(MAX-1) .EQ. 0) GO TO 4
000287          MX = MAX-1
000288          IMM = IMU(MX)
000289          IR = 2
000290          GO TO 4
000291        2 IF(IMU(MAX-1) .EQ. 0) GO TO 3
000292          MX = MAX-1
000293          IMM = IMU(MX)
000294          IR = 2
000295        3 IF(IMU(MAX-2) .EQ. 0) GO TO 4
000296          MX = MAX-2
000297          IMM = IMU(MX)
000298          IR = IR+2
000299        4 ISS = IR
000300          ISM = MX
000301          IDO = IMM
000302          IVV(N) = 0
000303          IFACI = IM(MX,IV)/1000
000304          IFACJ = IM(MX,IV) -1000*IFACI
000305          IUP = 1+(NV-1)/20
000306          DO 10 IJ=1,IUP
000307       10 MUU(IJ) = IW(IFACI,IJ) .AND. IW(IFACJ,IJ)
000308          DO 19 KK=1,IDO
000309          ITI = IM(MX,KK)/1000
000310          ITJ = IM(MX,KK) -1000*ITI
000311          DO 12 IJ=1,IUP
000312          MUA(IJ) = (IW(ITI,IJ) .AND. IW(ITJ,IJ)) .AND. MUU(IJ)
000313          IF(MUA(IJ) .NE. MUU(IJ)) GO TO 19
000314       12 CONTINUE
```

```
      IF(ISET1 .EQ. 2) GO TO 14
      INDI = 0
      INDJ = 0
      DO 13 JJ=1,NV
      IJ = 1+(JJ-1)/IBIT
      J = JJ-IBIT*(IJ-1)
      MFACI = (MUA(IJ) .AND. ICUBE(ITI,IJ)) .AND. MASK2(J)
      MFACJ = (MUA(IJ) .AND. ICUBE(ITJ,IJ)) .AND. MASK2(J)
      IF(MFACI .EW. MASK2(J)) INDI = INDI+1
      IF(MFACJ .EQ. MASK2(J)) INDJ = INDJ+1
      IF((INDI .GE. 2) .AND. (INDJ .GE. 2)) GO TO 14
   13 CONTINUE
   14 IF(IVV(N) .GE. 2) GO TO 15
      IST(1,N) = ITI
      IST(2,N) = ITJ
      IVV(N) = 2
      GO TO 19
   15 IVN = IVV(N)
      IF(INDI .LT. 2) GO TO 17
      DO 16 MM=1,IVN
      IF(ITI .EQ. IST(MM,N)) GO TO 17
   16 CONTINUE
      IVV(N) = IVV(N)+1
      IVN = IVV(N)
      IST(IVN,N) = ITI
   17 IF(INDJ .LT. 2) GO TO 19
      DO 18 MM=1,IVN
      IF(ITJ .EQ. IST(MM,N)) GO TO 19
   18 CONTINUE
      IVV(N) = IVV(N)+1
      IVN = IVV(N)
      IST(IVN,N) = ITJ
   19 CONTINUE
      GO TO (22,20,20,21), IR
   20 IDO = IMU(MAX)
      IR = 1
      MX = MAX
      GO TO 11
   21 IDO = IMU(MAX-1)
      IR = 2
      MX = MAX-1
      GO TO 11
   22 IR = ISS
      MX = ISM
      IVN = IVV(N)
      NTOTAL = (MX+1)*IVN*(IWFO+IWFI)
      IF(NTOTAL .LE. ISAVE) GO TO 51
      GO TO (30,40),ISET1
   30 NMAX = 0
      NMAXT = 0
      DO 33 KK=1,IVN
      I = IST(K,N)
      DO 31 IJ=1,IUP
   31 IA(IJ) = ICUBE(I,IJ) .AND. MUU(IJ)
      NCC = 0
      DO 32 JJ=1,NV
      JJJ = (JJ-1)/IBIT
      J = JJ-JJJ*IBIT
      IJ = JJJ+1
      IB = IA(IJ) .AND. MASK2(J)
      IF((IB-MASK1(J)) .LE. 0) GO TO 32
      NCC = NCC+1
      IF(IC1(JJ) .LE. IFI) GO TO 32
      NMAXT = NMAXT+1
   32 CONTINUE
      IF(ICC1(I) .LE. IFO) GO TO 33
      NMAX = NMAX+IWFO*NCC
   33 CONTINUE
      NMAX = NMAX+IWFI*NMAXT
      GO TO 50
   40 NCC = 0
      DO 44 KK=1,NV
      KKK = (KK-1)/IBIT
      K = KK-KKK*IBIT
      IJ = KKK+1
      IUU = MUU(IJ) .AND. MASK(K)
      IF(IUU-MASK1(K)) 44,41,42
   41 IF(IC0(KK) .LE. IFO) GO TO 44
      GO TO 43
   42 IF(IC1(KK) .LE. IFO) GO TO 44
   43 NCC = NCC+1
   44 CONTINUE
      NMAX = NCC*IVN*IWFO
      DO 45 K=1,IVN
      I= IST(K,N)
      IF(ICC(I) .LE. IFI) GO TO 45
      NMAX = NMAX+(MX+1)*IWFI
   45 CONTINUE
   50 IF(NMAX .LE. ISAVE) GO TO 51
      ISAVE = NMAX
      N= 3-N
   51 IV = IV+1
      IF(IV .LE. IMM) GO TO 4
      IV= 1
      GO TO (52,60,60,61), ISS
   60 IMM = IMU(MAX)
      IR = 1
      MX = MAX
      NTOTAL = IMM*(MX+1)*(IWFO+IWFI)
      IF(NTOTAL .LE. ISAVE) GO TO 62
      GO TO 4
   61 IMM = IMU(MAX-1)
      IR = 2
      MX = MAX-1
      NTOTAL = (IMM*(MX+1)+IMU(MAX)*(MAX+1))*(IWFO+IWFI)
      IF(NTOTAL .LE. ISAVE) GO TO 60
      GO TO 4
   62 N = 3-N
      IN = IVV(N)
      II = IST(1,N)
      JJ = IST(2,N)
      IF(ISET1 .EW. 1) GO TO 80
      DO 70 IJ=1,IUP
   70 MUU(IJ) = IW(II,IJ) .AND. IW(JJ,IJ)
      RETURN
   80 DO 81 IJ=1,IUP
      MUA(IJ) = IW(II,IJ) .AND. IW(JJ,IJ)
   81 MUU(IJ) = MUA(IJ) .AND. (.NOT. ICUBE(II,IJ))
      DO 82 I=1,IN
      DO 82 IJ=1,IUP
      II = IST(I,N)
   82 MUU(IJ) = MUU(IJ) .AND. (.NOT. ICUBE(II,IJ))
      DO 83 IJ=1,IUP
   83 MUU(IJ) = MUA(IJ) .AND. (.NOT. MUU(IJ))
      RETURN
      END
C
      SUBROUTINE CUBE
      DIMENSION IC0(100),IC1(100),ICC(100),MASK(20),MASK1(20),MASK2(20),
     1 ICUBE(100,5),IST(100,2),IVV(2),IA(5),IB(5),IC(5),ID(5),
     2  MUU(5),IO(100)
      COMMON /A/ NC,NV,IC0,IC1,ICC,ICUBE,ISET1,IFI,IFO
      COMMON /B/ MASK,MASK1,MASK2
      COMMON /F/ IST,MUU,IVV,N
      COMMON /G/ IO,IBIT
      DO 1 I=1,5
      IA(I) = 0
      IB(I) = 0
      IC(I) = 0
    1 ID(I) = 0
      II = IST(1,N)
      JJ = IST(2,N)
                                                          ,HCNUP,TUPNI,FBYP
      IF(ISET1 .EW. 1) GO TO 20
   10 DO 12 JJ=1,NV
      JJJ = (JJ-1)/IBIT
      J = JJ-JJJ*IBIT
      IJ = JJJ+1
      K = MUU(IJ) .AND. MASK(J)
      IF(K .EQ. 0) GO TO 11
      IA(IJ) = IA(IJ)+K
      GO TO 12
   11 IC(IJ) = IC(IJ)+MASK(J)
   12 CONTINUE
      NC = NC+1
      DO 13 IJ=1,IUP
   13 ICUBE(NC,IJ) = IA(IJ)
      NV = NV+1
      IUP = 1+(NV-1)/IBIT
      NVI = NV-(IUP-1)*IBIT
      IB(IUP) = MASK2(NVI)
      IN = IVV(N)
      DO 14 II=1,IN
      MII = IST(II,N)
      DO 14 IJ=1,IUP
   14 ICUBE(MII,IJ) = (ICUBE(MII,IJ) .AND. IC(IJ)) .OR. IB(IJ)
      GO TO 30
   20 DO 22 JJ=1,NV
      JJJ = (JJ-1)/IBIT
      J = JJ-JJJ*IBIT
      IJ = JJJ+1
      K = MUU(IJ) .AND. MASK(J)
      IF(K .EQ. 0) GO TO 21
      IA(IJ) = IA(IJ)+K
      GO TO 22
   21 IA(IJ) = IA(IJ)+MASK1(J)
      IC(IJ) = IC(IJ)+MASK(J)
   22 CONTINUE
      NC = NC+1
      NV = NV+1
      DO 23 IJ=1,IUP
   23 ICUBE(NC,IJ) = IA(IJ)
      IUP = 1+(NV-1)/IBIT
      NVI = NV-(IUP-1)*IBIT
      IB(IUP) = MASK2(NVI)
      ID(IUP) = MASK1(NVI)
      DO 24 KK=1,NC
      DO 24 IJ=1,IUP
   24 ICUBE(KK,IJ) = ICUBE(KK,IJ) .OR. ID(IJ)
      IN = IVV(N)
      DO 25 II=1,IN
      MII = IST(I,N)
      DO 25 IJ=1,IUP
   25 ICUBE(MII,IJ) = (ICUBE(MII,IJ) .AND. IC(IJ)) .OR. IB(IJ)
   30 RETURN
      END
C
      SUBROUTINE OUTPUT(NCO,NVO)
      DIMENSION IC0(100),IC1(100),ICC1(100),ICC(100),MASK(20),MASK1(20),
     1  ICUBE(100,5),IKEEP(100),IKEEPI(100),IORDER(50),IM(50,200),
     2  IOUT(100)
      COMMON /A/ NC,NV,IC0,IC1,ICC,ICUBE,ISET1,IFI,IFO
      COMMON /B/ MASK,MASK1,MASK2
      COMMON /C/ IM
      COMMON /E/ ICC1
      COMMON /G/ IOUT,IBIT
      COMMON /H/ IORDER
      COMMON /OUT/ IBC,IWC
      DO 1 I=1,50
      DO 1 J=1,200
    1 IM(I,J) = 0
      DO 2 I=1,100
    2 IOUT(I) = 0
      IUP = 1+(NV-1)/IBIT
      IWC = 1
      IBC = 0
      IF(ISET1 .EQ. 1) GO TO 40
      DO 3 I=1,100
    3 IKEEPI(I) = 0
      NCC = 0
      IGO = 2
      II = NCO+1
      JJ = NC
      DO 13 J=1,NVO
      IF(IC1(J) .GT. IFO) GO TO 11
   10 IF(IC0(J) .LE. IFO) GO TO 13
      IGOO = 1
      ICHAR = -J
      IUSE = IC0(J)
      GO TO 12
   11 IGOO = 2
      ICHAR = J
      IUSE = IC1(J)
   12 IL = 2*J+IGOO-2
      CALL FANSUB(IL,IUSE,NCC,IFO,NC,NV,ICHAR,1,0)
      GO TO (13,10), IGOO
   13 CONTINUE
      IF(NCO .EQ. NC) GO TO 30
      CALL ORDER(IUP,NCO,NVO,NC,NV,ICUBE,ISET1)
      DO 28 MK=II,JJ
      III = MK
      IF(IGO .EQ. 2) III=IORDER(MK-NCO)
      NCC = NCC+1
      LC = 0
      LCT = 0
      DO 27 JJJ=1,NV
      ILAB = 0
      ICOM = 0
      JJJJ = (JJJ-1)/IBIT
      J = JJJ-JJJJ*IBIT
      IJ = JJJJ+1
   21 IA = ICUBE(III,IJ) .AND. MASK(J)
      IF(IA-MASK1(J)) 27,22,23
   22 CALL FANOUT(JJJ,1,IRET,ICHAR,IFO,IM)
      IF(IRET .EQ. 2) GO TO 24
      ICHAR = -JJJ
      ILAB = 1
      GO TO 24
   23 CALL FANOUT(JJJ,2,IRET,ICHAR,IFO,IM)
      IF(IRET .EQ. 2) GO TO 24
      ICHAR = JJJ
      ILAB = 1
      IF(IKEEPI(JJJ) .EQ. 0) GO TO 24
      ILAB = 0
      ICHAR = IKEEPI(JJJ)
   24 LC = LC+1
      LCT = LCT+1
      IF(LC .NE. IFI) GO TO 25
      IF(LCT .EQ. ICC(III)) GO TO 26
      CALL OUT1(ICHAR,ILAB,0)
      CALL OUT2(NCC)
      NS = NCC
      NCC=NCC+1
      LC=1
      CALL OUT1(NS,0,0)
      CALL OUT2(NCC)
      CALL OUT1(NCC,0,1)
      NCC = NCC+1
      GO TO 27
   25 IF(LCT .EQ. ICC(III)) GO TO 26
      ICOM = 1
   26 CALL OUT1(ICHAR,ILAB,ICOM)
   27 CONTINUE
      CALL OUT2(NCC)
      IF(III .LE. NCO) GO TO 28
      NS = NCC
      NCC = NCC+1
      CALL OUT1(NS,0,0)
      CALL OUT2(NCC)
      ISCR = NV-NC+III
      IKEEPI(ISCR) = NCC
      IF(IC1(ISCR) .LE. IFO) GO TO 28
      CALL FANSUB(2*ISCR,IC1(ISCR),NCC,IFO,NC,NV,NCC,0,0)
   28 IKEEP(III) = NCC
   30 IF(IGO .EQ. 1) GO TO 70
      IGO = 1
      II = 1
      JJ = NCO
      GO TO 20
   40 II = NVO+1
      JJ = NV
      IGO = 2
      DO 41 I = 1,NCO
      IF(ICC1(I) .LE. IFO) GO TO 41
      IL = 2*I
      CALL FANSUB(IL,ICC1(I),NCC,IFO,NC,NV,IKEEP(I),0,0)
   41 CONTINUE
      NCC = NCC+1
      IF(NVO .EQ. NV) GO TO 60
      CALL ORDER(IUP,NCO,NVO,NC,NV,ICUBE,ISET1)
   50 DO 57 LL=II,JJ
      JJJ = LL
      IF(IGO .EQ. 2) JJJ= IORDER(LL-NVO)
      IJ = 1+(JJJ-1)/IBIT
      J = JJJ-(IJ-1)*IBIT
      LC = 0
      LCT = 0
      DO 54 III=1,NC
      ILAB = 0
      ICOM = 0
      IA = ICUBE(III,IJ) .AND. MASK(J)
      IF((IA-MASK1(J)) .LE. 0) GO TO 54
```

```
      LC = LC+1
      LCT = LCT+1
      CALL FANOUT(III,2,IRET,ICHAR,IFO,IM)
      IF(IRET .EQ. 1) GO TO 51
      IKEEP(III) = ICHAR
   51 ICHAR = IKEEP(III)
      IF(LC .NE. IFI) GO TO 52
      IF(LCT .EQ. IC1(JJJ)) GO TO 53
      CALL OUT1(ICHAR,0,0)
      CALL OUT2(NCC)
      NS = NCC
      NCC = NCC+1
      LC = 1
      CALL OUT1(NS,0,0)
      CALL OUT2(NCC)
      CALL OUT1(NCC,0,1)
      NCC = NCC+1
      GO TO 54
   52 IF(LCT .EQ. IC1(JJJ)) GO TO 53
      ICOM = 1
   53 CALL OUT1(ICHAR,0,ICOM)
   54 CONTINUE
      CALL OUT2(NCC)
      NCC = NCC+1
      LC = 0
      IF(IGO .EQ. 1) GO TO 56
      NS = NCC-1
      CALL OUT1(NS,0,0)
      CALL OUT2(NCC)
      ISCR = NC-NV+JJJ
      IKEEP(ISCR) = NCC
      IF(ICC1(ISCR) .LE. IFO) GO TO 55
      CALL FANSUB(2*ISCR,ICC1(ISCR),NCC,IFO,NC,NV,NCC,0,0)
   55 NCC = NCC+1
      GO TO 57
   56 PRINT 1000, LL
 1000 FORMAT(*+Z*12)
   57 CONTINUE
   60 IF(IGO .EQ. 1) GO TO 70
      IGO = 1
      II = 1
      JJ = NV0
      GO TO 50
   70 RETURN
      END
C
```

Minor Subroutines

```
      SUBROUTINE OUT1(ICHAR,ILAB,ICOM)
      DIMENSION IOUT(100)
      COMMON /G/ IOUT,IBIT
      COMMON /OUT/ IBC,IWC
      ITA = 6
      IST = 3
      IF(ICOM .EQ. 0) ITA = ITA-1
      IF(ILAB .EQ. 0) GO TO 1
      IST = 2
      IF(ICHAR .GE. 0) GO TO 1
      ICHAR = -ICHAR
      IST = 1
    1 IH = 27+ICHAR/100
      IT = 27+(ICHAR-100*(IH-27))/10
      IU = 27+ICHAR-100*(IH-27)-10*(IT-27)
      ICOMMA = 56B
      IF(ICHAR .GE. 100) GO TO 2
      ITA = ITA-1
      IH = IT
      IT = IU
      IU = ICOMMA
      IF(ICHAR .GE. 10) GO TO 2
      ITA = ITA-1
      IH = IT
      IT = IU
    2 DO 10 IDO = IST,ITA
      GO TO (3,4,5,6,7,8), IDO
    3 IPACK = 76B
      GO TO 9
    4 IPACK = 30B
      GO TO 9
    5 IPACK = IH
      GO TO 9
    6 IPACK = IT
      GO TO 9
    7 IPACK = IU
      GO TO 9
    8 IPACK = ICOMMA
    9 IOUT(IWC) = IOUT(IWC)+IPACK
      IBC = IBC+1
      IWC = IWC+IBC/10
      IBC = IBC-10*(IBC/10)
      DO 10 K=1,6
      IOUT(IWC) = IOUT(IWC)+IOUT(IWC)
   10 CONTINUE
      RETURN
      END
C
```

```
      SUBROUTINE OUT2(NCC)
      DIMENSION IOUT(100)
      COMMON /G/ IOUT,IBIT
      COMMON /OUT/ IBC,IWC
      IWC = IWC+1
      IF(IBC .EQ. 0) GO TO 4
      IWC = IWC+1
      IS = 9-IBC
      IF(IS) 3,3,1
    1 DO 2 K=1,IS
      IOUT(IWC) = IOUT(IWC)+55B
      DO 2 K=1,6
    2 IOUT(IWC) = IOUT(IWC)+IOUT(IWC)
    3 IOUT(IWC) = IOUT(IWC)+55B
    4 PRINT 1000, NCC, (IOUT(I),I=1,IWC)
 1000 FORMAT(7X,I3,*  NAND     *10A10)
      DO 5 I=1,IWC
    5 IOUT(I) = 0
      IWC = 1
      IBC = 0
      RETURN
      END
C
```

```
      SUBROUTINE FANSUB(IL,IUSE,NCC,IFO,NC,NV,ISTOR,ILAB,ICOM)
      DIMENSION IM(50,200)
      COMMON /C/ IM
      ICHAR = ISTOR
      ILEFT = IUSE
      INN = ILEFT-IFO
      IN = (INN-1)/(IFO-1)
      NCC = NCC+1
      IM(1,IL) = 1
      IM(2,IL) = NCC+1
      IM(3,IL) = INN-IN*(IFO-1)
      IM(4,IL) = ILEFT
      IN = 2*IN+1
      CALL OUT1(ICHAR,ILAB,ICOM)
      CALL OUT2(NCC)
      DO 1 K=1,IN
      NS = NCC
      NCC = NCC+1
      CALL OUT1(NS,0,0)
    1 CALL OUT2(NCC)
      RETURN
      END
C
```

```
      SUBROUTINE FANOUT(IARR,IEO,IRET,ICHAR,IFO,IM)
      DIMENSION IM(50,200)
      IL = 2*IARR+IEO-2
      IRET = 1
      IF(IM(1,IL) .EQ. 0) RETURN
      IF(IM(4,IL) .GT. IFO) GO TO 1
      ICHAR = IM(2,IL)
      IRET = 2
      RETURN
```

```
    1 IF(IM(1,IL) .NE. 2) GO TO 2
      ICHAR = IM(2,IL)
      IRET = 2
    2 IF(IM(3,IL) .NE. 1) GO TO 3
      IM(2,IL) = IM(2,IL) + 2*(IM(1,IL)-1)
      IM(1,IL) = 2
      IM(3,IL) = IFO
    3 IM(4,IL) = IM(4,IL)-1
      IM(3,IL) = IM(3,IL) -1
      RETURN
      END
C
```

```
      SUBROUTINE ORDER(IUP,NCO,NVO,NC,NV,ICUBE,ISET1)
      DIMENSION ISAVE(50),IORDER(50),MASK1(20),MASK2(20),MASK(20),
     1 ICUBE(100,5),IO(100)
      COMMON /B/ MASK,MASK1,MASK2
      COMMON /G/ IO,IBIT
      COMMON /H/ IORDER
      DO 1 I=1,50
    1 ISAVE(I) = 1
      JS = 0
      IND = 0
      IF(ISET1 .EQ. 1) GO TO 20
      JUP = 1+NVO/IBIT
      NVS = 1+NVO-(NVO/IBIT)*IBIT
      II = NCO+1
   10 DO 16 I=II,NC
      IF(ISAVE(I-NCO) .EQ. 0) GO TO 16
      DO 11 IJ=JUP,IUP
      IF(ICUBE(I,IJ) .GE. MASK1(NVS)) GO TO 13
   11 CONTINUE
   12 JS = JS+1
      IORDER(JS) = I
      ISAVE(I-NCO) = 0
      GO TO 16
   13 NV1 = NVO+1
      DO 14 IPOS = NV1,NV
      J = IPOS-IBIT*((IPOS-1)/IBIT)
      IJ = 1+(IPOS-1)/IBIT
      IA = ICUBE(I,IJ) .AND. MASK(J)
      IF(IA .EQ. 0) GO TO 14
      IF(ISAVE(NC-NV+IPOS-NCO) .NE. 0) GO TO 15
   14 CONTINUE
      GO TO 12
   15 IND = 1
   16 CONTINUE
      IF(IND .EQ. 0) GO TO 30
      IND = 0
      GO TO 10
   20 II = NVO+1
   21 DO 24 J=II,NV
      IF(ISAVE(J-NVO) .EQ. 0) GO TO 24
      NC1 = NCO+1
      ISUB = 1+(J-1)/IBIT
      NVS = J-IBIT*((J-1)/IBIT)
      DO 22 I=NC1,NC
      IF((ICUBE(I,ISUB) .AND. MASK2(NVS)) .EQ. 0) GO TO 22
      IF(ISAVE(NV-NC+I-NVO) .NE. 0) GO TO 23
   22 CONTINUE
      JS = JS+1
      IORDER(JS) = J
      ISAVE(J-NVO) = 0
      GO TO 24
   23 IND = 1
   24 CONTINUE
      IF(IND .EQ. 0) GO TO 30
      IND = 0
      GO TO 21
   30 RETURN
      END
C
```

(continued from page 102)

computer word and the number of output characters that can be stored in a word. The changes are as follows:

1. In the main program the user must supply the initial value for IBIT in the DATA statement. This value is the number of bits per word in the computer being used.
2. The output routines, OUT1 and OUT2, must be changed, as shown in Table 2, to reflect the different internal codes used to represent characters and also the number of characters that can be stored in a word. ■■

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2. Su, S.Y.H., "Trade your Karnaugh Maps for Topological Procedures that Easily Reduce Switching Functions that have Many Variables," *Electronic Design*, No. 21, Oct. 11, 1973, pp. 88-92.
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4. Su, S.Y.H., "Computer-Oriented Algorithms for Synthesizing Multiple-Output Combinational and Finite Memory Sequential Circuits," Ph. D. Thesis, Univ. of Wisconsin, Madison, Wis., 1967.
5. Su, S.Y.H., and Dietmeyer, D.L., "Computer Reduction of Two-Level Multiple-Output Switching Circuits," *IEEE Transactions on Computers*, Vol. C-18, No. 1, Jan., 1969, pp. 58-63.

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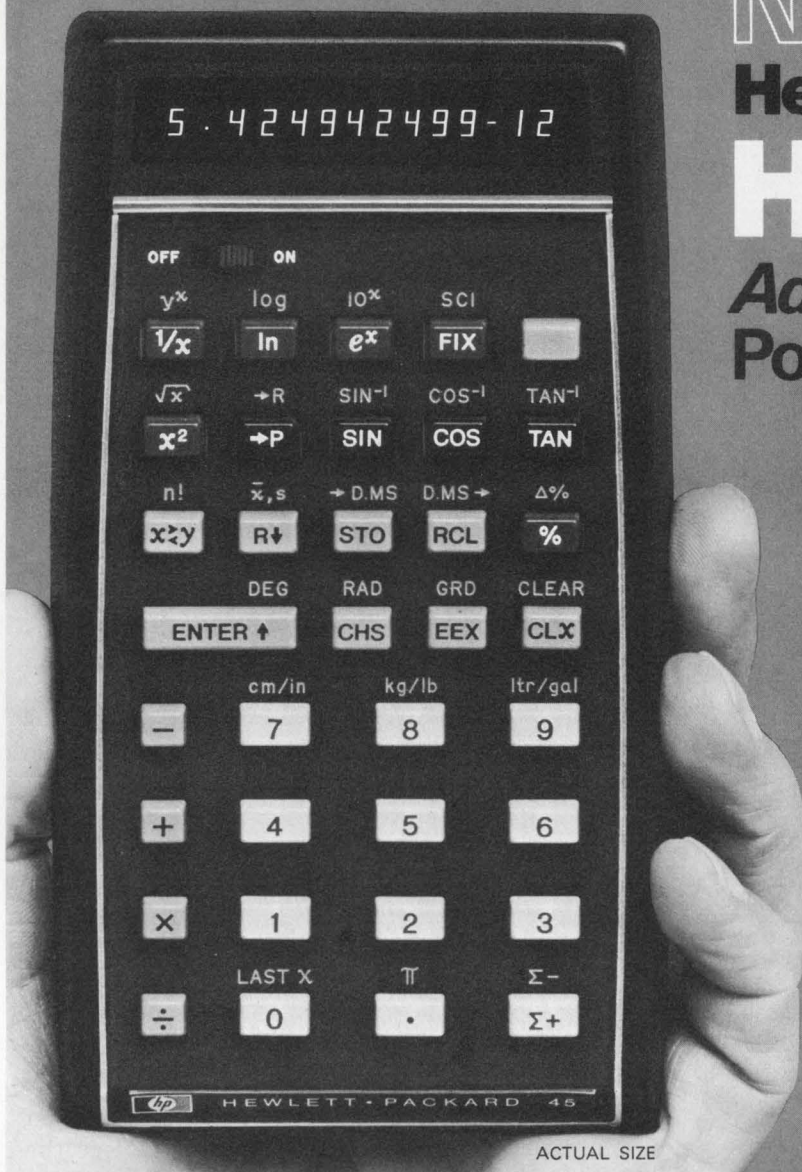

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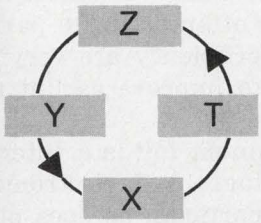
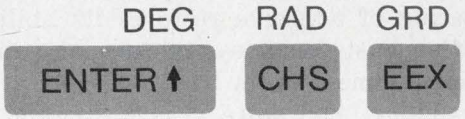


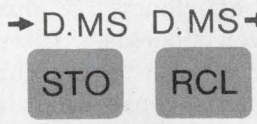
Operational stack has 4 registers . . . for automatic storage and retrieval of intermediate solutions. The stack design permits review of stored data at any time.

9 additional memory registers are addressable . . . can be used for storage and retrieval of data, or to perform register arithmetic. A 10th ("Last X") register lets you recall last input argument for error correction or for multiple functions of same argument.

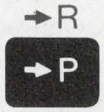


Trig functions may be performed in any of 3 selectable angular modes . . . degrees, radians or grads. Decimal angles are calculated in whichever mode is specified. The HP-45 also computes natural and common logarithms, as well as antilogarithms.

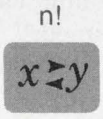
Permanent U.S./metric constants permit instant conversion . . . for rapid calculation of problems involving length, weight or volume. And you get 10-digit accuracy!



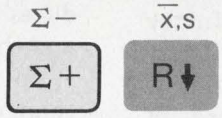
Instant conversion from an angle in any angular mode to degrees/minutes/seconds (*e.g.*, 45.89° = 45° 53′ 24″) . . . with the answer automatically rounded to the nearest second. Or convert from D/M/S to the equivalent decimal angle.



Instant conversion from polar to rectangular coordinates . . . or vice-versa. And vector calculations are simple when you also use the Σ+ key to simultaneously accumulate two coordinates.



Factorial function allows rapid calculations of combinations and permutations . . . to reduce problem-solving time to seconds. You can quickly find the factorial of positive integers.



Statistical analysis is easier . . . because the Σ+ key provides a running total when summing numbers, keeps track of the number of entries, and automatically computes the sum of the squares. The x̄,s key calculates the arithmetic mean and the standard deviation.

Beyond the basic four functions (+ − × ÷), the HP-45 is pre-programmed to:

Perform trigonometric functions:
- Sine
- Arc sine
- Cosine
- Arc cosine
- Tangent
- Arc tangent

Perform logarithmic functions:
- Common logarithm
- Natural logarithm
- Common antilogarithm
- Natural antilogarithm

And perform:
- Serial calculations
- Mixed serial calculations
- Chain calculations
- Mixed chain calculations

Calculate:
- The square root of the number displayed
- The square of the number displayed
- The reciprocal of the number displayed
- The raising of any positive number to any power
- The factorial of positive integers
- Percentage and percent differences
- Sum of the squares
- The mean of entries made with the "Σ+" key
- The standard deviation of entries with the "Σ+" key

Automatically convert:
- The decimal angle in any of the angular modes in the display to degrees/minutes/seconds
- The degrees/minutes/seconds angle in the display to a decimal angle
- Polar coordinates to rectangular coordinates
- Rectangular coordinates to polar coordinates
- Centimeters to inches
  Inches to centimeters
- Kilograms to pounds
  Pounds to kilograms
- Liters to gallons
  Gallons to liters

And the HP-45 will also:
- Simultaneously accumulate two sets of entries for statistical and vector calculations
- Allow for deletion of erroneous entries
- Recall the last argument of a calculation to check for accuracy
- Display the constant Pi at the touch of a key
- Permit selective data storage and retrieval in up to 9 registers
- Operate in any of three trigonometric modes—degrees, radians or grads
- Perform register arithmetic
- Perform vector arithmetic
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INFORMATION RETRIEVAL NUMBER 38

Dust filters can block cooling air and overheat electronic equipment. Here's data on how to select them, how they affect airflow and when to change them.

Dust destroys electronic components, upsets calibrations and wears out bearings and other sliding surfaces. Dust also hinders the transfer of heat from components to cooling air, and the result is premature failure. So it's important, obviously, to filter the cooling air before it enters the electronic equipment. But surprisingly little has been published about the effects of filters on cooling capacity and filter life. The filter should match the environment. However, the filter you choose is, at best, a compromise between the filter's efficiency and its life or air-pressure loss.

Dust comes in all sizes. The average size of particles in the atmosphere is about 3 μ in diameter. For test purposes, the AFI-USA (Air Filter Institute) code provides a standard dust-composition atmosphere as follows:

Dust type	Particle size	Composition
Street dust	0-5 μ - 39% 5-10 μ - 18% 10-20 μ - 16% 20-40 μ - 18% 40-80 μ - 9%	72%
Carbon soot	0.8 μ	25%
Cotton dust	—	3%
		100%

The amount and composition of the dirt in your equipment's environment is the first factor you must estimate before you choose a filter material. A working estimate of the weight of dust per cubic meter that can be expected in various environments is:

Zone 1: Heavy industrial — 0.0030 g/m^3
Zone 2: Average industrial — 0.0008 g/m^3
Zone 3: Average residential — 0.0003 g/m^3
Zone 4: Relatively clean room — 0.00014 g/m^3

Woven fiberglass is probably the most widely used filter material. It can trap particles in sizes from 3 μ up; it provides good efficiencies that range from 63 to 98%, which depends on weave and thickness; and it holds large quantities of dirt. However, plastic foam is best for very small particles. It can trap 1-μ particles, has a very high efficiency—roughly 98 to 99%—but it clogs rapidly and requires frequent cleaning or changing. For large-particle filtering—or merely as a fan guard—wire mesh is often used. Its particle-trapping capability and efficiency are very poor initially, but this tends to improve as lint accumulates.

Slitted, expanded aluminum foil is a filter material particularly advantageous to electronic applications. It traps fine particles, as does plastic foam, and it is more easily washed for reuse. A spray coating of adhesive restores its ability to capture fine dust particles. Of special value to electronic equipment is its RFI and EMI attenuation capability. And since it is metal and nonflammable, UL approval is more easily obtained.

Lawrence F. Edwards, Product Manager, Amphenol Sales Div., Component Marketing Service, Broadview, Ill. 60153.

Calculating filter life

Fig. 1 shows how the efficiency (% dust removed) of a typical woven fiberglass filter pad for a 4-11/16-in. fan varies with dust accumulation. The efficiency remains constant at about 75% for most of the operating life of the pad, and it increases rapidly when the trapped dust finally prevents proper "breathing." At this point the pressure drop caused by the clogged pad produces an unacceptable loss in cooling capacity, and the pad must be replaced or cleaned.

To determine how frequently a filter should be changed, use the simple equation

$$T = \frac{C}{W},$$

where T = filter operating life in hours (h),
C = filter capacity in grams (g),
W = weight of dust deposited in one hour (g/h).

To find W:

$$W = F \times D \times 3.6,$$

where F = air flow in liters/sec (l/s),
D = dust density of environment in g/m^3.

For example, from the efficiency plot of the fiberglass filter in Fig. 1, we see that the filter's maximum trapping capacity is 14 g. However, the final filter capacity could be less if, instead of by efficiency, the capacity was determined by

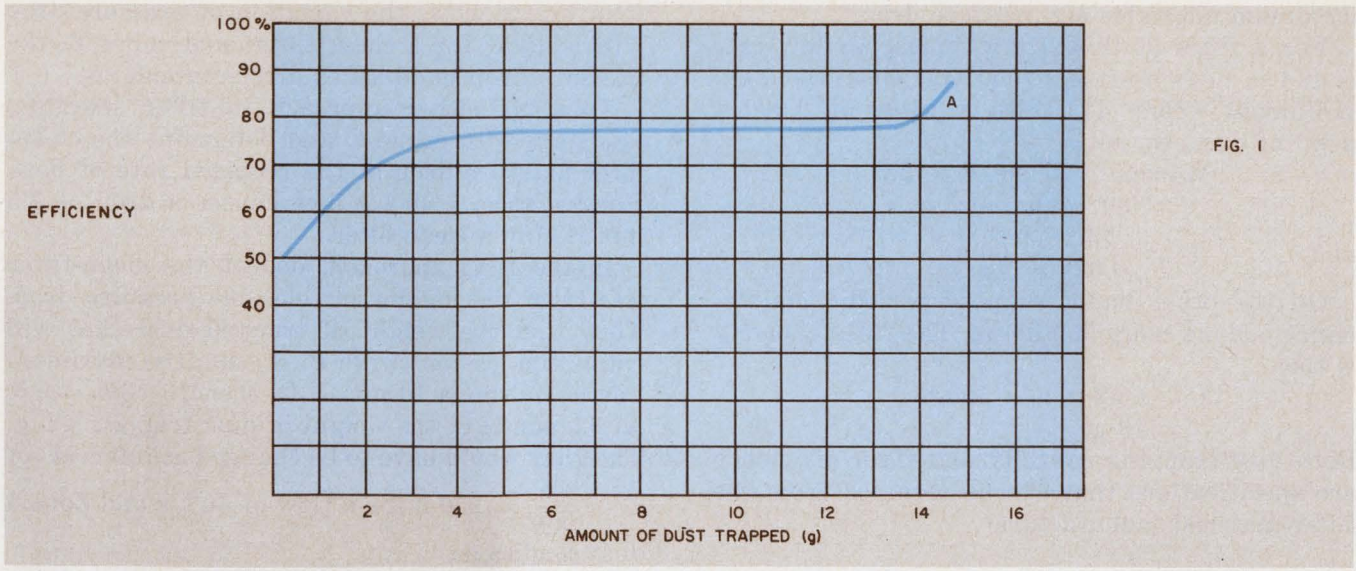

FIG. 1

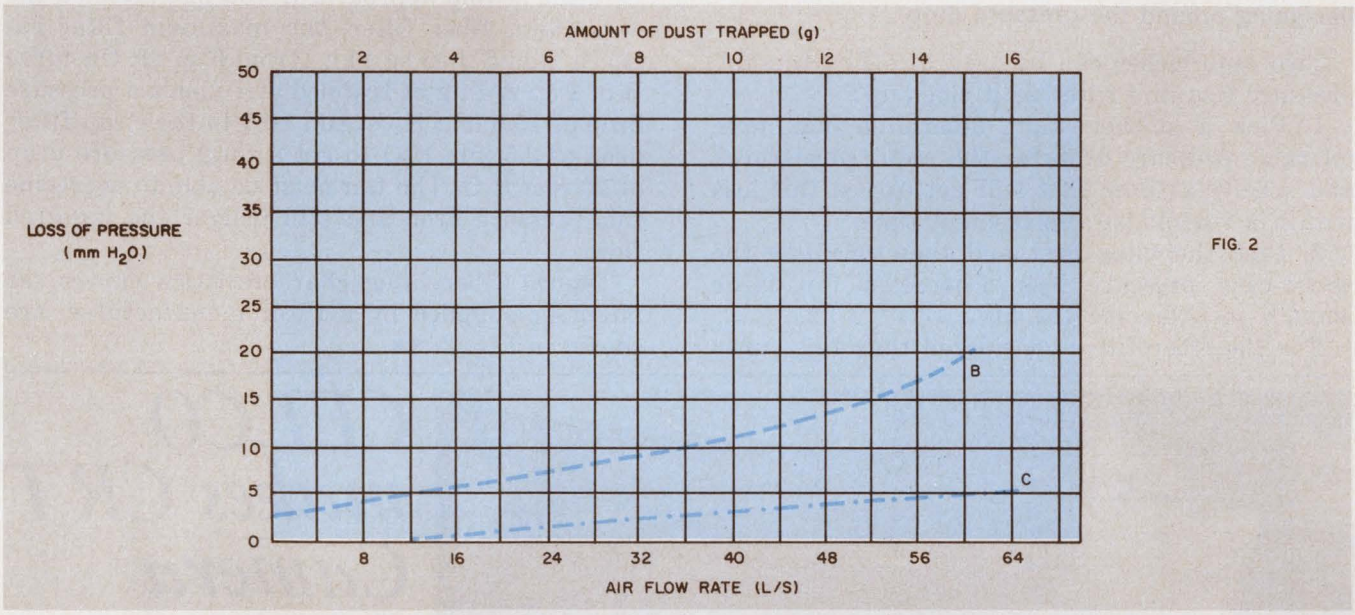

FIG. 2

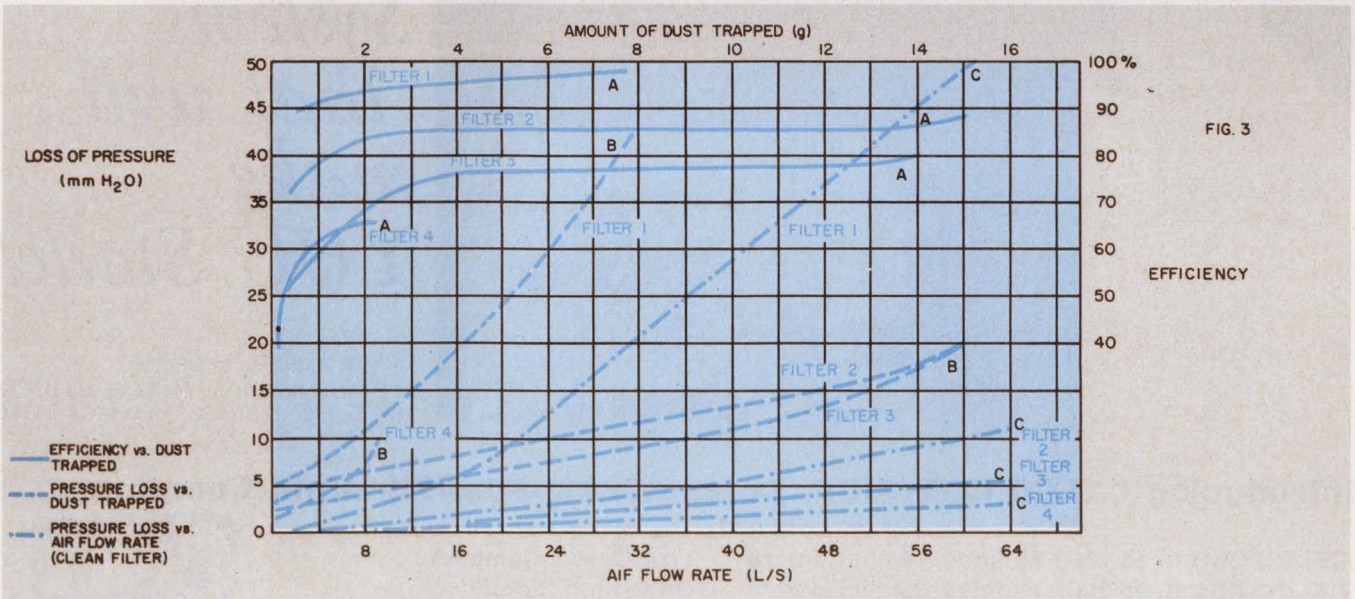

FIG. 3

Filter efficiency remains nearly constant until accumulated trapped dust causes it to suddenly increase—a signal that the filter should be cleaned or replaced. While this is the ultimate filter life, allowable pressure-loss may be a prior criterion and thus require earlier replacement or cleaning of the filter.

maximum allowable air-pressure drop.

For a filter of this size a typical airflow rate is 40 l/s. Let's assume a relatively clean-room environment (Zone 4). With a value of 0.00014 g/m³ of dust, we get

$$W = 40 \times 0.00014 \times 3.6$$
$$= 0.02 \text{ g/h}$$

and

$$T = \frac{14}{0.02} = 700 \text{ h.}$$

On the other hand, suppose periodic maintenance is done every 500 hours. The filter capacity is then

$$C = 0.02 \text{ g/h} \times 500 \text{ h}$$
$$= 10 \text{ g.}$$

Both dust-trapping capacity and filter efficiency are specifications that can be obtained from the filter-material manufacturer.

Designing around the pressure drop

Two approaches can be used to offset the air-pressure loss in a filter as it clogs up:

1. Pick a suitable fan; determine maximum tolerable pressure drop for the required airflow; and specify a filter that will not exceed this loss within a reasonable replacement time.
2. Pick the filter first and then calculate the worst-case pressure loss. Choose a fan large enough to overcome the loss.

For the fiber filter considered thus far, curve C in Fig. 2 shows the variation of pressure drop with airflow for a clean filter, and curve B, the pressure drop build-up as dirt accumulates.

To apply either approach in filter selection, you start with curve C and determine the clean-filter pressure drop at the required rate of flow. For instance, a 40 l/s flow causes a drop of 3.5 mm H_2O in a clean filter.

In the first approach, deduct the clean-filter loss from the maximum tolerable pressure drop. Then find the weight of trapped dust that will cause this loss on curve B. If, say, the maximum tolerable drop is 10 mm H_2O, then $10-3.5 = 6.5$. At 6.5 mm H_2O, the weight of dust trapped is 5 g. The filter would have to be changed at intervals of

$$T = \frac{5}{0.02} = 250 \text{ h}$$

for a flow of 40 l/s and Zone 4 dust conditions.

In the second approach, if you had selected the 4-11/16-in. fiber filter, the maximum filter capacity would then be 14 g (from Fig. 1). On curve B of Fig. 2, 14 g of trapped dirt yields a pressure drop of 16.5 mm H_2O. Add 16.5 to the clean filter drop of 3.5 mm H_2O to get a total pressure drop of 20 mm H_2O. The fan must be able to overcome this pressure drop and still deliver the required flow.

Typical fiber-filter characteristics curves, as might be supplied by a filter manufacturer, are shown in Fig. 3. ■■

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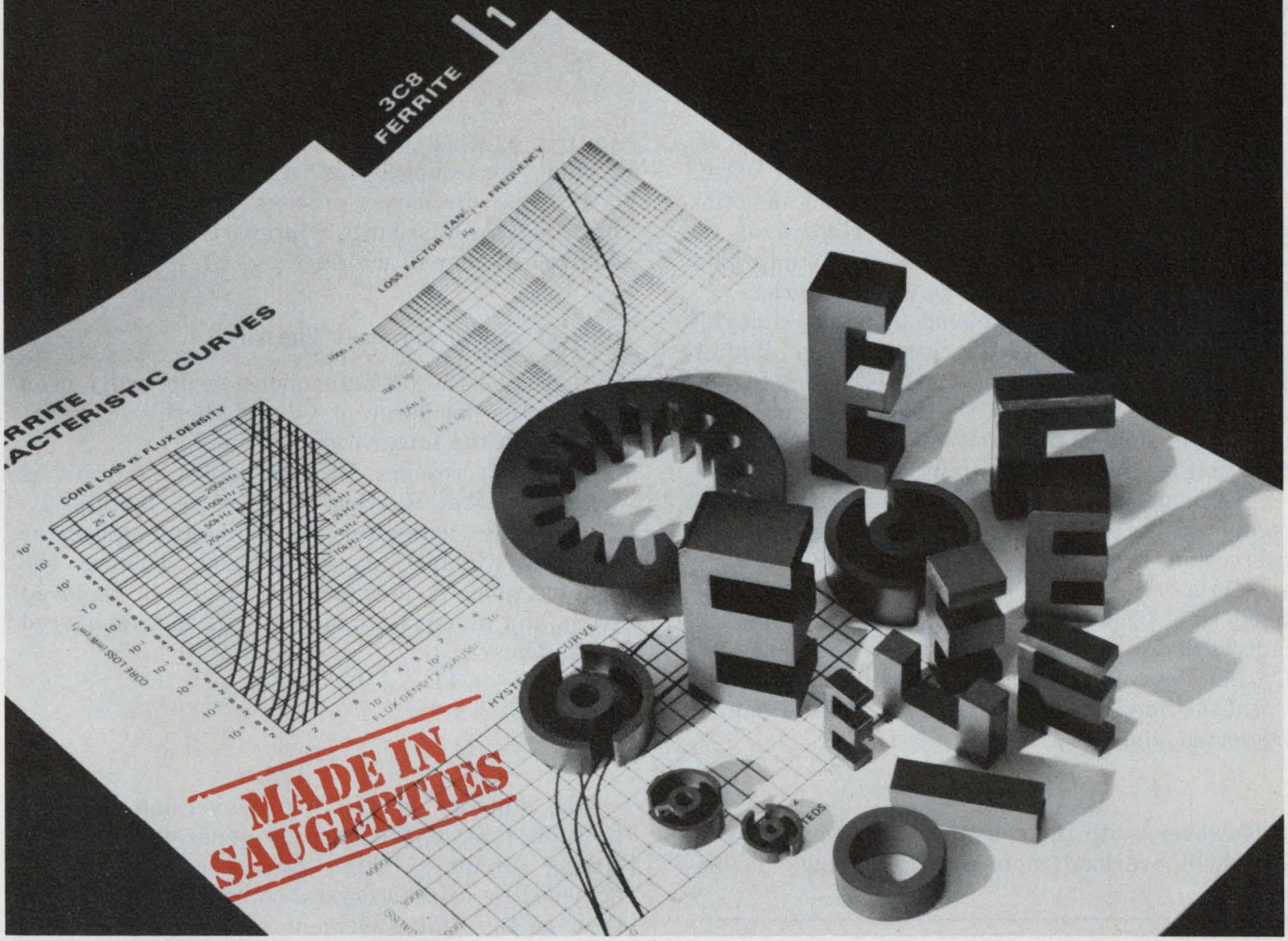

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INFORMATION RETRIEVAL NUMBER 40

Linearize your v/f converter. By adding a constant-current source to the usual feedback arrangement, you can cover five decades with 0.0005% linearity.

You can design a voltage-to-frequency (v/f) converter that covers five decades with exceptional linearity and with a minimum of trimming. The secret lies in precise control of the discharge of a capacitor used as an op-amp feedback element. Here's how the circuit works.

Most v/f converters depend upon the charging of a capacitor in the feedback loop of an op amp; the capacitor is discharged when a certain output level is reached. With this arrangement it turns out that nonlinearity is almost strictly a function of the discharge circuit.

The usual way to improve linearity is with compensating circuits or some form of feedback correction. For example, to control the discharge, a reference capacitor, C_1, can be charged to a defined level, then switched into the charging circuit with a comparator (Fig. 1). The charge of C_1 then flows into C and the charging is repeated.

In the ideal case, the switching time can be neglected and the frequency is then:

$$f = \frac{I}{V_{ref}C_1} = \text{constant} \times V_1.$$

However, with the conventional scheme, the op amp will overload momentarily during the discharge, which will result in a change in current, I, and—consequently—in frequency, f.

But the discharge process can be controlled better if the discharge current is taken from a controlled-current source (Fig. 2).

Bengt Alvsten, University of Lund, Sölvegatan 14, S-223 Gz, Lund, Sweden

Current source improves linearity

In Fig. 2 the op amp operates normally even during the discharge of C, and there's no interruption in the integration.

When V_2 reaches V_{ref} in value, a circuit is triggered, that delivers a pulse of length, T_d. This pulse activates the current generator through which C is discharged. During the cycling time, T, a charge, $I_d \times T_d$, is removed from, and an equal amount $I \times T$ is transferred to C. Thus:

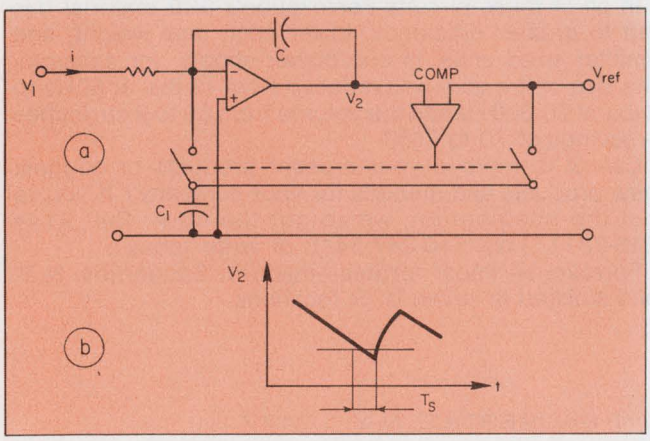
$$IT - I_dT_d = 0$$

and

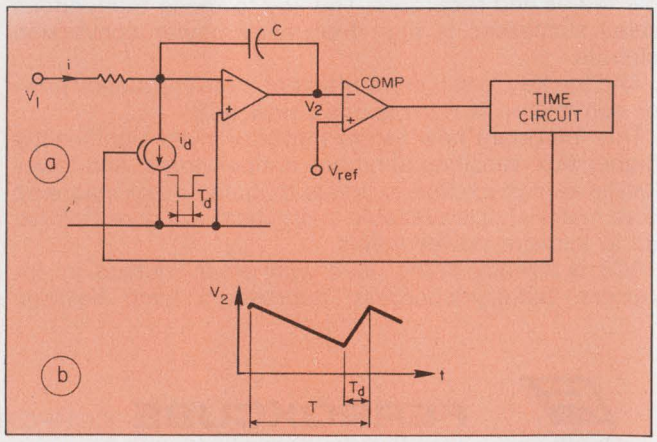
$$f = \frac{1}{T} = \frac{I}{I_dT_d}.$$

The stability of the v/f conversion depends now on that of the current generator and the timing circuit. A high degree of stability is achieved by using a crystal-controlled clock oscillator as the timing element (Fig. 3).

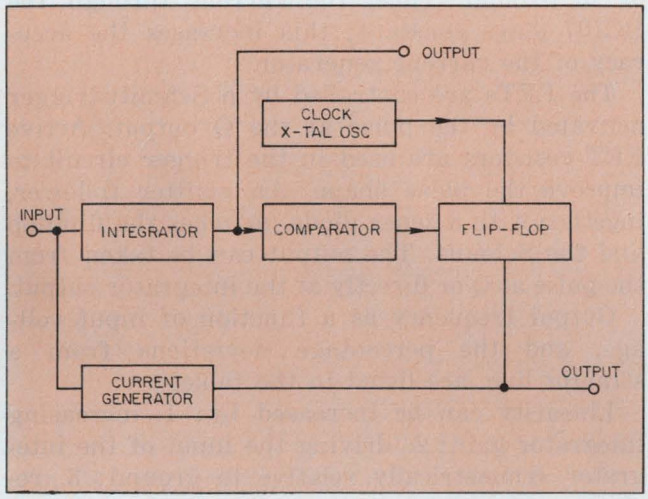
Again, the purpose of the timing circuit is to deliver a pulse with a well-defined length. The



1. **Linearity is improved in feedback-type v/f converter** (a) by discharging feedback capacitor through C_1 at the right moment during the cycle (b).



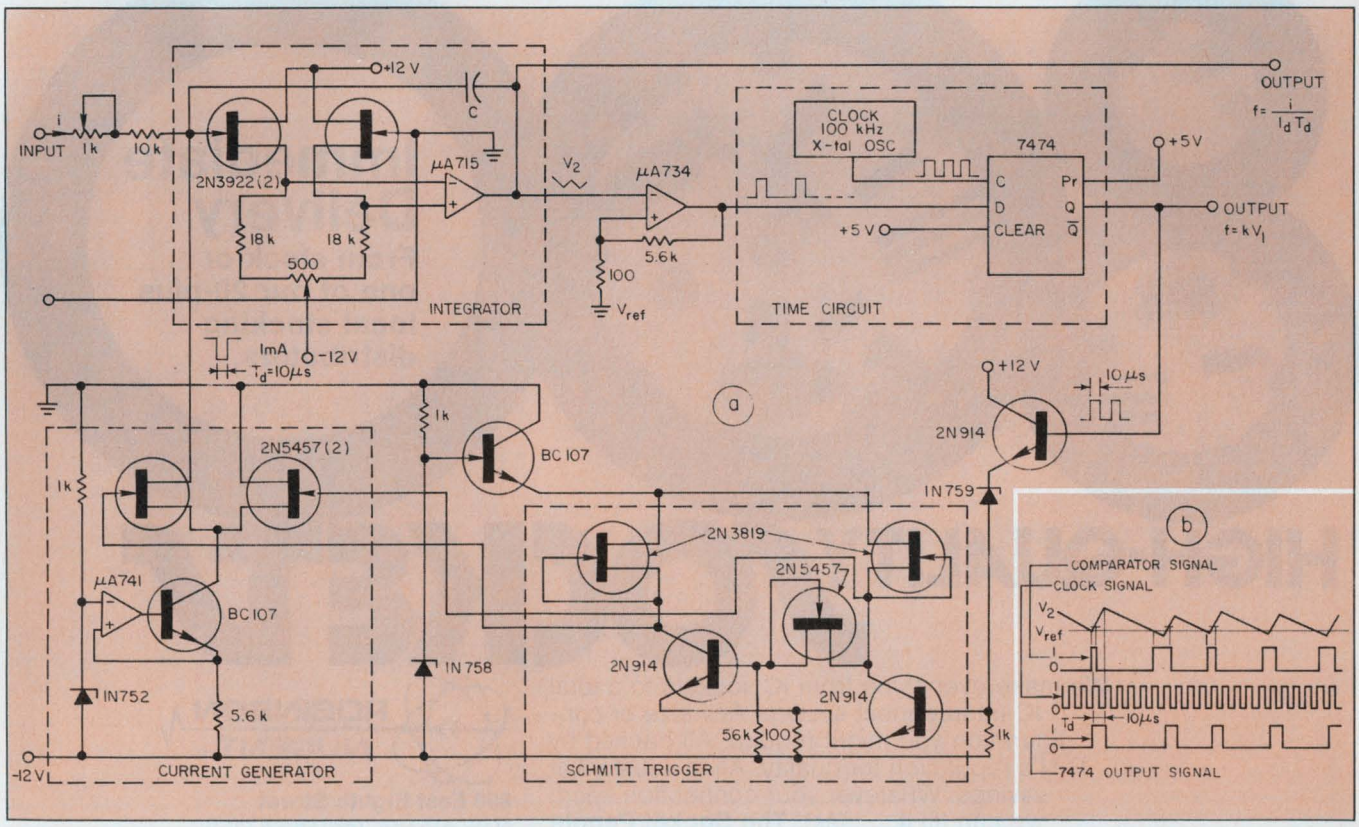
2. **Best linearity is obtained** by discharging C through a constant-current generator (a). Improved output occurs during T_d (b).



3. **Using a crystal oscillator as the timing control** device ensures high stability.

V/f converter performance:

V_{in} $\pm 10^{-5}$ volts	Output (Hz)	Deviation (%)
0.00023	1.25670	1.5
0.00203	10.3181	0.7
0.02003	100.294	0.05
0.04003	200.284	0.02
0.08003	400.286	0.01
0.20003	1000.22	0.003
0.40003	2000.24	0.001
0.80003	4000.15	0.003
2.00003	10000.2	0.001
4.00003	20000.7	0.001
8.00003	40000.6	0.0003



4. **Complete v/f converter** (a) combines FETs, ICs and bipolar transistors to achieve high linearity over a wide span. Waveforms are shown in (b). Linearity can be further increased by modifications—see text.

pulse starts when the integrator output signal passes a certain level. Since the length of the pulse is determined by a free-running clock, synchronization is needed between the signals from the integrator and the clock.

To synchronize, a comparator senses the integrator signal and sets a flip-flop in a state such that the flip-flop is triggered by the next clock pulse. The flip-flop's output pulse then activates the current generator.

Since the comparator signal changes during discharge, and the next clock pulse resets the flip-flop, the discharge time, T_d, is thus determined by the clock frequency.

Note that the comparator pulse appears arbitrarily in the time interval between two clock pulses. This causes the integrator output level to be modulated and the time interval between two discharge pulses to oscillate around the shown value for 1/f. However, these don't affect the v/f accuracy in the steady state.

Circuit verifies theory

A practical design for a complete converter is shown in Fig. 4. The integrator is a μA715 op amp equipped with FET inputs to minimize input-bias currents. The voltage-to-current converter consists of two resistors, with one resistor variable for calibration. The μA734 comparator couples directly to the output of the integrator; the signal at this point is shown in Fig. 4.

The μA734 comparator signal is fed into the D-input of a 7474, D-type, edge-triggered flip-flop. With a clock-oscillator frequency of 100 kHz, a 10-μs pulse will be produced at Q. This pulse controls the path of the discharge current.

The current generator is designed in a conventional way. A μA741 controls the current in a BC107 transistor. Two FETs in the collector circuit of the BC107 shift the current to capacitor C or to ground. Thus, the current through the BC107 stays constant; this increases the accuracy of the current generator.

The FETs are controlled by a Schmitt-trigger activated by the pulse at the Q output. Active FET resistors are used in the trigger circuit to improve the pulse shape. An emitter follower, together with a zener diode, matches the flip-flop and the Schmitt. The output can be taken from the pulse at Q or directly at the integrator output.

Output frequency as a function of input voltage, and the percentage deviations from a straight line, are listed in the table.

Linearity can be increased by: 1. increasing integrator gain; 2. driving the input of the integrator symmetrically relative to ground; 3. replacing the input resistor with an active voltage-to current converter; and 4. including a feedback loop. ■■

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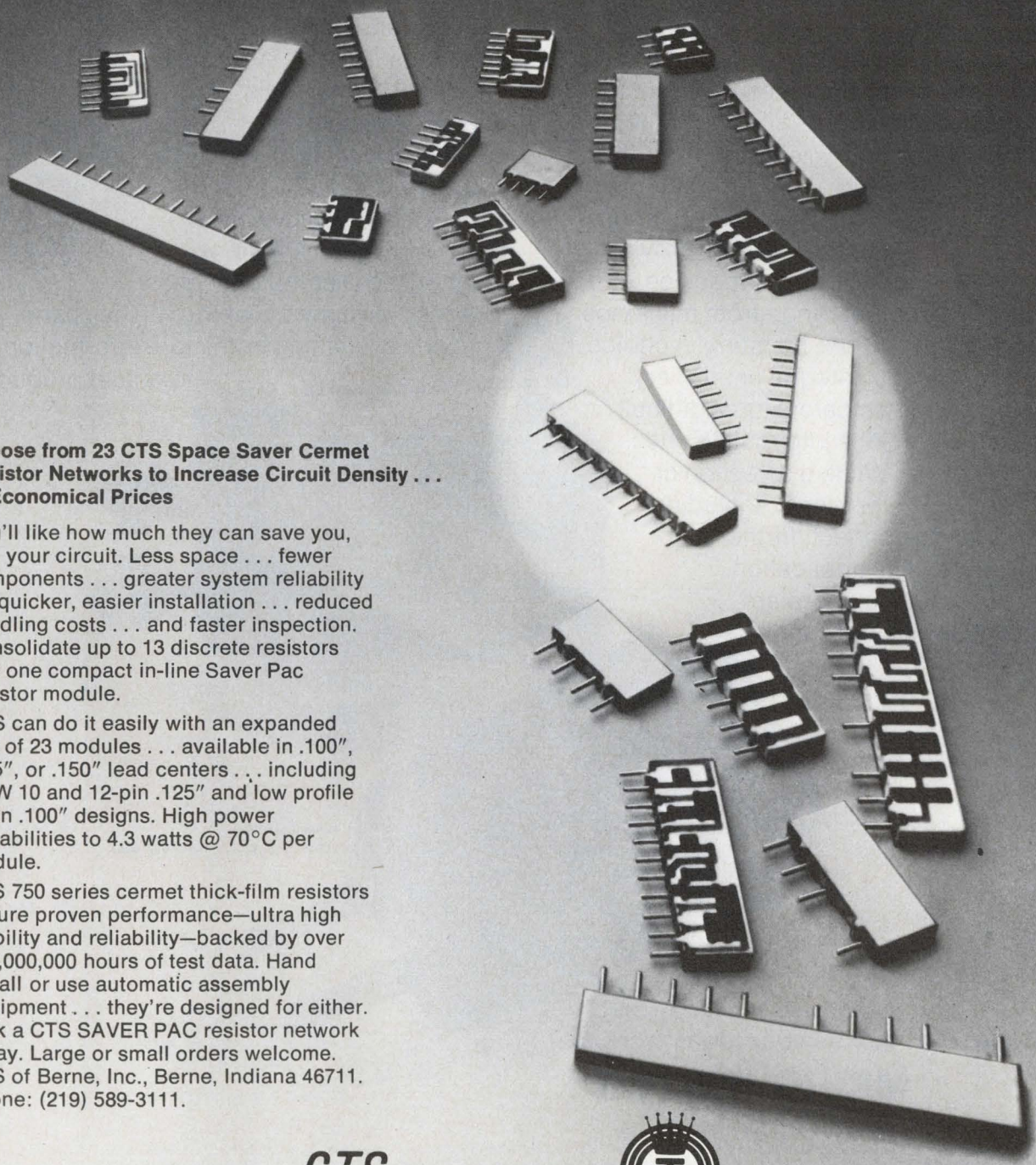

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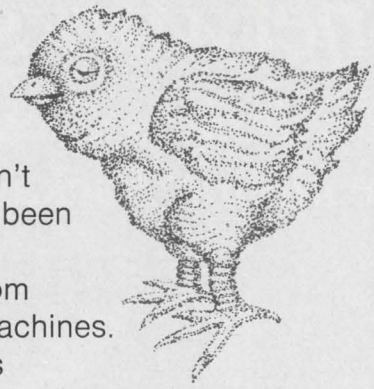

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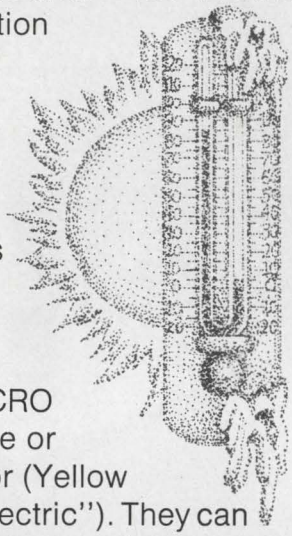

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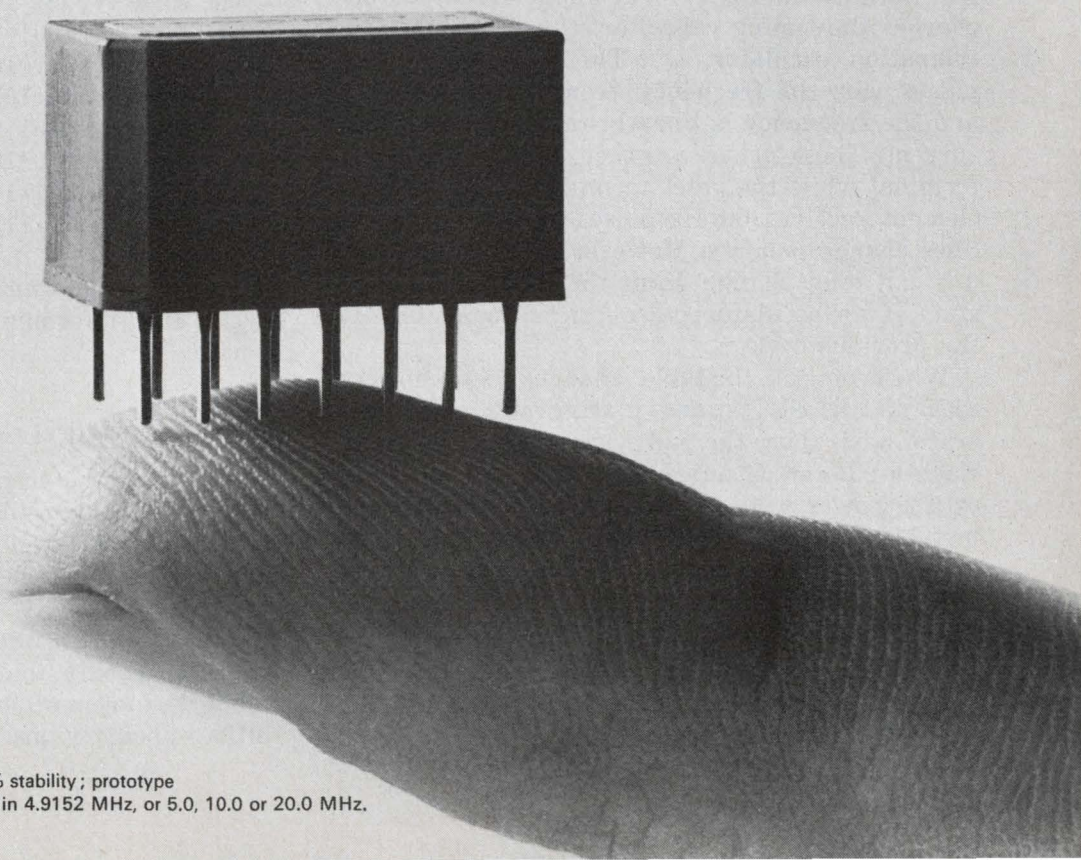

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Use thyristor switches for proportional temperature control. These zero-switching circuits provide rapid but smooth control.

Proportional temperature control offers major advantages in applications that require fast warm-up. This type of circuit controls power smoothly and rapidly. By contrast "burst" controllers tend to cause temperature fluctuations due to their intermittent extremes of power.

In the proportional system of Fig. 1, an error signal can control a thyristor switch. The switch, in turn, applies the line voltage to the load. To avoid generation of any electrical interference, the thyristor switch is always either ON or OFF for one or more complete cycles.

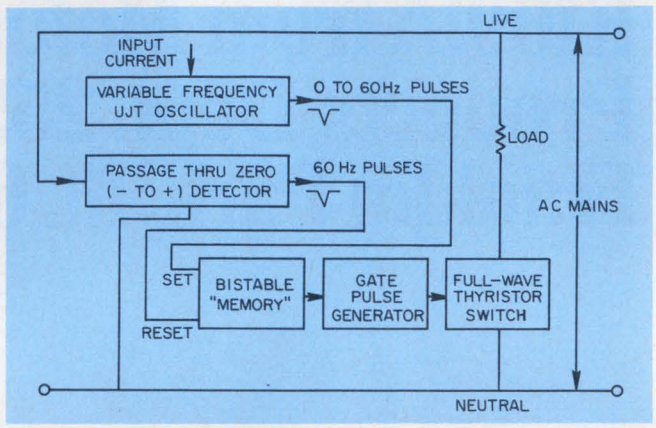
The proportional controller has several advantages.

- The average power delivered to the load is directly proportional to the input current.
- At all power levels, the particular ac line cycles selected for application to the load give the smoothest supply of power.
- A step change of input current results in a step change of output power within a maximum delay time of one cycle.

Figure 2 shows a practical version of the system outlined in Fig. 1. The input error current charges the timing capacitor, C_4, of unijunction-relaxation oscillator, Q_5. The oscillator output pulses vary in frequency from zero to 60 Hz, and the frequency is linearly related to the input current. These pulses are then applied to the set terminal while the reset terminal of the bistable element receives 60 Hz pulses each time the ac lines change polarity. However, the bistable output can only change from the SET to RESET state if an oscillator pulse has occurred during the previous cycle.

Whenever the bistable changes between the SET and RESET states, it triggers a pulse generator and, thus, the full wave thyristor switch. Each oscillator output pulse causes one full cycle of line power to be applied to the load. Also, the bistable element "remembers" the output pulse and won't change state until the next positive-going zero crossing of the line.

Maurice Wright, Group Research Center, Joseph Lucas Ltd., Solihull, Warwick, England.



1. **A closed-loop feedback system** controls the temperature of any small oven.

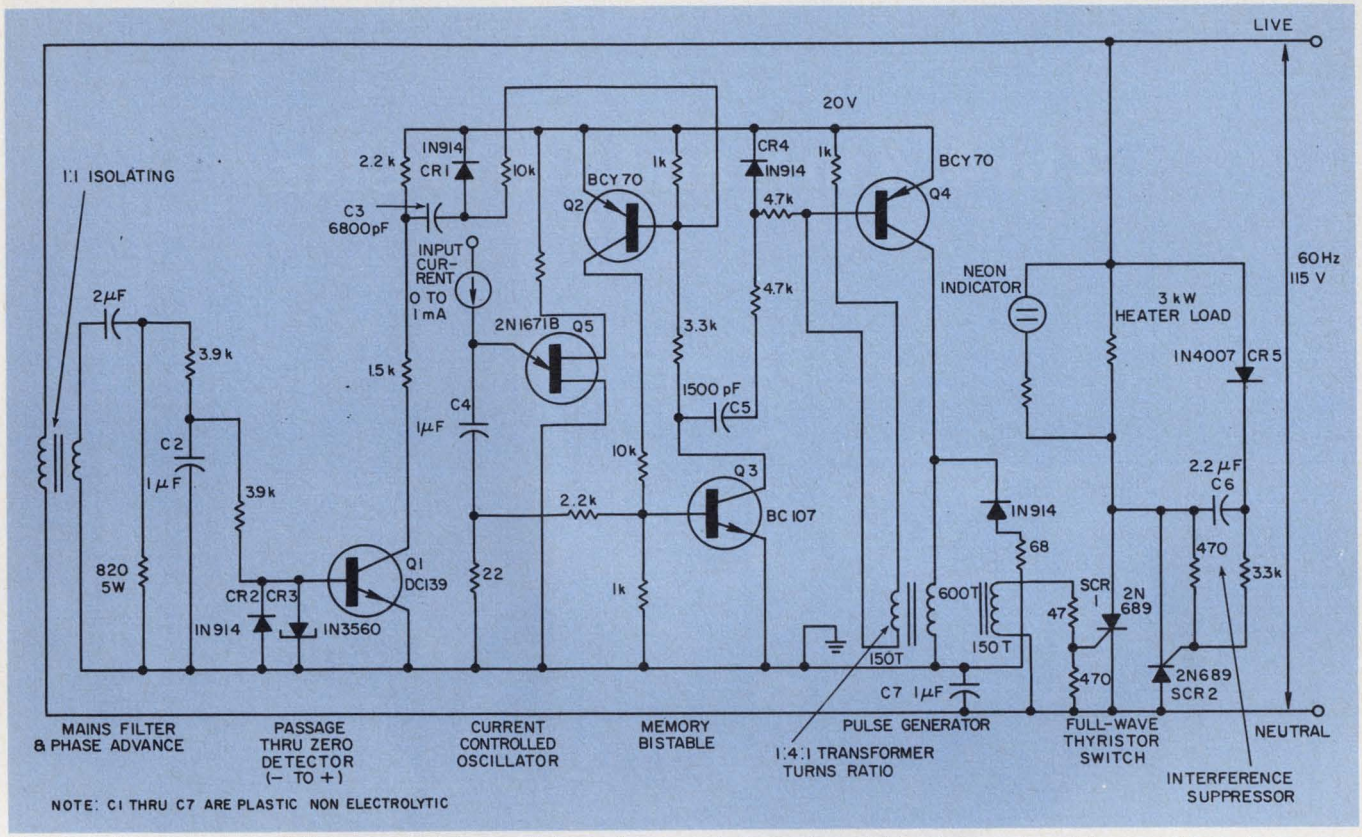
If, for example, the oscillator frequency is 20 Hz, every third cycle is applied to the load. If the frequency is 40 Hz, two successive full cycles, followed by one OFF cycle, are applied to the load. If we use a "1" to represent a cycle applied to the load and a "0" to represent a missing cycle, some typical load patterns are:

20 Hz	10010010010010010010010010010
30 Hz	10101010101010101010101010101
36 Hz	10110101101011010110101101011
40 Hz	11011011011011011011011011011
42 Hz	11011011101101101111011011101
50 Hz	11111011111011111011111011111
Step change from 60 to 0 Hz	11111111111111111110000000000

This system guarantees that the ON and OFF cycles are uniformly spaced throughout any time period.

Building a practical circuit

Following the schematic through, we see that the zero detector consists of a tunnel diode, CR_3, feeding the base-emitter junction of Q_1. To eliminate false outputs caused by transients on the ac power lines, an RC filter precedes the zero detector. The same filter gives sufficient phase advance to ensure that the tunnel diode switches from its low impedance to high impedance condition about 1 ms before the ac lines pass



2. **The circuit uses a full-wave** thyristor switch and a UJT oscillator to control the heater current and thus the temperature. This stable, closed-loop system also uses a neon lamp as a telltale indicator.

through zero — to + (positive going).

The pulse generator output pulse has a duration of 3 ms. This ensures that the thyristor switch is gated to conduct as the ac line voltage passes through zero. To avoid the loss of a selected cycle due to the coincidence of the oscillator and line trigger pulses, the bistable design should guarantee that:

- All trigger pulses have short duration.
- The oscillator SET pulse has a shorter duration than the zero RESET pulse—say 20 μs and 60 μs, respectively.
- If both output pulses are present simultaneously, the bistable output should depend on the oscillator pulse. Thus, for coincident pulses, the bistable output will be in its SET condition for at least 20 μs and in its RESET condition for at least 40 μs (this being the time difference when the zero pulse only is applied).
- The bistable output time constant of 8 μs is short enough to differentiate a 20 μs output pulse and ensure triggering of the pulse generator.

The pulse generator gates SCR_1 for the positive half-cycle. During this half-cycle, the load voltage charges C_6 to provide gate current for SCR_2 when the ac lines change polarity. Thus, a full cycle is applied to the load.

Controlling furnace temperature for a furnace temperature-control application, the output voltage of a thermocouple and a reference voltage feed the input terminals of a difference amplifier. The amplifier output feeds a current to the oscillator circuit in Fig. 2. During the initial furnace warm-up, the reference voltage exceeds the thermocouple voltage and the amplifier is saturated, giving a maximum output current. This output current, from the collector of a pnp transistor, operates the oscillator at a frequency just over 60 Hz (for a 60-Hz line frequency). Thus, there is at least one SET pulse during each cycle and the heater is fully energized. The amplifier gain is such that the amplifier stays in saturation until the furnace temperature is within about 3% (30 C for control at 1000 C) of the required temperature. Further increases in temperature cause a drop in oscillator frequency.

Once the frequency falls below 60 Hz, heater power drops. Because the controller is a closed loop system, aging and variations in ambient temperature have little effect on the furnace temperature control.

A neon lamp in parallel with the heater forms a useful indicator since:

- A continuous glow confirms that both SCRs are conducting during the initial warm-up.
- Once the furnace temperature stabilizes the lamp flickers steadily.
- If the glow around each electrode is different, there is a fault in the circuit (usually an SCR failure). ■■

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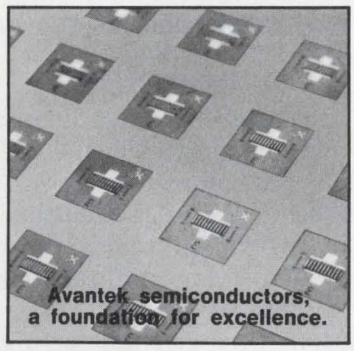

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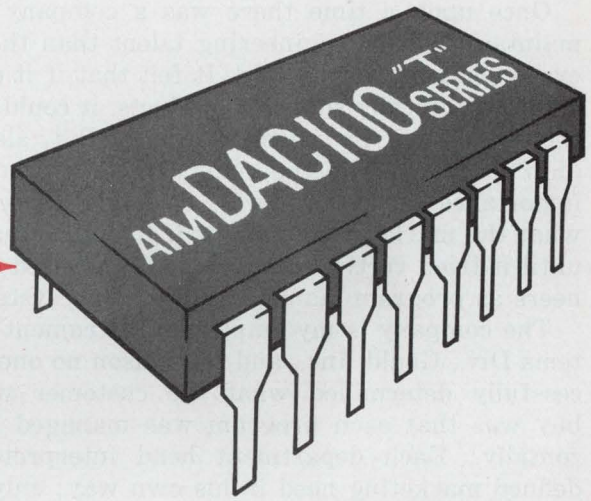

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INFORMATION RETRIEVAL NUMBER 46

Giving engineers the 'business'

via vertical organization, says this division head, has improved both our project success and the company's ability to manage.

Once upon a time there was a company that maintained more engineering talent than the average company its size did. It felt that if it could create technically superior products, it could gain the No. 1 spot in the marketplace. But, alas, it didn't work. While the company recognized the importance of its products, it didn't appreciate what the market really wanted. It didn't, that is, until it tried vertical management and used engineers as program managers under that system.

The company is my employer, Instrument Systems Div., Gould, Inc., and the reason no one successfully determined what the customer would buy was that each program was managed horizontally: Each department head interpreted a defined marketing need in his own way; only the general manager knew what the grand business plan was for the product.

Under vertical management, which was started at Gould a few months ago, the directors of marketing, engineering, operations, quality control, and probably a sales manager, formulate a business plan together around a new product or idea. A business plan recognizes all aspects of what has to go into this product. The plan says: This is what the market wants; this is what the product must look like; this is how we're going to produce it; this is the investment we're going to make in it; and this is the profit we expect on it.

Engineers learn the business

The job of the program manager is to see to it that this business plan is met. I pick engineers for this job because they have excellent educational backgrounds and the technical expertise to make those tough initial design decisions. We have outstanding technical men who may never become program managers; they're looked on favorably for their innovative ability, and they're not expected to carry an idea all the way through to a product.

But there are other engineers here who are more geared to the business world. They're dynamic, and although they may well be as innovative as the others, their motivation is that one day they want to be president of Gould and they recognize that they're not going to get there by sitting on a bench in a corner and inventing things. That's the class of engineer I want to talk about, along with an example of how vertical management is working for us.

The advantage in use of a vertical management concept over a horizontal concept are dramatized in the handling of our data-acquisition system project. We decided that the best way to make that system was to formulate a business plan in which all of the department heads discuss the problems from the beginning. What are the limitations of the engineering group, for example, and can they meet these specs? What are the reliability requirements on the product? Do we have the kind of equipment that will allow us to make our design; and if we don't, can the equipment be procured in time to allow us to get the kind of factory cost we need to make the kind of return on investment we must have?

In the past, the engineer that we chose to manage this project would not have been exposed to the business plan and, in all probability, would not have related to the customers' needs. In most cases he would not have known how the quality-control people were going to measure the product against the market. He would not have talked with the manufacturing people, and in many cases, his limited understanding of our manufacturing capability would have dictated his design. He might not have created a design that he believed was perfect if he thought it meant committing the company to buying a $50,000 piece of test equipment. And that may be a wrong decision. To remain competitive we may be forced to make an investment of $50,000 or even $500,000 to help us to design the right products, and it's important to know what our investments are going to be as early as possible.

The need to invest in more automated assembly equipment and automated circuit-board test equipment for our data-acquisition system project was recognized from the first day. I have to believe that these changes would not have been made if we had managed horizontally where

Joseph J. Sacco, Vice President and General Manager, Instrument Systems Div., Gould, Inc., Cleveland, Ohio 44114.

Joseph J. Sacco

Education: B.S., Chemistry, Northeastern University.

Responsibility: Vice President and General Manager of Instrument Systems Div. of Gould, Inc., and responsible for Data Systems Div., Measurement Systems Div., and Gould Instruments Europe.

Experience: President of Ferroxcube Corporation, a subsidiary of North American Philips Corporation; managed memory products in the Electronics Instrument Division of Burroughs Corp. and was general manager of the Electronic Memory Systems Division; directed product development at Memory Products Division, RCA, and memory core manufacturing and test operations were established under his management; conducted research in ferrite materials for digital applications at the MIT Lincoln Laboratory—helped develop the pilot production facility for the SAGE Air Defense Program and the first transistorized computer.

Employer: Following World War I, Charles Brush, Jr., Theodore C. Browne and R. C. Baldwin Sawyer founded the Brush Laboratories Company, which engaged in diversified industrial research. In the late 1920's, Bengt Kjellgren joined the firm and developed a technique for growing synthetic piezoelectric crystals for use in a variety of acoustic applications. The resulting expansion into sales of microphones, loudspeakers and phonograph pickups was largely responsible for the organization of the Brush Development Company. The magnetic pen motor and wire-tape recorder, among other instruments, were introduced and marketed by Brush following World War II.

In 1952, Brush merged with the Cleveland Graphite Bronze Company and formed Clevite Corporation. Brush continued as a major innovator and manufacturer of direct writing recorders and expanded into experimental work in piezoelectric ceramic materials and the development of underwater acoustic sending and receiving devices. Dix Brown's patents for pressure ink recording (1962) and improved pen linkage, coupled with other improvements in pens and pen motors in the late 1960's, were the catalysts for Instrument Systems Division's present leadership position in the industry. Present developments include the X-Y printer/plotter, digital recording devices and new O.E.M. recorders.

everyone was concerned only with his own little piece of the action.

The engineer-in-charge now realizes that his sole responsibility is to make this project go. He has assets available to him that he never had before, and he begins to understand things like gross margin and expense levels. He learns about cash flow and profit before tax and what that means to the division. In fact he's running his own business—with all the tools he needs to do it —and he's relating to the two major goals in business: to make a profit and to satisfy the customer.

Cultivating the business engineer

Fifteen years ago an engineer was happy to sit on the bench; there was status in being a Ph.D. But engineers have gone through a frustrating time because their ultimate promotion was to chief engineer and, in this division, that's a thankless job. He's not supposed to do the engineering, and he's hung with a budget and the assignment of people to projects. I can get a clerk to do that job. That's not managing anything. It's overseeing a budget and a distribution of manpower and you can't afford a $30,000-a-year technical man doing something like that.

In most cases you know pretty early in the game who of your engineering people is motivated in the management direction. You find out in simple ways—the guy who likes to go to a trade show, who likes to talk to people, who likes to demonstrate the product, who likes to go on calls with the field engineers and the marketing people. He really has an appreciation of the business world in general and he's motivated to create something to which he can tie his name.

That's a different motivation from the guy who's satisfied with his name on as many patents and technical papers as possible. There's nothing wrong with that either. The business-oriented engineers could innovate, too, but we found that many of them saw that all they were doing was overseeing the budget and they were worried about where they were going from there. The business engineer wants to be able to do his own thing; and his job satisfaction comes from relating to how many units are sold, seeing how much profit the company makes on them and speculating on the next great thing he can do for the world.

The bouquets and the brickbats

One tremendous side-effect benefit we've gotten from the vertical management concept is that it develops our management ability. In the final analysis, a lack of good managers can really slow down a company's growth and can affect its profits. But when you hire someone from the outside you're buying an unknown quantity. Gould believes in hiring from within. Of course, one of the pitfalls is the syndrome: "He's a nice guy and he's been around for a long time, so let's give him a shot at it." That doesn't happen here.

We have a philosophy in the company: Nobody gets anything by divine right, by right of accession, or because he's been around a long time. For our engineers this is a tremendous opportunity. If we gave a man a small plant to run and he couldn't handle the first big problem that came along, it could destroy him. But if we bring a man along slowly, let him make his mistakes where they can be controlled so that no mistake becomes a disaster, he's allowed to do his own thing and to implement it.

He works with the accounting department to pick up a fair amount of factory cost accounting, and with the purchasing department to understand purchase-price variance. It's great to say that if we're going to build ten-million components, we can buy these transistors for half a buck apiece. But he has to be realistic enough to know what he's doing during the two years before he reaches that ten-million-dollar level. And who's going to absorb those losses? You don't say, "If volume is there, the price ought to be all right." So people are very sensitive about what can and cannot be done in a factory.

Vertical management also allows people to work as a team. They work from a total problem point of view, with a recognition that, to be responsive, things have to occur that are going to be somewhat different from the setup of the old system. All become much better planners. They can adjust schedules and can adapt them to any problem they may have. That was never going to happen with the old system because everybody said, "This is my responsibility and this must happen this way because I have no authority to do it any other way."

The only serious drawback of the vertical system is that if the entire project is not successful, for whatever reason, it can have a tremendous negative impact on the fellow who's managing it. My job is tougher now because I have to manage people who have more authority than they once had. There's a higher risk, too, because we're not documenting as much as with the old system; but the schedule has certainly been maintained.

You had to be very lucky to satisfy the customer and to make a profit under the old system. With the new it's a real-time situation on a continuing basis with a total involvement on the part of a group of people who have the best feel for what they're doing and where they stand on it. If I suspect that something is wrong, I demand a meeting—just to give me a nice warm feeling. The way it should work is that these people should call a meeting whenever they hit upon a problem. ■■

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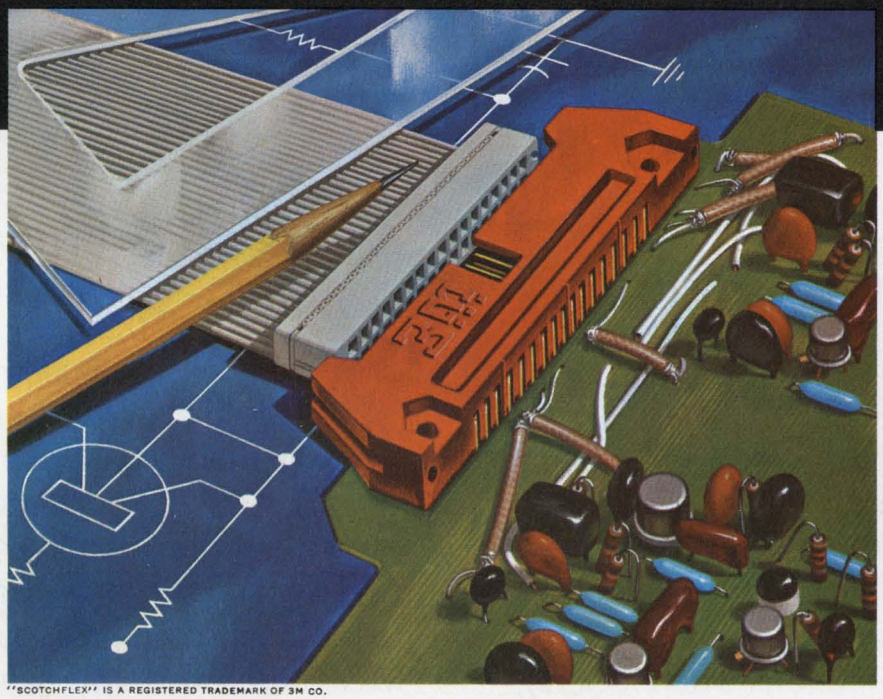

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For full information on the "Scotchflex" systems approach to circuitry, write to Dept. EAH-1, 3M Center, St. Paul, Minn. 55101.

3M COMPANY

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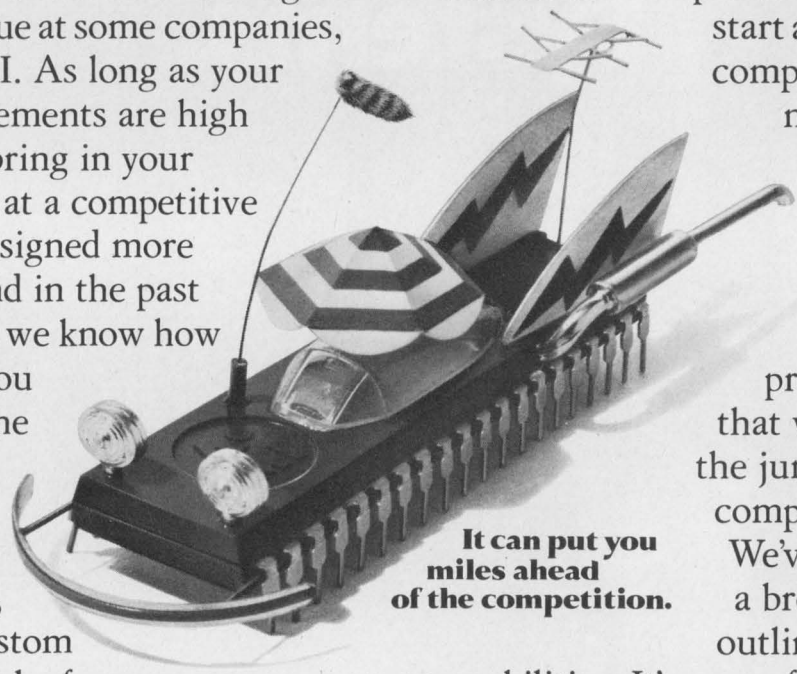

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INFORMATION RETRIEVAL NUMBER 48

42A Motor Line: *Diameter is 4.3 inches. Standard continuous duty ratings are ⅛, ⅙ and ¼ hp at 2500 rpm, 115V D-C. Available with or without NEMA Type C face mounting shield.*

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ideas for design

Modified current-limiter circuit ensures turn-on of power supply with constant-current loads

Short-circuit protection of series-regulated power supplies usually includes current limiting plus foldback. Foldback is desirable since it limits the short-circuit dissipation of the pass transistors. However, if the load characteristics approximate those of a current sink, the power supply—during turn-on time—will settle at the first stable point and not reach the expected output voltage.

The turn-on problem can be solved and the foldback feature retained in the series-regulated supply (Fig. 1) by addition of the components shown in Fig. 2b. As long as

$$(V_{IN} - V_{OUT}) < (V_Z + V_{CR2} + V_{BE(Q3)}),$$

CR_1 remains reverse biased and the current limiter has the characteristics shown in Fig. 1. If the output terminals are shorted, then

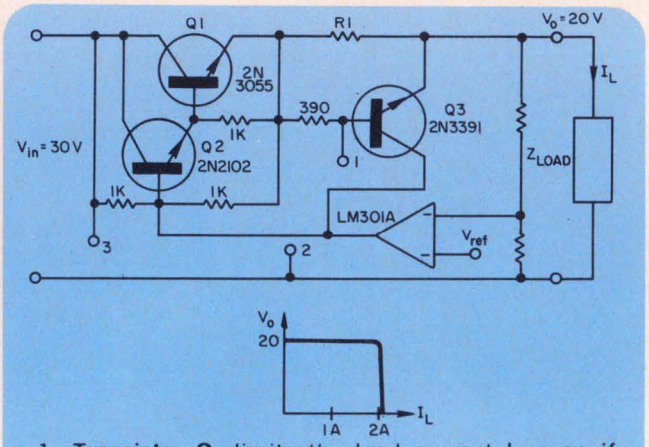
$$(V_{IN} - V_{OUT}) > (V_Z + V_{CR2} + V_{BE(Q3)}),$$

and the current flowing through CR_1, CR_2 and R_2 forces Q_3 into saturation. Since Q_3 does not rely on I_L to stay in saturation, I_L drops to a few milliamps. With the short removed, the output voltage increases again to its nominal value.

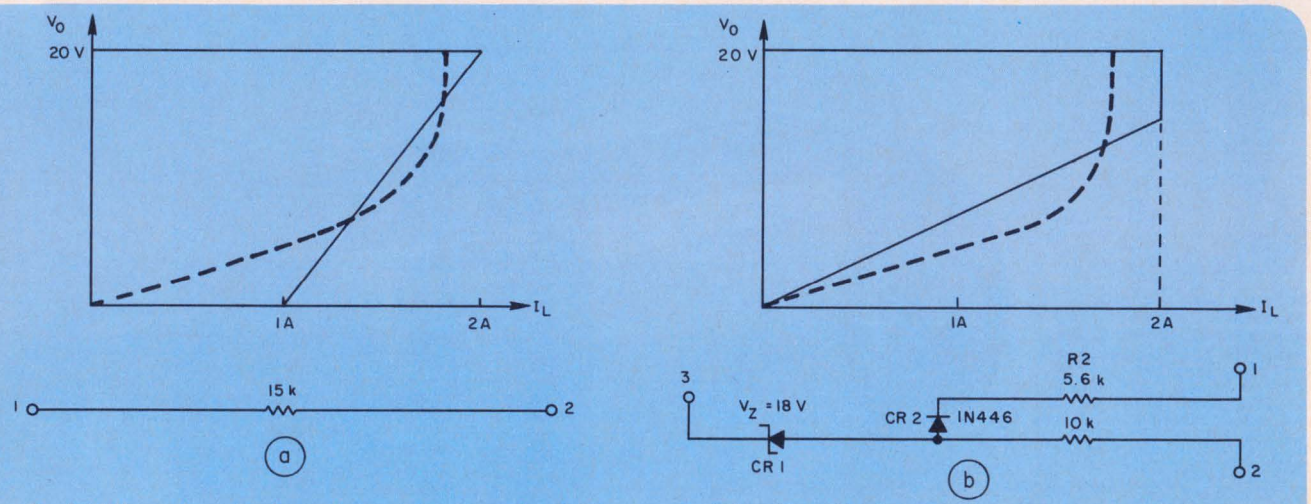
Representative values are shown on the schematic. The technique described can be used with any series-regulated power supply.

Kjeld K. Christensen, Senior Engineer, Kruse Electronics Div., Systron Donner Corp., 735 Palomar Ave., Sunnyvale, Calif. 94086.

CIRCLE NO. 311



1. **Transistor Q_3** limits the load current I_L even if the output is shorted, but it does not provide foldback for the series-regulated supply.



2. **Addition of a single resistor** (a) gives the foldback characteristic (b). Use of the two diodes (c) modifies the VI characteristic to ensure full output with current-sink loads.

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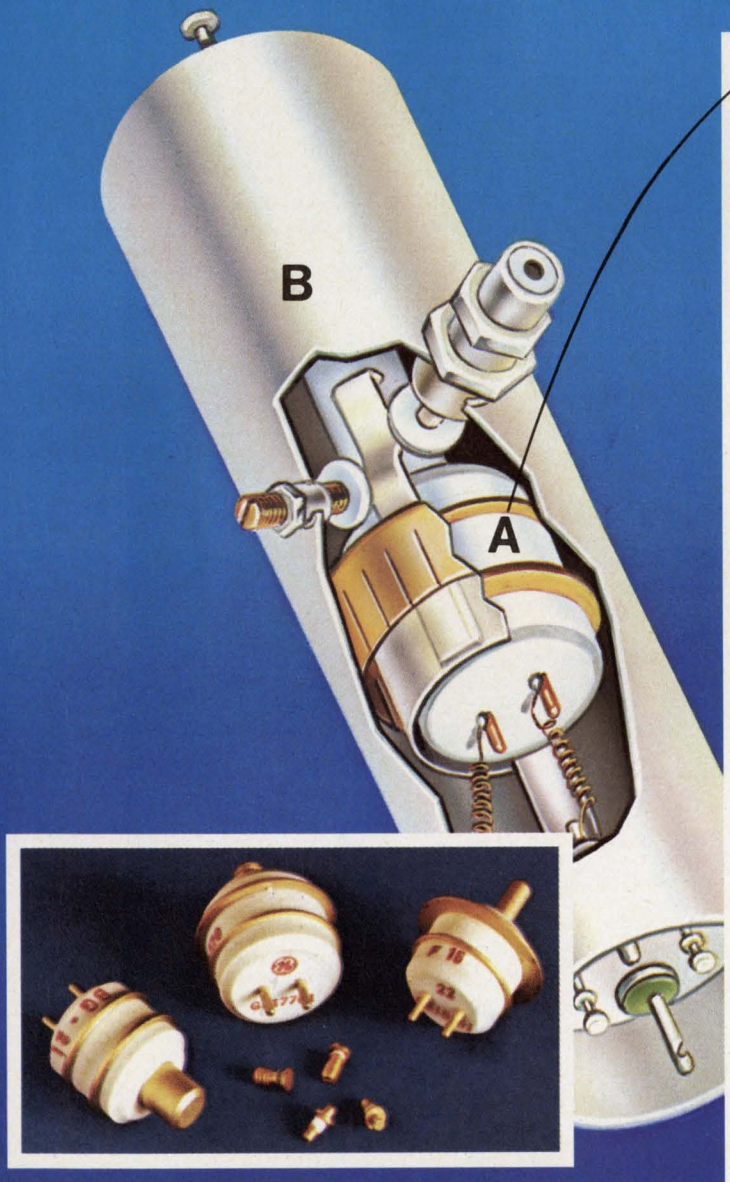

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360-09

GENERAL ELECTRIC

Circuit based on four-bit addition finds average value of BCD numbers

In certain monitoring applications, the parameter of interest is the average value of an analog quantity taken over the sampling period. As is often the case, the average value and inputs must be expressed in BCD format.

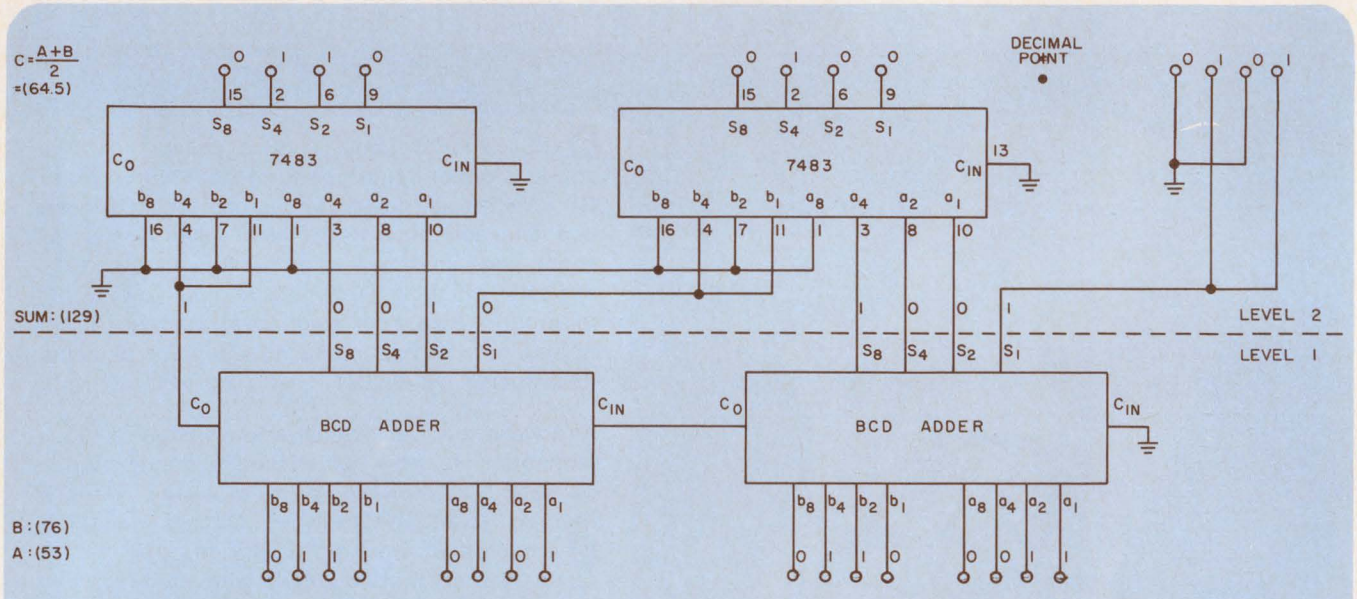
The expression

$$C = \frac{A + B}{2}$$

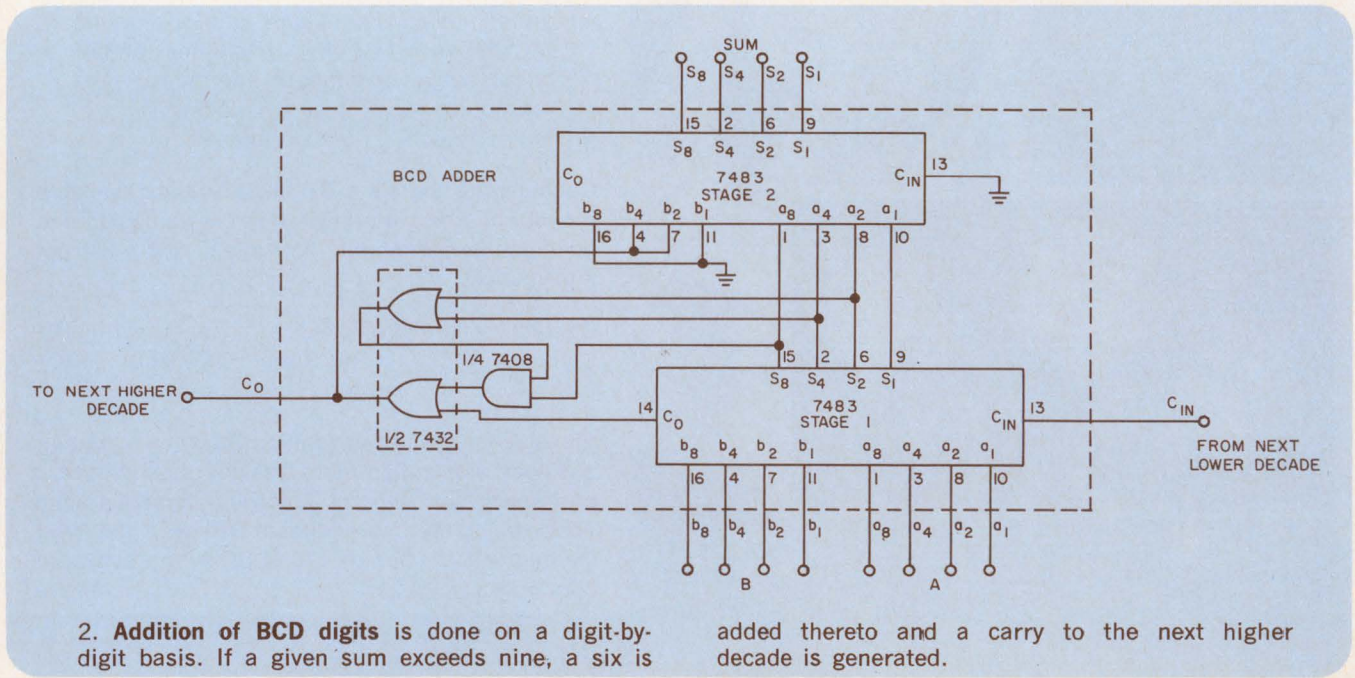
gives the average value of two numbers A and B. The computation involves two algorithms—addition and division-by-two.

The algorithm for BCD addition is well-known: Add individual digits together as in binary addition; if the sum exceeds nine, add six to it and output a "carry" bit to the next higher decade.

Division by two requires the following steps: Shift each digit to the right by one bit position; add five to the next lowest digit if the bit shifted



1. **Average-value circuit** uses two levels of full-adder logic. BCD adder blocks perform BCD addition of numbers A and B. The second logic level performs a divided-by-two algorithm.



2. **Addition of BCD digits** is done on a digit-by-digit basis. If a given sum exceeds nine, a six is added thereto and a carry to the next higher decade is generated.

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TI's new N-Channel dual-gate MOS FETs are a family of real performers. The 3N211, 3N212 and the 3N213 deliver 6dB more gain than our 3N204 family. And up to 8dB more gain than any other MOS FET you may presently be using.

You also get high output impedance, low noise figure, high forward transconductance.

TI builds this dual-gate family with monolithic, back-to-back diode protection that blocks out troublesome transients. Nitride passivation is also used for better reliability. This eliminates time-consuming precautionary assembly steps and means lower production costs, fewer wasted devices.

This all new dual-gate family gives you the competitive edge you'd expect from the people who offer the industry's broadest line of N- and P-Channel J-FETs and MOS FETs. And more are coming. UHF and new VHF dual-gate MOS FETs will be arriving soon.

Noise Figure and Gain Parameters

Type	Application	NF (Max) dB	@ Freq MHz	Gps (Min) dB	@ Freq MHz
3N201	FM, VHF RF amp	4.5	200	15	200
3N202	VHF mixers	–	–	15	200
3N203	Intermediate freq amp	6.0	45	20	45
3N204	VHF, UHF, RF amps	3.5	200	14	450
3N205	VHF mixers	–	–	17	200
3N206	Intermediate freq amp	4.0	45	25	45
3N211	VHF RF amp	3.5	200	24	200
3N212	VHF mixers	–	–	21	200
3N213	Intermediate freq amp	4.0	45	27	45

Prices for the 3N211 and 3N312 are 70¢ in 1,000-piece quantities. And 75¢ for the 3N213.

For data sheets, indicate by type number and write: Texas Instruments Incorporated, P. O. Box 5012, M/S 308, Dallas, Texas 75222.

TEXAS INSTRUMENTS
INCORPORATED

84143

out is a ONE; add zero if a ZERO is shifted out. In the example, A = 53 and B = 76. With the implied decimal point included, the output is the average value 64.5.

Two levels of full-adder logic implement the average-value circuit (Fig. 1). BCD adders—in the first level—perform the addition of numbers A and B, two four-bit adders in the second level implement the divide-by-two algorithm.

The right-shift operation is achieved by connecting the S_8, S_4 and S_2 outputs of the BCD adders to the a_4, a_2 and a_1 inputs of the second-level adders; and by wiring the a_8 inputs to logic ZERO.

The following connections implement the add-five portion of the averaging algorithm: S_1 outputs are connected to the b_1 and b_4 inputs of the next lowest output stage; the carryout of the last BCD stage is connected to b_1 and b_4 of the highest output digits; the b_8 and b_2 inputs of the second level are connected to logic ZERO.

Two stages of logic are needed to implement the BCD full adders shown in Fig. 2. If the sum of the digits exceeds nine, it is corrected by adding six to it in the second stage. Note that only single 4-bit adders are required in the averaging stage since the sum never exceeds nine. The circuit has the following features:

- The BCD nature of the inputs is preserved, which minimizes hardware costs.
- Circuit operation is static, which allows high-speed operation.
- Longer numbers can be handled simply by cascading ICs.

V. R. Godbole, Systems Design Engineer, North Electric Co., P.O. Box 688, Galion, Ohio 44833.

CIRCLE No. 312

Temporal-priority circuit latches after receipt of first input signal

Certain data-processing applications require identification of which of several signals arrives first. The circuit shown latches the first pulse received and inhibits further change until it receives an external reset command.

Initially, all six signal inputs are at logic ZERO; the reset line is at logic ONE. Consequently, all eight inputs to the 8-input NAND gate are ONEs, which makes the clock input to the flip-flop a ZERO.

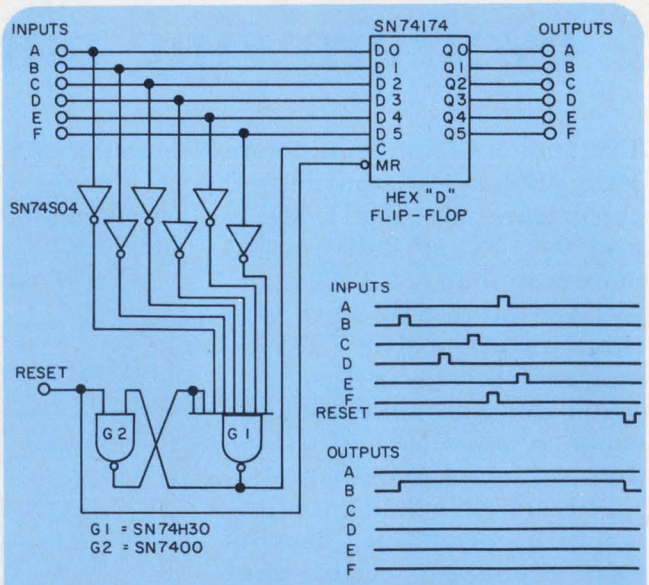
A pulse that occurs on one of the input lines makes the corresponding input to G_1 a ZERO, which changes the output of G_1 to a ONE. This has two consequences: First, the output transition causes the data at the flip-flop's input to be transferred to the output. Second, the output of G_2 becomes a ZERO, which thereby latches G_1. Pulses that occur on any of the other lines will not be transferred since the output of G_1 remains a ONE.

When the reset line is set to ZERO, the output of the flip-flop is cleared and the latching condition is removed because G_1 becomes a ONE. The circuit is reinitialized when the reset line returns to ONE.

Propagation delays in the inverters and G_1 limit the circuit's ability to discriminate between nearly coincident inputs. The minimum delay is 17 ns—based on the maximum delays specified by the manufacturer.

Fred E. Hicks, Junior Engineer, General Electric Co., 831 Broad St., Utica, N.Y. 13503.

CIRCLE No. 313



Hex flip-flop provides a logical output of the first pulse received. Once G_1 and G_2 latch, the pulse on the input line is transferred to the output of the flip-flop, and further output transitions are inhibited. A momentary ZERO on the reset line clears the flip-flop and arms the circuit for the next set of inputs.

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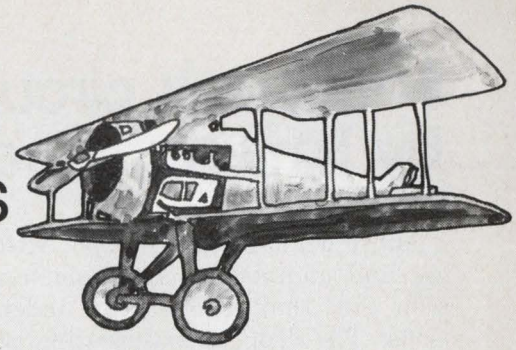

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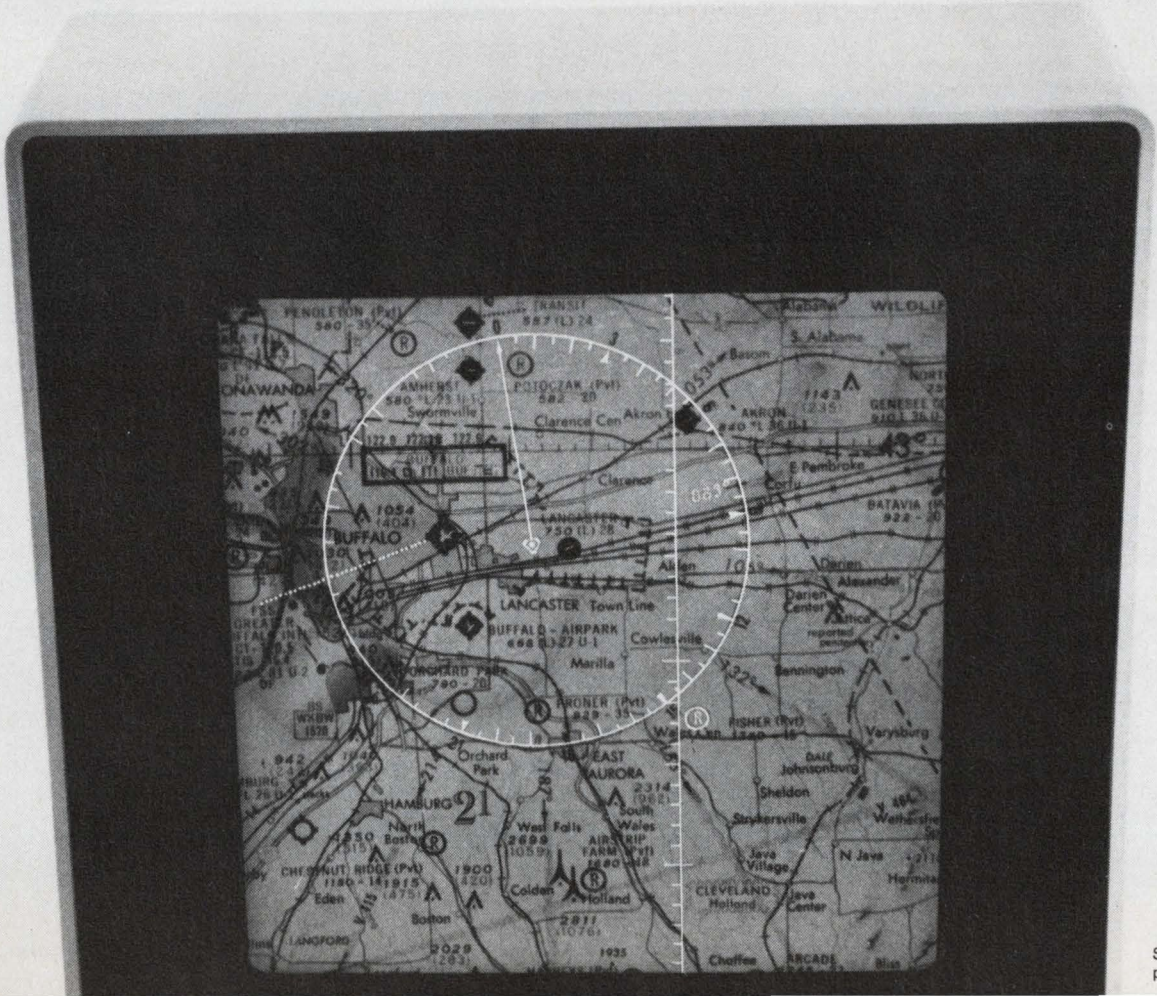


Simulation of rear projection on screen.

Feedback circuit improves electron-gun aim by limiting acceleration-voltage changes

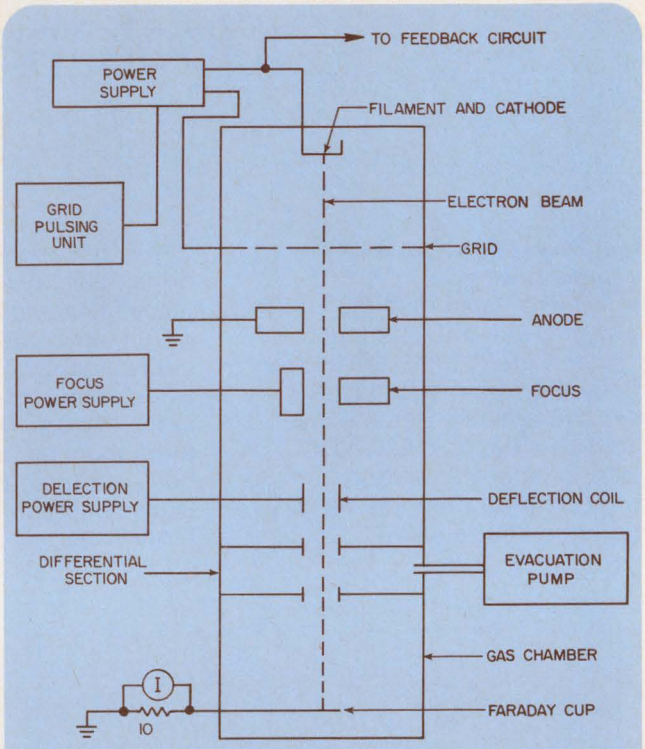
Many devices, such as spot welders, gas ionizers and gamma-ray spectrometers, use an electron gun that is operated under pulsed conditions. The drop in accelerating potential during pulsing often causes unacceptable aiming accuracy of the electron beam. The use of additional capacitors across the high-voltage supply is often unacceptable—because of excessive currents that may develop in case of a short-circuit or arcing.

But an inexpensive feedback circuit that keeps the voltage drop of the accelerating potential within prescribed limits provides a reliable and safe way to reduce beam wander.

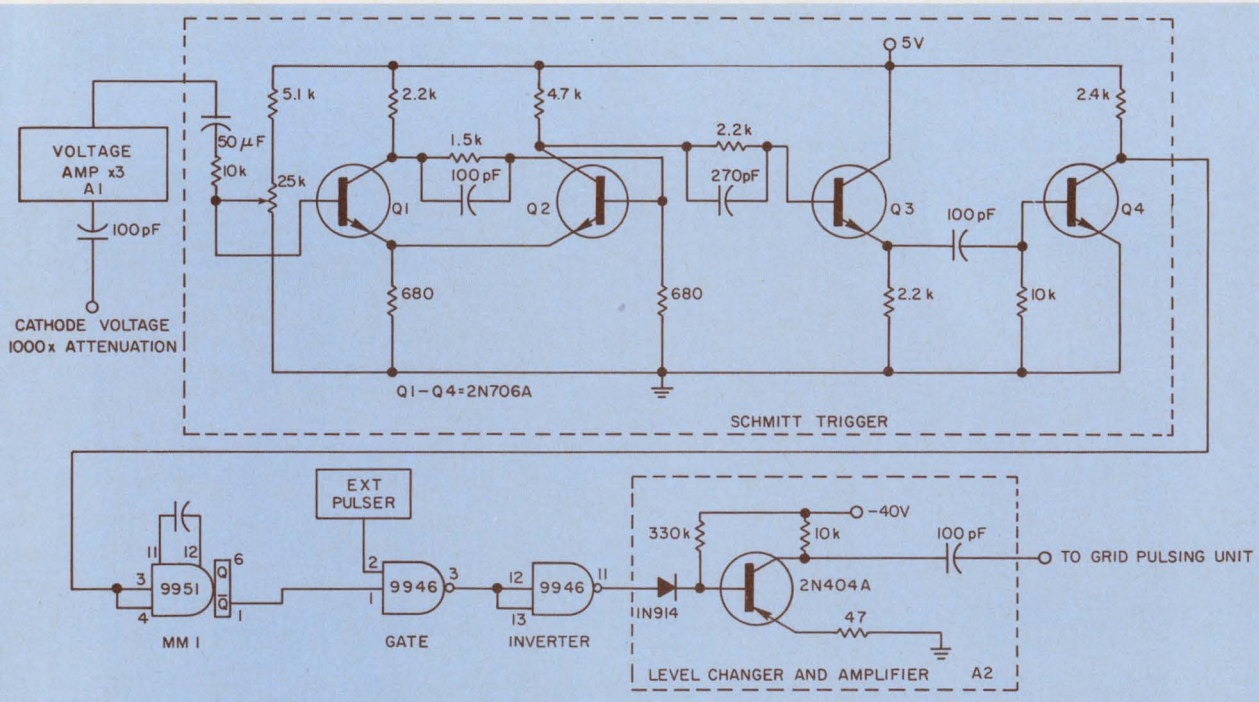
The accelerating potential, the cathode voltage in Fig. 1, is attenuated 1000 times and is ac-coupled to the input of the feedback circuit (Fig. 2). This blocks the dc component, but allows the circuit to sense the ac variations.

The ac variations are amplified, then applied to the input of a Schmitt trigger, which has an adjustable threshold. Monostable multivibrator MM_1 normally provides a logic ONE output to the gate. A logic ONE from the external pulser passes through the gate, is inverted, and produces a pulse at the output of A_2—which turns on the electron beam.

When the input voltage to the Schmitt trigger falls below the level set by R_1, the trigger fires,



1. **Poor voltage regulation causes** focus change and beam deflection in pulsed operation of an electron gun.



2. **Feedback circuit minimizes** effect of accelerating-voltage changes by cutting the beam off when the cathode voltage changes by a preset amount. Potentiometer R_1 determines the cut-off point.

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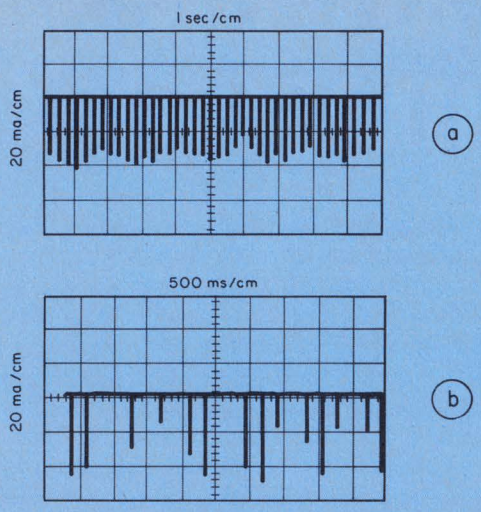


3. **Beam current that passes** through the electron-gun aperture is approximately the same for each pulse (a) with use of the feedback circuit. Without the feedback circuit, the current pulses are nonuniform (b), an indication of beam wander.

and causes MM_1 to change state. The output of MM_1, now a logic ZERO, closes gate G_1 and thereby terminates the electron-beam pulse.

The monostable remains set for 10 ms to prevent the gate from being enabled more than once during a single-trigger pulse. The delay prevents the Schmitt trigger from enabling the gate, should the cathode voltage rise to the point where the trigger resets—before the external pulse ends.

Under full-beam current, the cathode voltage drop is about 1.5 kV, which gives a 4.5 V input swing to the Schmitt trigger. If the swing is clamped 800 V—by adjustment of R_1—the operator can obtain satisfactory deflection and focus of the beam. An LM311 voltage comparator can be substituted for the Schmitt trigger without addition of another negative power supply.

Samir K. Dalal, Systems Engineer, Wyle Laboratories, 3200 Magruder Blvd., Hampton, Va. 23366.

CIRCLE NO. 314

Two resistors remove limiting effects of input voltages on current-mode amplifiers

When designing with current-mode amplifiers, you must also consider input voltages. The base-emitter voltages of the input transistors can limit the reproducibility of a circuit. But by adding just two resistors, you can eliminate their influence and simplify circuit calculations as well.

The output voltage of the simple stage is shown by the expression

$$e_o = r\left[\left(\frac{e_+}{R_1} - \frac{e_-}{R_3}\right) + V_{BE}\left(\frac{1}{R_3} - \frac{1}{R_2} + \frac{1}{R_4} - \frac{1}{R_1}\right)\right]. \quad (1)$$

The addition of two extra resistors, R_2 and R_4, eliminates the influence of V_{BE} if you choose $R_4 = R_1$ and $R_2 = R_3$. This reduces Eq. 1 to

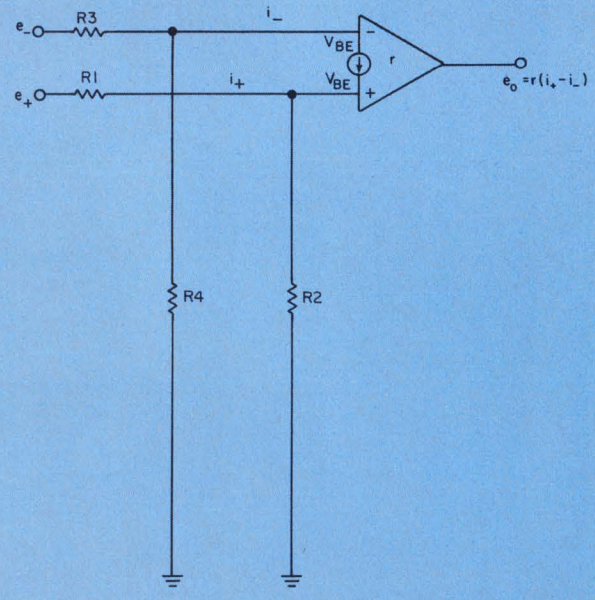
$$e_o = r\left(\frac{e_+}{R_1} - \frac{e_-}{R_3}\right), \quad (2)$$

in which V_{BE} no longer appears. You can now compute the current difference as if V_{BE} were zero and the extra resistors were not present.

With more complex input arrangements, you must use equivalent source resistances—Thevenin equivalents. Then the diagram applies, where R_1 and R_3 are the equivalent source resistances.

Dr. J. E. Sigdell, F. Hoffmann-La Roche & Co. Ltd., Bioelectronics Dept., CH-4002, Basel, Switzerland

CIRCLE NO. 315



Effect of input V_{BE} on current-mode amplifiers can be eliminated if R_4 and R_2 are added to the circuit, provided $R_4 = R_1$ and $R_2 = R_3$. The amplifier output equals a constant times the difference in input currents, as usual.

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Line-voltage control technique improves resolution, lowers parts cost

The classic method of varying the power-line voltage for design or production testing is to connect the load to the power source through a variable autotransformer (a). But there are three shortcomings.

First, the 105-to-125-V range over which most equipment is tested uses only a small percentage of the total rotation of the autotransformer's control knob. This may make it difficult to set the desired output voltage precisely. Second, controlling a large amount of power requires a large, and therefore expensive, variable autotransformer. Third, variable autotransformers have poor load regulation. This may necessitate continual readjustment.

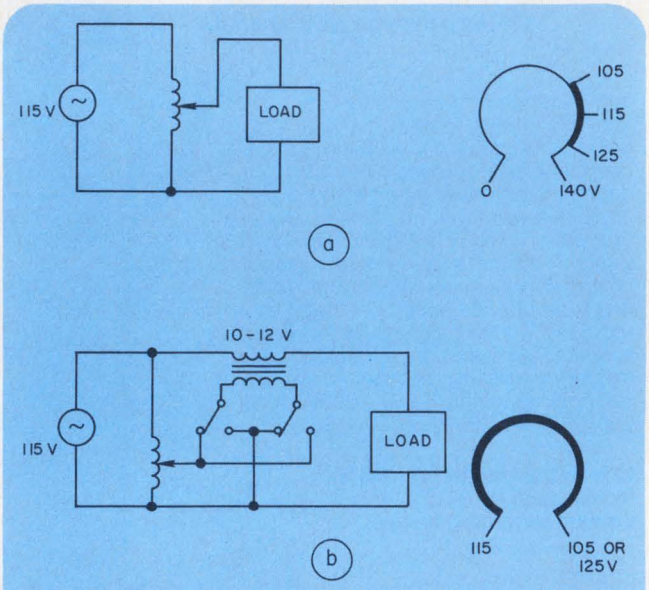
The voltage-control method in the diagram (b) overcomes these problems. A low-power—and low-cost—variable autotransformer controls the primary current of a filament transformer whose high-current secondary winding is connected in series with the load and power source. The DPDT switch in the filament transformer primary circuit allows the secondary winding's output voltage either to aid or to oppose the power-source voltage. Since a full revolution of the autotransformer's control knob will either increase or decrease the line voltage by an amount equal to the filament transformer's rated output voltage, very precise control is achieved easily. Moreover, use of the comparatively low impedance of the secondary winding results in excellent load regulation (compared with that of an autotransformer alone).

The secondary winding of the filament transformer must be rated to handle the maximum expected load current. The current rating of the variable autotransformer must equal the maximum expected load current divided by the voltage step-down ratio of the filament transformer.

The technique is especially attractive, from both a control and monetary standpoint, when the desired output-voltage range is small.

Michael J. Salvati, Staff Engineer, Sony Corp. of America, 47-47 Van Dam St., Long Island City, N. Y. 11101.

CIRCLE No. 316



Autotransformer technique for setting load voltage (a) often requires expensive transformers and gives poor voltage resolution. The improved technique (b) gives better resolution at lower cost.

IFD Winner of July 5, 1973

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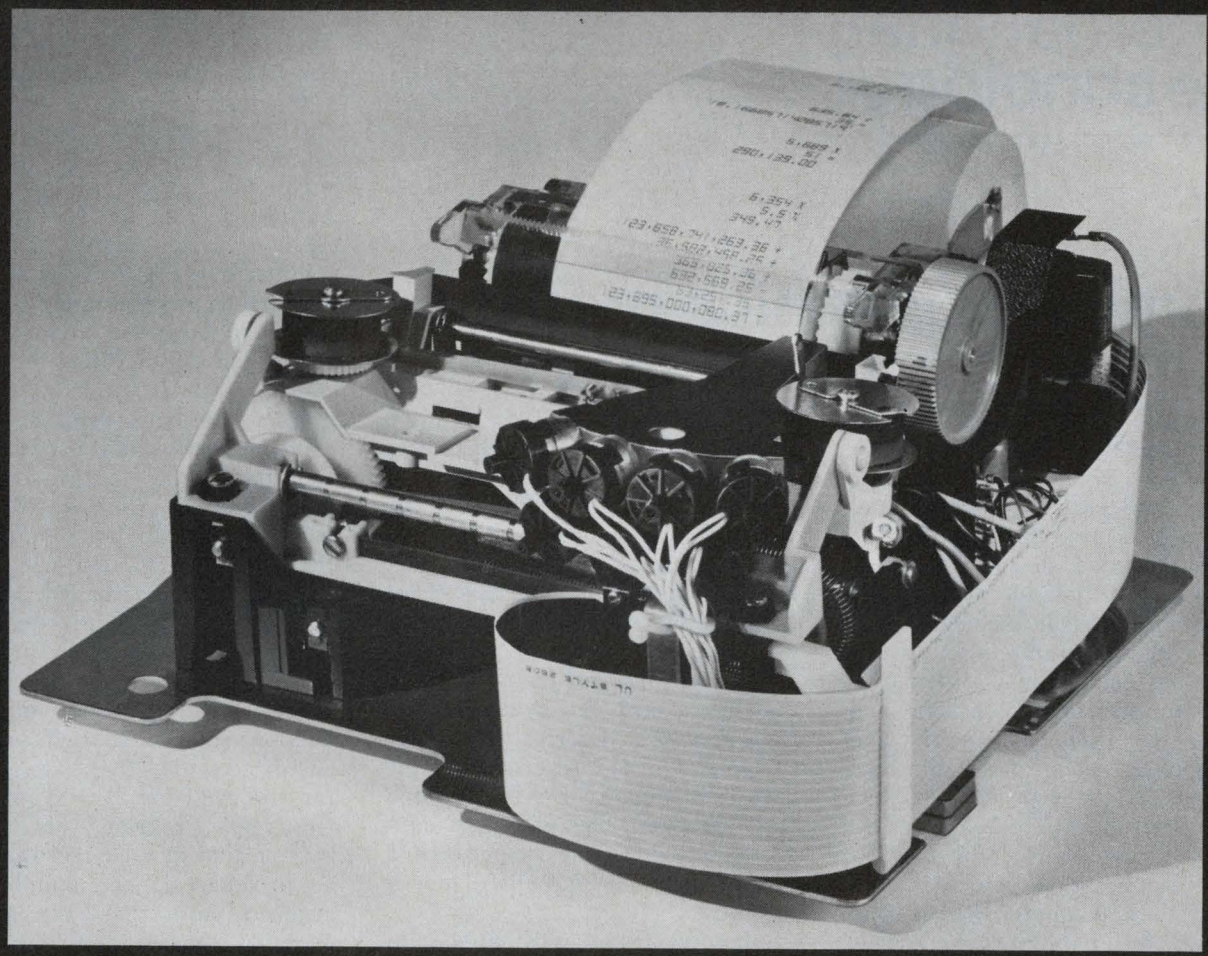

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Computer graphics prepare numerical control tapes

A system that prepares numerical-control (N-C) tapes with the aid of a low-cost computer-graphics terminal has been developed by the Computer-Aided Design Centre in Cambridge, England. Advantages over other methods include simplified parts-programming procedures, less opportunity for parts-programming errors, easier and cheaper correction of errors and considerable reduction in the lead time needed to reproduce control tapes.

The terminal used is a Tektronix storage tube, which is connected to a computer system via the switched public-telephone network. The system can be run on a range of different computers.

The basic structure differs from other systems because component-geometry definition is divorced for cutter-path definition. The three stages of N-C processing are kept separate and are dealt with by three different programs—bounded-geometry definition, machining-sequence definition and post-processing. The user calls them up as required.

The definition of bounded geometry is carried out by a program that processes descriptions of 2-D composite curves. Alternatively the definition may be the output of a CAD process. The geometry data are inputted to the computer, and the program is executed from a terminal.

Diagnostic messages can be inspected at the terminal, and the geometry data file can be amended as necessary. Users can also inspect the successfully processed geometry graphically, to check for shape errors not indicated by normal-error diagnostics. The cycle may be repeated until the user is satisfied that the geometry is correct.

The second program is an interactive one that accepts the geometric description of the curves outputted from the first program. Sequences of cutter movements may be specified in relation to this predefined geometry by a simple command language and by use of the graphical facilities of the terminal.

Users need not refer directly to component coordinates or to geometry parts that are less-than-complete composite curves. All supplementary information required on the final control tape can also be specified and finally processed with cutter-path information to produce an APT-compatible CLFILE.

Post-processing and tape production can be carried out with post-processors that are written for the APT or 2CL system. The first two programs may be reentered and new control tapes may be produced if the simple intermediate data files are kept in readable character form. In this way error-free production tapes can be produced in hours—rather than days—with a minimum of computer processing.

CIRCLE NO. 202

Sea mines destroyed by remote vehicle

A remotely controlled vehicle for destroying sea mines has been developed by a British division of Sperry at Bracknell, England.

Known as the Sperry Cat system, the vehicle is designed to operate in conjunction with a mine-hunting vessel, which acts as the mother ship. The system consists of a small, low-profile, unmanned surface catamaran known as the mine-disposal vehicle (MDV), a submersible weapon carrier and a radio-control console aboard the mine hunter. The object is to place a charge close enough to a mine to destroy it.

When a mine-like echo is detected by the sonar and the target range and bearing are identified, the MDV and an armed-weapon carrier are sent to the area. The weapon carrier is lowered, allowed to flood and sink, and is maintained at a controlled height from the sea bed by use of a drag rope.

A sonar transponder mounted in the tail of the weapon carrier assists the mine-hunting control officer to identify the carrier and steer it remotely along the sonar beam. When the slant range of the target and the weapon carrier are the same, the officer releases the charge from the carrier so it drops adjacent to the mine. The drag rope is jettisoned and the carrier, now buoyant, rises to the surface and is winched in aboard the MDV. The latter retires to a distance while the mine is exploded.

Signal processing uses thin-film waveguides

Acoustic surface-wave, thin-film waveguides have been used for a variety of nonlinear signal-processing techniques by reasearchers at University College in London. By use of nonlinear effects, thin-film waveguides are used to receive a surface-wave beam that travels at right angles to the waveguide axis. Tapered funnels have been used to solve the problem of coupling a transducer structure that is tens of wavelengths wide to a waveguide that is typically one wavelength wide. The functions of convolution and imaging have been carried out, but other forms of signal processing are possible with the basic system. ■■

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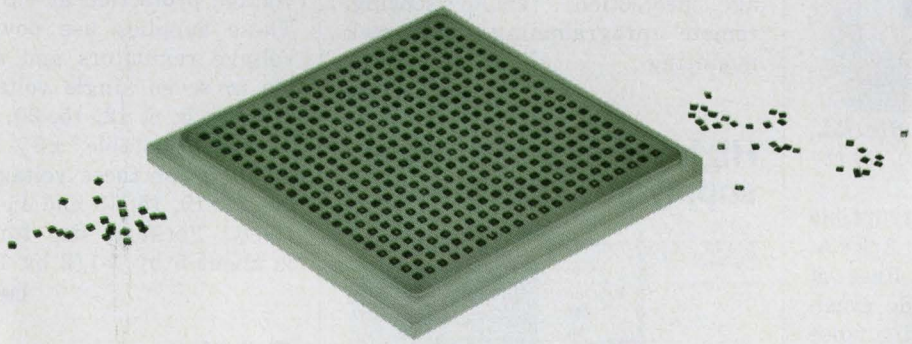

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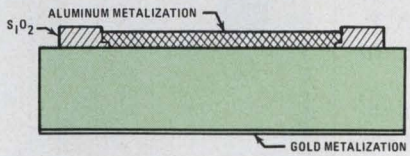

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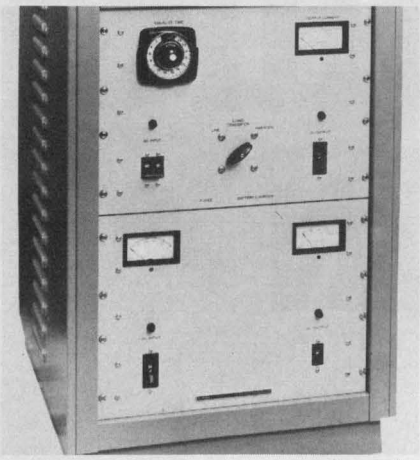


Topaz Electronics, 3855 Ruffin Rd., San Diego, Calif. 92123. (714) 279-0111. $4400.

The "Mini-UPS" uninterruptible power system can deliver 3 kVA. It will operate on power lines of 95 to 130 V ac and provide excellent attenuation of power-line noise spikes. Each unit comes complete with battery charger, inverter and choice of either relay or solid-state transfer switch. Integral meters show battery voltage and output voltage. The operation mode is indicated by panel lights. A wide choice of full load back-up time is available through battery selection.

CIRCLE NO. 250

Mini dc-to-dc converters fit in flatpack case

LRC Inc., 11 Hazelwood Rd., Hudson, N.H. 03051. (603) 883-8001.

Dc-to-dc converter Models PS-1501 and PS-1502 flatpack supplies operate from ±5 to ±25 V and ±10 to ±25 V and provide output voltages from +45 to −70 V and output currents of ±30 mA (PS-1501) and ±50 mA (PS-1502). Both miniature supplies operate with efficiencies up to 80%. The supplies are only 0.65 in. square by 0.15 in. high and are ruggedized for use in stringent military environments. Screening to MIL-STD-883 is available.

CIRCLE NO. 251

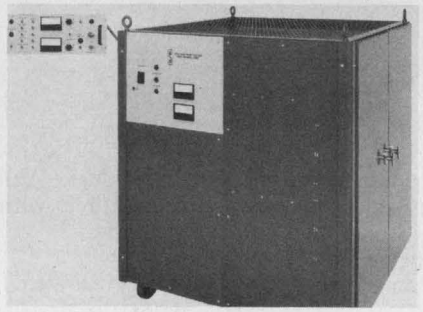
Single output supplies deliver 0.1% regulation

ACDC Electronics, Oceanside Industrial Center, Oceanside, Calif. 92054. (714) 757-1880. From $32; stock.

Series OEM5N low current power supplies offer five more models ranging from 5 V at 3 A to 24 V at 1 A. These units deliver 0.1% regulation and have protection against overload and short-circuit. Provisions are made for overvoltage protection, remote sensing, remote programming and rack mounting.

CIRCLE NO. 252

High voltage sputtering supply has 60 kW output

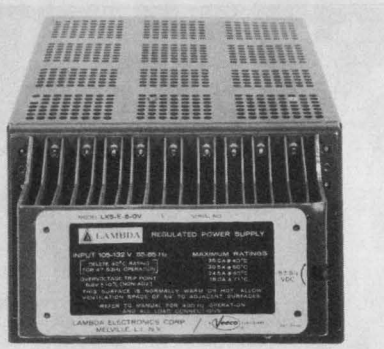


Spellman High Voltage Electronics Corp., 1930 Adee Ave., Bronx, N.Y. 10469. (212) 671-0300. $16,000; 10 to 12 wk.

The Model HP6-10,000RX high-voltage sputtering power supply has been designed for a 60 kW continuous dc output (0 to 6 kV at 10 A) with a 90 kW short term capability. It is servo regulated against ±5% line voltage variations and uses primary reactors to limit short-circuit output current to 30 A and maintain constant output power for load variations in the 4.5 to 60 kV output voltage range. Input power requirements are 480 V/60 Hz, three phase at 100 kVA. The main power cabinet measures 52 by 53 by 58 in. including casters, and weighs approximately 3000 lb. The remote control panel measures 8-3/4 by 24 by 7 in. and weighs 30 lb.

CIRCLE NO. 253

Lone output dc supplies require no blower

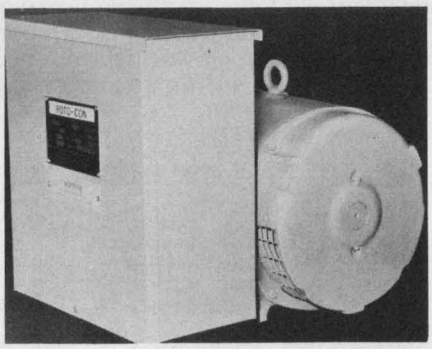


Lambda Electronics Corp., 515 Broad Hollow Rd., Melville, N.Y. 11746. (516) 694-4200. $300.

The LX-E series of single output power supplies is convection cooled and requires no blowers. The 5-V models have built-in, fixed, overvoltage protection at 6.8 V ±10%. These supplies use power hybrid voltage regulators and are available in seven single voltage output models: 5, 6, 12, 15, 20, 24 and 28 V, all adjustable ±5%. Currents at 40 C for these voltages are 35, 34, 21, 19, 15, 13 and 11 A, respectively. Package size for all units is about 5 by 7-1/2 by 11-3/4.

CIRCLE NO. 254

Get three-phase power from single-phase lines



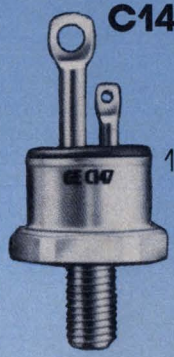
Ronk Electrical Ind., 106 E. State St., Nokomis, Ill. 62075. (217) 563-8333.

The Roto-Con rotary phase converter transforms single-phase power to three-phase. It gives up to 150% breakdown torque. It can be used with variable-speed, instant-reverse, frequently-started and continuous-duty motors. It can also provide power to several motors separately or simultaneously. Roto-Con models are available for multimotor installations up to 100 hp total load, with any individual motor not exceeding 50 hp.

CIRCLE NO. 255

COMPACT and COOLER

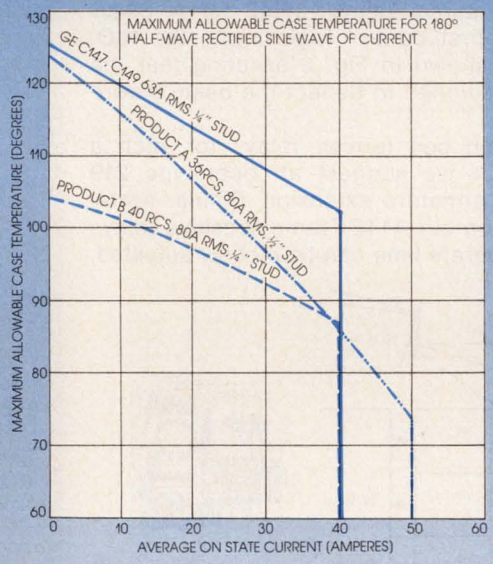
NEW 63A SCRs FROM GENERAL ELECTRIC



C147-FOR PHASE CONTROL
63A RMS @ 95° C Case
Up to 1,200V AC
200A/μsec. di/dt
1,000A Peak One-Cycle Surge
Priced as low as *$9.25

C149-FOR INVERTERS
63A RMS @ 95° C Case
Up to 600V AC/DC
10 μsec. t off
1,000A Peak One-Cycle Surge
Priced as low as *$12.75

*Suggested resale prices, 10-99 quantities



These two new SCRs have low power dissipation, providing an added measure of reliability... run at 15° C cooler case temperature than their competitive counterparts. Hermetically sealed in a ¼"-28 stud mount package, their more compact size and more efficient operation allows the use of smaller, lower cost heatsinks.

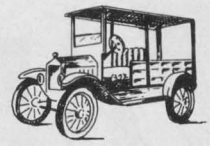
The C147 and C149 are available from any authorized GE semiconductor distributor. For further information contact either your authorized GE semiconductor distributor or any GE Electronic Components Sales Office or write on company letterhead to General Electric Semiconductor, Building 7-49, Electronics Park, Syracuse, N.Y., 13201, U.S.A.

THYRISTORS

GENERAL ELECTRIC

INFORMATION RETRIEVAL NUMBER 56

relays rewarded



Our congratulations and FIVE $50 U.S. Savings Bonds from the Struthers-Dunn 50th Anniversary Relay Contest are awarded to:

Dr. M. Sayar
Rehovot, Israel

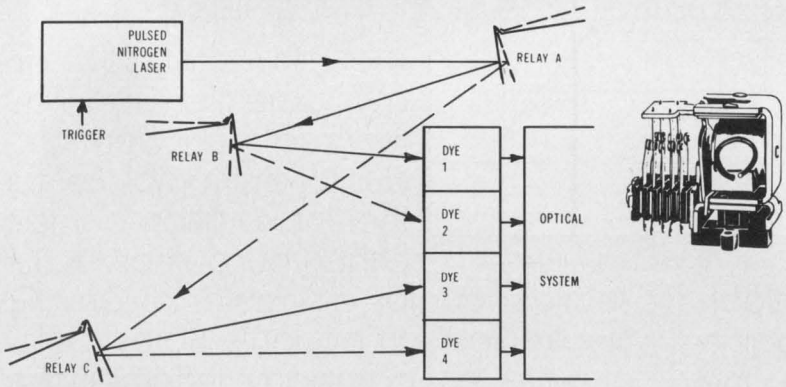
for this solution to a relay problem, independently judged the third most imaginative entry of wide interest to users of relays.

LIGHT DEFLECTION BY RELAYS

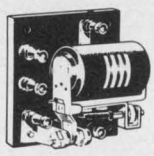
Relays not only trigger but actually *deflect* a laser beam in this extraordinary application. Following delays of 0, 30, 10, and 70mS after control command, four dye cells are illuminated by a pulsed nitrogen laser according to a sequence programmed by control logic.

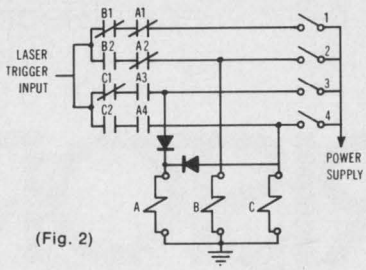
Deflection of the laser is done as shown in Fig. 1 using relays with polished and coated armatures which act as front surface mirrors. Relays are also adjusted for the required delays: 10mS for A, 30mS for B, 70mS for C. Except for the first control logic input, the N.O. relay contacts trigger the laser as shown in Fig. 2 assuring that the reflective armatures are properly positioned to deflect the beam before the laser is triggered.

Believe it or not Struthers-Dunn can furnish relays for such a specialized application. For relay A we suggest an open-type 219 Frame modified to have a mirrored armature extension. Similar armature modifications can be furnished on our A112 Frame sensitive relays which will serve for B and C since operate time can be closely adjusted.



(Fig. 1)



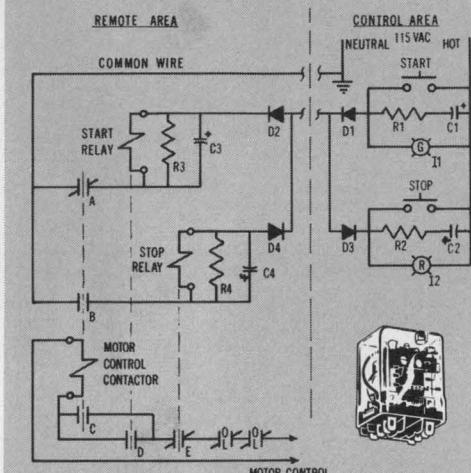


(Fig. 2)

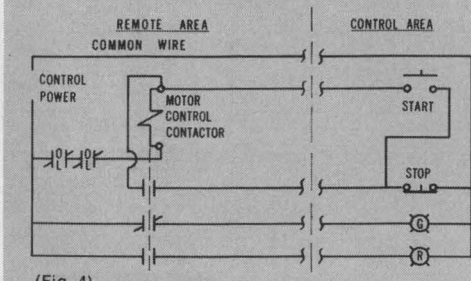
1 vs. 4 WIRE REMOTE MOTOR CONTROL

Two relays and a few inexpensive electronics allow remote control of any size motor with just one wire plus a common as shown in Fig. 3. By contrast, 4 wires plus a common are needed in the conventional circuit of Fig 4. The diagrams are arranged to separate the components at the control area from those at the remote area.

Key to this cable saver is the use of diodes D1 through D4 to provide a one-way path for the Start signal and indicator while using the same path, but with reversed polarity, for the Stop signal and indicator. Resistors R1 through R4 merely reduce any series interaction between relay coils and indicator lights, while capacitors C1 through C4 block dc components introduced by the diodes. Any Struthers-Dunn dc relay could be used in this 'line-saving' circuit by properly matching capacitors, lamps, and relay coils. Specifically recommended is the 283 Frame, 10 amp, general purpose relay. The 283 offers quick-connect terminals spaced for standard plug-in mounting and pierced to accommodate solder-wiring. Congratulations and $50 to A. C. M., Dumas, Texas for calling this suggestion to our attention.



(Fig. 3)



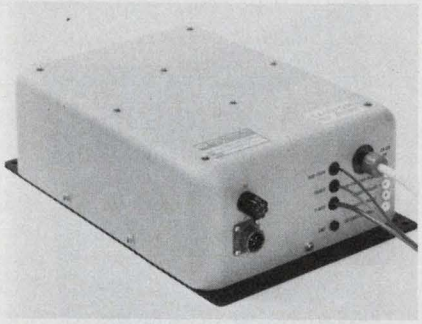
(Fig. 4)

STRUTHERS-DUNN, INC.
PITMAN, NEW JERSEY 08071
Canada: Struthers-Dunn Relay Div., Renfrew Electric Co., Ltd.

150 PAGES OF RELAYS FOR MOST ANY CIRCUIT
The latest compilation of one of the world's broadest relay lines from the company that has developed an average of 9 new relay designs a month since 1923. Circle reader service card number for your copy.

INFORMATION RETRIEVAL NUMBER 57

High voltage supply has three adjustable outputs



Sierra Systems, Inc., 650 Vaqueros, Sunnyvale, Calif. 94086. (415) 969-3056. $1050 (10-up); 4 to 6 wk.

Model 752 CRT power supply delivers four output voltages, three of which are adjustable. The adjustable ranges are: accelerator voltage, 24 kV to 28 kV at 25 μA, focus voltage, 7 kV to 9 kV at 10 μA and intensity control voltage, 500 V to 700 V at 10 μA. The fourth output is a photomultiplier supply voltage that is factory set at −1.5 kV at 2 mA. The regulation and ripple specifications for all voltages are ±0.5% and 0.1% pk-pk, respectively. The output voltages can also be monitored at externally accessible test points with a microammeter. The input supply voltage for the 752 is 28 V dc. The unit is fully shielded and filtered for both radiated and conducted RFI.

CIRCLE NO. 256

Current supply can be pulsed to give 200 A

Merrick Engineering Inc., 725 Melpark Dr., Nashville, Tenn. 37204. (615) 383-0502.

The TXR-200 pulsed current supply can be used to deliver straight dc or pulsed dc over the range of 0.25 to 200 A, with a pulse repetition rate of 2000 to 25,000 pulses/s. Welding current consists of two separate components, background and pulsed current. Background current (nonpulsating dc) 0.2 to 99.9 A is controlled by a direct reading digital dial. Pulse peak is indirectly adjustable up to 500 A. Speed of regulator response is 4 μs and corrections are made instantaneously for changes in either arc length or line voltage.

CIRCLE NO. 257

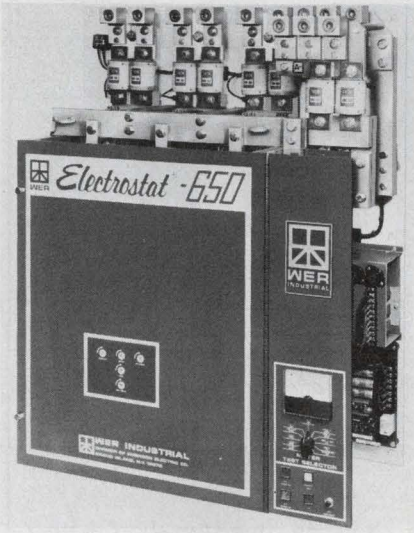
Dual tracking supply tracks to within 0.1%

Power-One, 10526 Jordan, Chatsworth, Calif. 91311. (213) 887-5730. $31.96 (100-up).

Dual tracking power supply Model AA15-0.8 delivers +15 V at 800 mA or ±12 V at 1 A. Some of its other features are: tracking accuracy of 0.1%, line regulation of 0.01%, load regulation of 0.02% and ripple content of 1.5 mV pk-pk.

CIRCLE NO. 258

Series of drive controls handles motors to 700 hp



WER Industrial Div. of Emerson Electric Co., Grand Island, N.Y. 14072. (716) 773-2321.

The Electrostat 600 Series is a six-SCR drive control designed for single motor or system applications. Options can be added for multimotor drive, torque, followers, field regulator control or field regeneration applications. The same regulator control is used for all motor horsepower ratings. Drives to 150 hp are supplied in a NEMA I 24 by 30 by 12 in. enclosure or on a 21 by 21 in. panel. Larger drives, from 200 to 700 hp, are supplied in NEMA I 30 by 36 by 14 in. wall mounted enclosure or on a 27 by 33 in. panel. Standard features include an up-front drive monitor test meter, an adjustable current limit with light indicator, ac line reactors with dc circuits, instantaneous fault trip, line and armature current limiting fusing, phase loss and low voltage protection and adjustable acceleration/deceleration and jog.

CIRCLE NO. 259

POWER SOURCES

Modular dc supplies have dual regulated outputs

Semiconductor Circuits, Inc., 306 River St., Haverhill, Mass. 01830. (617) 373-9104. $98 (1 to 9); stock to 2 wk.

The P2.12.300 and P2.15.300 modular power supplies provide dual regulated outputs of ±12 V dc and ±15 V dc, respectively, at ±300 mA. These units are epoxy encapsulated in a black anodized aluminum case measuring 2.5 by 3.5 by 1.56 in. For both supplies regulation is 0.01% (max.) for line (105 to 125 V ac) and 0.05% (max.) for load (NL to FL). Ripple and noise is less than 1 mV rms and the temperature coefficient is 0.02%/°C. There is no derating in performance over the operating temperature range of −25 to 71 C.

CIRCLE NO. 260

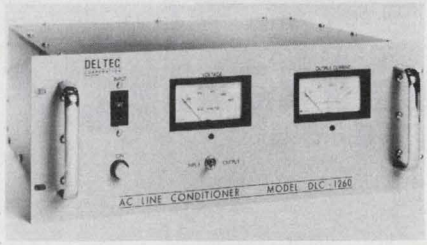
Power supply drives 33 different lamp types

Schoeffel Instrument Corp., 24 Booker St., Westwood, N.J. 07675. (201) 664-7263. $275; stock to 30 day.

A universal spectral power supply can operate over 33 spectral lamps with a useful range of 1800 to 7000 Å. The supply current is adjustable by a front panel control from 0.9 to 1.5 A. Typical lamps which can be used with the system include: cadmium, zinc, mercury, argon, krypton, sodium and caesium. The supply is in a 10 by 12 by 7 in. case and weighs 15 lb.

CIRCLE NO. 261

Ac line conditioner delivers up to 5000 VA

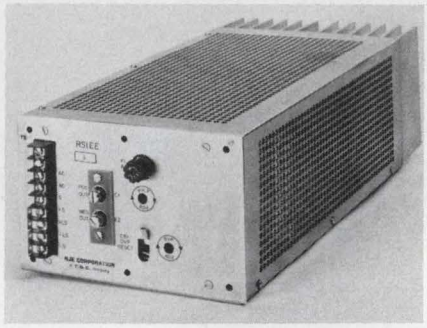


Deltec Corp., 3849 Gaines St., San Diego, Calif. 92110. (714) 297-4466. $50 per 100 VA.

The DLC 1260 ac line conditioner can deliver 1200 VA. The input to the unit is 75 to 130 V ac with an output of 117 V ac ±3%. Noise suppression and common-mode rejection is greater than 120 dB. The 1260 is supplied in a rack mount cabinet 7 by 17 by 14 in. and weighs approximately 35 lb. Additional units of the DLC series are available to power levels of 5000 VA and inputs of 240 V ac and 50 Hz.

CIRCLE NO. 262

Modular supplies offer Lambda compatibility



NJE, 50 Culver Rd., Dayton, N.J. 08810. (201) 329-4616.

The RSI/RXI line of system power supplies offers more than 130 models that are interchangeable with Lambda modules. In addition, the OEM designer has the choice in same unit size of output current/regulation tradeoffs at no change in price. Specifications for the RSI line are 105 to 132 V ac input operating range, 47 to 400 Hz input frequency, 1 mV rms ripple (3 mV pk-pk), −20 to 71 C operating temperature range, 25 μs transient recovery time, ±25% internally adjustable overload protection and remote programming/remote sensing terminals. Options available are overvoltage protection, 205 to 265 V ac input voltage and MIL coatings.

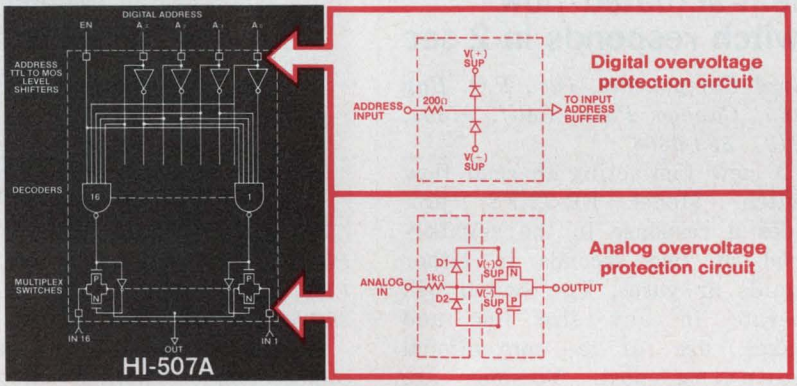
CIRCLE NO. 263

Encore:

It's our latest monolithic analog multiplexer with internal overvoltage protection--the HI-507A Dual 8 Multiplexer. And it's pin for pin interchangeable with the DG-507.

Just recently we introduced the first monolithic multiplexer with internal overvoltage protection—our HI-506A 16-channel multiplexer, featuring performance characteristics previously unavailable. Now we offer a dual 8-channel unit incorporating all the advantages of the 16-channel unit.

As with the HI-506A, this new device combines our DI/CMOS (dielectric isolation) process with a unique circuit design to provide on-board protection against analog input overvoltage. In the event of overvoltage in one channel there is no output error when other channels are being addressed. This same protection circuit also eliminates latch-up, as well as unpredictable operational characteristics that could result from transient voltages originating in either the signal or supply. A second similar circuit provides the necessary safeguards against static charges. Additionally, break-before-make switching eliminates undesirable channel interaction. Applications for the new device include data acquisition, telemetry systems, process control and general analog switching. The device is available in volume now for off-the-shelf delivery. For details see your Harris distributor or representative.



Features:

Internal overvoltage protection, both analog and digital

No channel interaction with power loss

Break-before-make switching

DTL/TTL and CMOS compatibility

Supply current	**4mA at 1 MHz toggle rate**
Power requirement	**7.5mW disabled**
Power requirement	**7.5mW enabled**
Access time	**500 ns**
Power supply	**±15V**
Signal range	**±15Vdc**
Supplied 28-pin DIP	

	100-999 units
HI 1-506A-5/HI 1-507A-5 0°C to +75°C	**$28.60**
HI 1-506A-2/HI 1-507A-2 −55°C to +125°C	**$57.20**

Harris

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A DIVISION OF HARRIS-INTERTYPE CORPORATION
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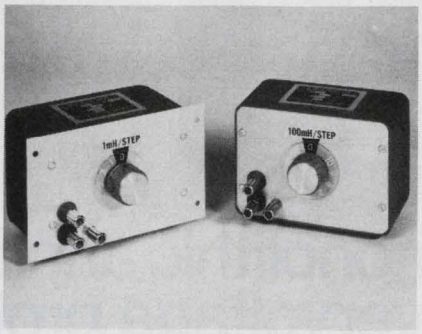
WHERE TO BUY THEM: ARIZONA: Phoenix—Liberty, Weatherford; Scottsdale—HAR (602) 946-3556 **CALIFORNIA:** Anaheim—Weatherford; El Segundo—Liberty; Glendale—Weatherford; Long Beach—HAR (213) 426-7687; Mountain View—Elmar; Palo Alto—Weatherford, HAR (415) 964-6443; Pomona—Weatherford; San Diego—Weatherford, Western **COLORADO:** Denver—Elmar, Weatherford **WASHINGTON, D.C.:** HAR (202) 337-3170 **FLORIDA:** Hollywood—Schweber; Melbourne—HAR (305) 727-5430 **GEORGIA:** Atlanta—Schweber **ILLINOIS:** Chicago— Schweber; Schaumburg—HAR (312) 894-8824 **MARYLAND:** Rockville—Schweber **MASSACHUSETTS:** Lexington—R&D; Waltham—Schweber; Wellesley—HAR (617) 237-5430 **NEW MEXICO:** Albuquerque—Weatherford **NEW YORK:** Melville—HAR (516) 249-4500; Syracuse—HAR (315) 463-3373; Rochester—Schweber; Westbury—Schweber **OHIO:** Beachwood—Schweber; Dayton—HAR (513) 226-0636 **PENNSYLVANIA:** Wayne—HAR (215) 687-6680 **TEXAS:** Dallas—Weatherford, HAR (214) 231-9031; Houston—Weatherford **WASHINGTON:** Seattle—Liberty, Weatherford.

LEGEND FOR HARRIS SALES OFFICES & DISTRIBUTORS: Harris Semiconductor (HAR); Elmar Electronics (Elmar); Harvey/R&D Electronics (R&D); Liberty Electronics (Liberty); Schweber Electronics (Schweber); R. V. Weatherford Co. (Weatherford); Western Radio (Western).

INFORMATION RETRIEVAL NUMBER 60

Decade inductors are accurate to ±1%



Sprague Electric Co., 347 Marshall St., North Adams, Mass. 01247. (413) 664-4411.

Type 4W precision decade inductors for design and experimental work in the frequency range of 150 to 20,000 Hz, are available in units with 0.001, 0.01, 0.1, and 1.0 H steps. Each unit has 10 steps. With four decades inductors in series, any inductance from 0 to 11.11 H can be selected in 0.001 H steps with a guaranteed accuracy of ±1% at 1 kHz and 25 C.

CIRCLE NO. 264

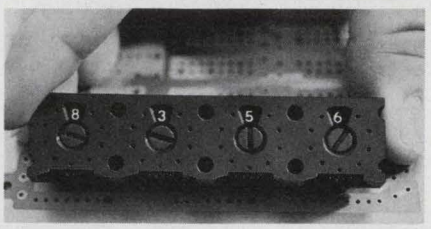
Heat-actuated flow switch responds in 2 sec

Fluid Components, Inc., P.O. Box 1165, Canoga Park, Calif. 91304. (213) 883-0806.

A new fast-acting thermal flow switch, Model FR-72-FS, provides a response in the neghborhood of two seconds in either liquids or gases. The switch will operate in any size line and makes use of a conventional mounting port. Versions are available for liquid flow rates from 0.01 to 2 ft/s, and gas flow rates from 0.1 to 15 ft/s. Operating temperatures range from −100 to 300 F. All surfaces in contact with the medium are of stainless steel. The switch is heat actuated, has no moving parts and is field adjustable. Electrical circuity is all solid state, modular construction and enclosed in an explosion proof housing. An external circuit may be connected to either the normally-open or normally-closed contacts of the output relay.

CIRCLE NO. 265

Screwdriver sets rotary PC-board switch

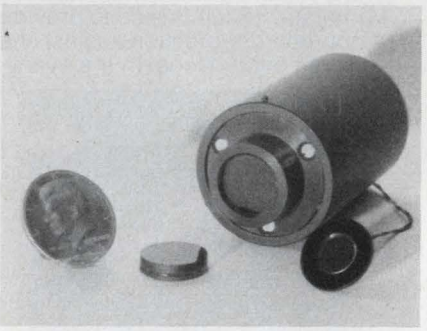


Electronic Engineering Company of California, 1441 E. Chestnut Ave., Santa Ana, Calif. 92701. (714) 835-6000. $1 per station (OEM qty); stock to 6 wks.

EECO 21-S switches are single-piece, multistation units with one to 11 separate switch stations. Solder pins provide both input and output interconnections as well as a firm mount to either or both sides of a PC board. Code circuitry is integral and no rivets, stator pattern or special board platings are required. The switches are 0.44 deep × 0.775 high × 0.80 wide in. per switch station.

CIRCLE NO. 266

Light sensor measures with built-in electronics



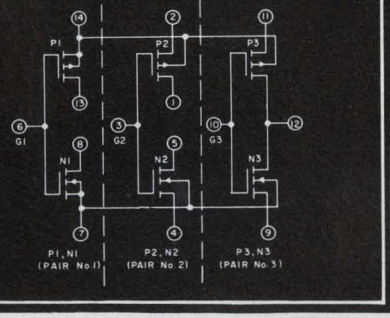
Photon Products, Inc., P.O. Box 1230, Cupertino, Calif. 95014. (408) 296-5226. $235 (unit qty).

A new series of light sensors comes complete with a silicon detector, filter, amplifier and microcircuitry in a single compact unit. Three models cover the complete visible and near-visible photometric range: ISP-610; 610-740 nm; ISP-55; 380-740 nm; and ISR-590; 410 nm to 1.0 μ. Dark-current noise is as low as 10 pA with zero bias. All models feature binary programmable range selection for automatic or manual ranging. Adjustable gain and ambient offset controls permit interfacing to microscopes, probe stations or other production facilities. The units are powered by 18 V dc.

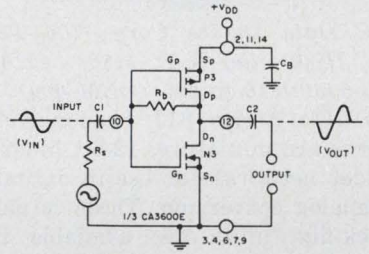
CIRCLE NO. 267

Linear COS/MOS... RCA's CA3600E premieres

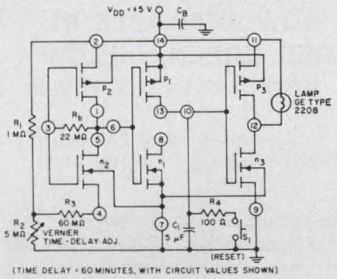
CA3600E schematic diagram



CA3600E transistor pair biased for linear-mode operation



Analog timer using CA3600E



Meet the linear IC with the advantages of COS/MOS. The new RCA CA3600E Transistor Array... three pairs of complementary enhancement-type MOS (p-channel/n-channel) transistors on a single chip.

The CA3600E is designed for a great variety of applications requiring virtually infinite input impedance, wide bandwidth, matched characteristics, lower power consumption and general purpose circuitry.

And that's not all. With the new CA3600E you get performance advantages that include square-law characteristics, superior cross-modulation performance, and a greater dynamic range than bipolar transistors.

Whether you're working in timing, sensing and measuring or any other applications, or if you're tired of fighting beta variation in your bipolar circuit, let your "linear" imagination run wild. The features offered in the new CA3600E COS/MOS Linear IC are too good to pass up.

- ☐ Virtually infinite input resistance/100 gigohms
- ☐ Each transistor rated for operation up to 15V and 10 mA
- ☐ Low gate-terminal current/10 picoamps
- ☐ No "popcorn" (burst) noise
- ☐ Matched p-channel pair/gate-voltage differential (I_D = −100uA) ... ±20mV (max)
- ☐ Stable transfer characteristics over a temperature range of −55°C to +125°C
- ☐ High voltage gain/up to 53dB per COS/MOS pair.

Supplied in the 14-lead dual-in-line plastic package, the CA3600E is available in production quantities from your local distributor or direct from RCA.

For complete data sheet/application note write: RCA Solid State, Section 57K11, Box 3200, Somerville, N.J. 08876. Or phone: (201) 722-3200.

RCA Solid State

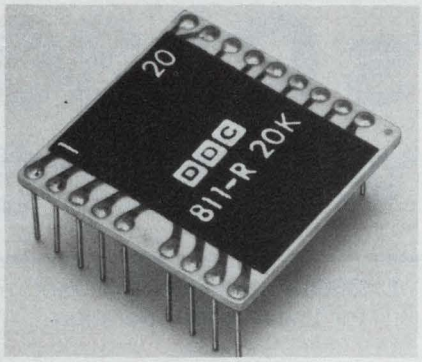
products that make products pay off

International: RCA, Sunbury on Thames, U.K., or Fuji Building, 7-4 Kasumigaseki, 3-Chome, Chiyoda-Ku, Tokyo, Japan. In Canada: RCA Limited, Ste. Anne de Bellevue 810, Canada.

INFORMATION RETRIEVAL NUMBER 62

COMPONENTS

Second source for Beckman ladder network

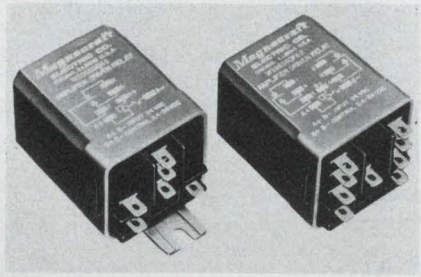


ILC Data Device Corp., 100 Tec St., Hicksville, N.Y. 11801. (516) 433-5330. $10 to $25 (OEM qty).

DDC's Series 811 Ladder Networks are miniature, 12-bit binary ladder networks for use in digital-to-analog conversion. These cermet thick-film units are available in eight standard models with resistance values of 5 k, 10 k or 20 kΩ. The networks are directly interchangeable with like units of Beckman Instruments Co. Maximum voltage ratio errors are as low as 122 ppm over a −55 to 125 C or −20 to 80 C operating temperature range.

CIRCLE NO. 268

General-purpose relay has built-in amplifier

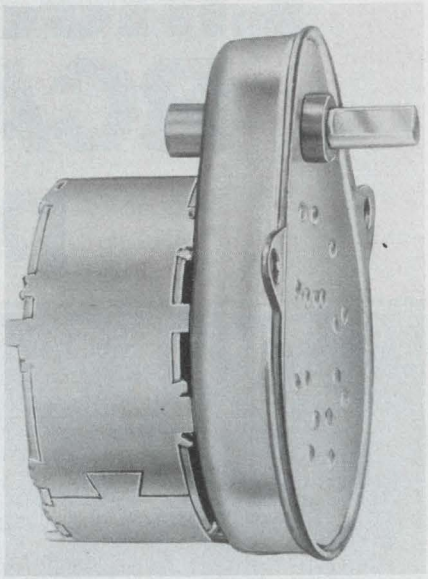


Magnecraft Electric Co., 5575 N. Lynch Ave., Chicago, Ill. 60630. (312) 282-5500.

Class 388 amplifier-driven, general-purpose relay allows 10-A switching with extremely low power control. The amplifier circuit presents a very-high impedance to the control circuit. This makes it especially suited for IC low-power signal levels. A control voltage as small as 2.4 V dc will energize the relay via its 24-V-dc supply voltage. Polarity and transient protection are standard. The relay has either plug-in or surface mounting.

CIRCLE NO. 269

Timing motor made with barium-ferrite rotor



Cramer Div., Conrac Corp., Mill Rock Rd., Old Saybrook, Conn. 06475. (203) 388-3574.

The Cramer 105 motor is a high-torque, permanent-magnet synchronous motor with both mechanical and electrical direction control. It has a barium-ferrite rotor, and stator poles of different widths to provide high starting and running torque under all load conditions. The power input is 2.7 W at 115 V and 60 Hz. Starting and running torque for this permanently lubricated motor is 300 oz-in. at 1 rpm and 60 Hz. Motor output speeds range from 1 to 60 rpm. This motor is particularly suited to timing applications.

CIRCLE NO. 270

Pushbutton tests plug-in relay

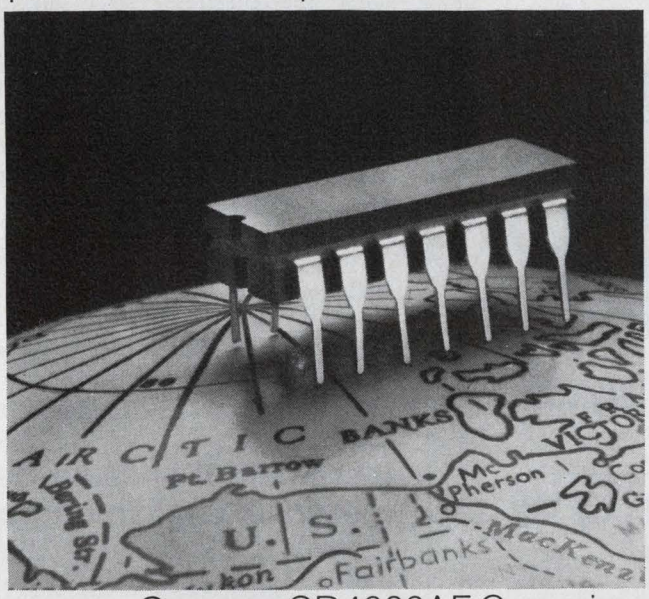
Deltrol Controls, 2745 S. 19th St., Milwaukee, Wis. 53215. (414) 671-6800.

A test button in the cover of Series 165B/166B plug-in relay enables maintenance personnel to manually check circuit functions without energizing the relay coil. The relay is available in SPDT, DPDT and 3PDT contact configurations with contact ratings of 5 and 10 A. Terminals are a 3/16-in. quick-connect type that are spaced for a standard plug-in receptacle or for single-lead quick-connect lugs or solder connections. The series comes in a large selection of ac or dc coil voltages.

CIRCLE NO. 271

RCA COS/MOS in low cost ceramic.

RCA now offers COS/MOS in a new low cost ceramic package. So you can select, from our complete line of COS/MOS circuits, an IC package to meet your exact needs for performance and price.



Our new CD4000AF Ceramic IC's feature electrical characteristics identical to the present AD and AK series weld seal ceramic COS/MOS circuits. You get a completely hermetic package designed to operate over the full military temperature range of −55°C to +125°C... at a commercial price.

Compare the prices of our new ceramic IC's. If you've needed the temperature range and hermetic features of ceramic, but couldn't afford

TYPE NO.	FUNCTION	AF PRICE (1000+)
CD4001AF	Quad 2-input NOR gate	$ .98
CD4011AF	Quad 2-input NAND gate	.98
CD4013AF	Dual "D" master-slave Flip-Flop	2.03
CD4020AF	14-stage binary/ripple counter	5.90
CD4027AF	Dual J-K master-slave Flip-Flop	3.14
CD4029AF	Presettable up/down counter	7.94
CD4042AF	Quad clocked "D" latch	4.23
CD4046AF	Micropower phase-locked loop	5.63
CD4047AF	Monostable/Astable multivibrator	3.75

the price, now you can discover the digital world of COS/MOS in RCA's new low cost ceramic package.

Our complete new line of COS/MOS CD4000AF Series Ceramic IC's, in 14-lead or 16-lead dual-in-line packages, are available at your local distributor. Or you can order them direct from RCA.

For complete pricing and data sheet write: RCA Solid State, Section 57K11 Box 3200, Somerville, N.J. 08876.Or phone: (201) 722-3200.

RCA Solid State
products that make products pay off

International: RCA, Sunbury-on-Thames, U.K., or Fuji Building, 7-4 Kasumigaseki, 3-Chome, Chiyoda-Ku, Tokyo, Japan. In Canada: RCA Limited, Ste. Anne de Bellevue 810, Canada.

INFORMATION RETRIEVAL NUMBER 64

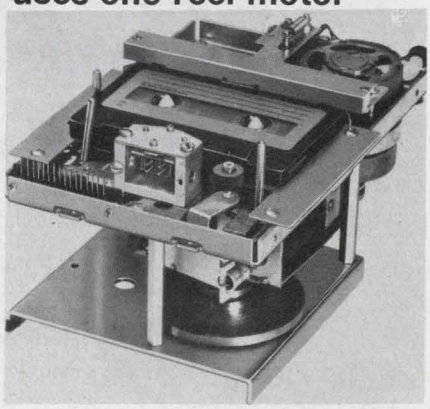
Tach generator output rate is selectable

Avtron Manufacturing, Inc., 10409 Meech Ave., Cleveland, Ohio 44105. (216) 641-8310.

Super Tach generates a choice of 15, 30, 60, 120, 150, 300, 600, or 1200 pulses per revolution by just setting the internal switch. The unit uses a LED source, has zero-speed direction sensing, and a NEMA-56C face. Output is a 15-V square wave. An analog dc output that is proportional to speed is also available.

CIRCLE NO. 272

Cassette tape transport uses one reel motor

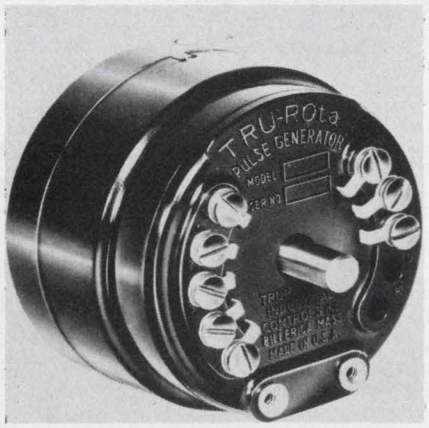


The Amilon Corp., 49-12 30th Ave., Woodside, N.Y. 11377. (212) 274-1794. From $125 (1000 up).

Designated the A7 system, Amilon's one-reel-motor and one-capstan-motor tape transport is functionally superior to two or three motor mechanisms for cassette applications, according to the company. Two or three motor systems are better suited to the stronger tape of reel-to-reel devices, which require the tape to pull the rotor of the unused motor. Additional features include front loading, separate BOT and EOT sensors and single or dual direction read/write.

CIRCLE NO. 273

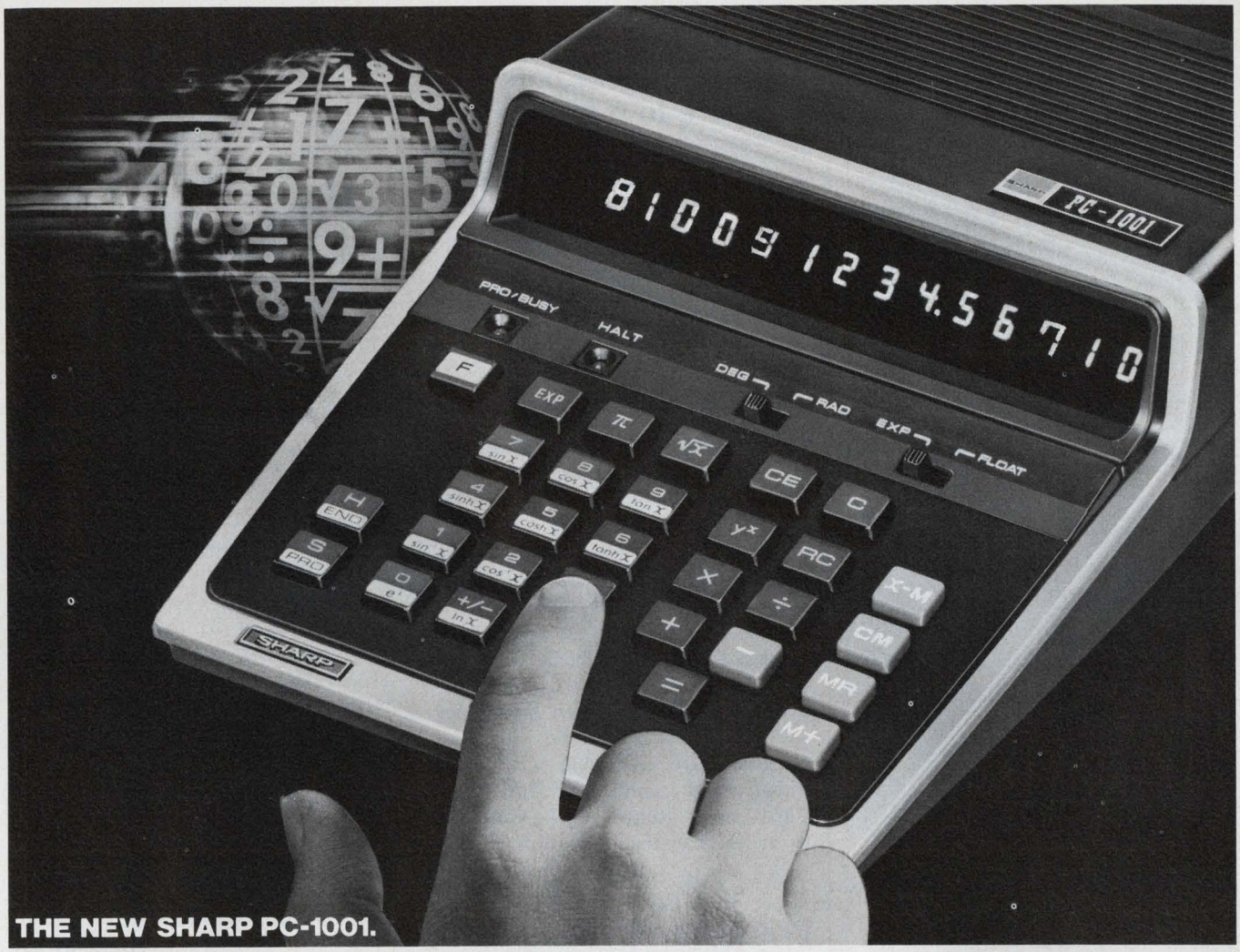
Incremental encoder has metric or English output



Trump-Ross Industrial Controls, Div. of Datametrics, 265 Boston Post Rd., North Billerica, Mass. 01862. (617) 663-3451.

Tru-Rota is a dual-count, optical, rotary, incremental encoder that is compatible for use in English or metric systems. Resolution in English units is as high as 2000 lines and in metric up to 2540 lines.

CIRCLE NO. 274



THE NEW SHARP PC-1001.

THE SCIENTIFIC PROGRAMMABLE BIG ENOUGH FOR YOUR DESKTOP AND SMART ENOUGH TO OPERATE IN SCIENTIFIC NOTATION.

For fast, accurate answers to complex everyday scientific and engineering problems—count on Sharp's new PC-1001. Because not only is the PC-1001 ideal as a desktop, scratch pad, scientific, programmable calculator...it also features a 10-digit display that automatically operates in scientific notation. Results of the functions can be computed in degress or radians at the touch of a switch.

With the PC-1001, difficult programming of functions is already incorporated. So you compute instantly with just a one-touch key operation. A total of "15" different scientific functions are hardwired in, including trigonometrical, inverse trigonometrical, hyperbolic, exponential, and logarithmic. In addition, 64 steps of programming or 8 registers are available for formula and equation evaluation.

And you can use both decimal point positioning systems. Both the floating decimal point and the exponential system—with exponential display capacity from 10^{-99} to 10^{100}-1 and 0.

The PC-1001 also features a new simplified keyboard operation.

Get the full information on Sharp's PC-1001—the desktop, scientific programmable scratch pad calculator. Just plug in its AC cord and try it. You'll find it indispensable. Phone toll-free (800) 447-4700 for your nearest Sharp Dealer. In Illinois (800) 322-4400. Or just mail the coupon today.

FROM SHARP®

THE COMPANY THAT CREATED THE INDUSTRY™

In Canada: Dodwell & Co. Ltd. Head Office: Ontario, Canada. (Check Yellow Pages for other offices.)

Sharp Electronics Corporation, Dept. ED-1
10 Keystone Place, Paramus, N. J. 07652

Gentlemen: Please send me full information on Sharp's PC-1001.

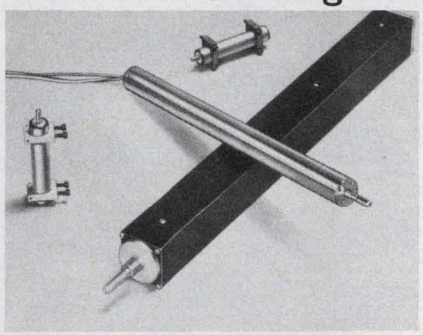
Name _____ Company _____

Address _____

City _____ State _____ Zip _____

INFORMATION RETRIEVAL NUMBER 66

Precision linear pots measure to 5 ft long

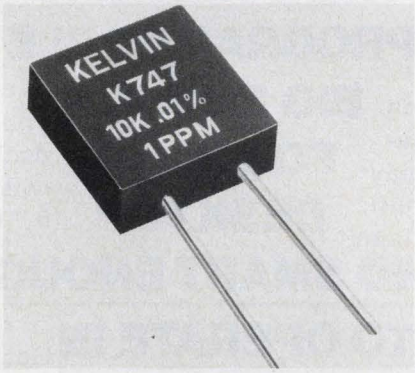


Servo Instrument Corp., Gamewell Div., 235 Lynn St., Baraboo, Wis. 53913. (608) 356-9095.

Conductive-plastic and wirewound, precision, linear-motion potentiometers in 1/2, 3/4 and 1-1/4-in. D models have lengths from 0.125 to 12 in. in conductive-plastic types and 0.25 to 5 ft in wirewound. Resistance ranges cover 50 Ω to 100 kΩ with linearities as low as 0.1%. Single and dual elements are available with both linear and nonlinear functions. Taps and switches can be installed to order. Dissipation is 1.5 W/in.

CIRCLE NO. 275

Precision wirewound resistor replaces film

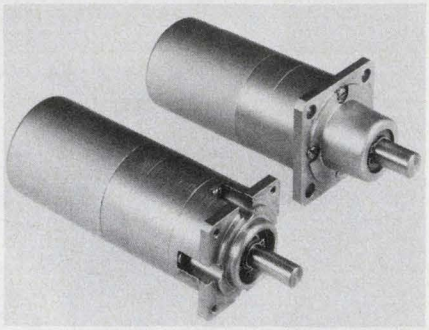


Kelvin, 5919 Noble Ave., Van Nuys, Calif. 91401. (213) 782-6662. As quickly as 4 days (additional charge).

Designed to interchange with Vishay S102 bulk metal-film resistors, the K747 resistor is claimed to have a wider resistance range, a lower temperature coefficient and better tracking. The K747 is available with resistance tolerances to ±0.005% and TCs to 1 ppm. Cost savings of up to 50% can be realized over bulk metal-film resistors.

CIRCLE NO. 276

PM gearmotors meet military specifications



Wertronix Corp., 2673 Culver Ave., Dayton, Ohio 45429. (513) 299-5596. $35 typical (OEM qty); 4 to 6 wks.

The type DMR gearmotor is designed for compact-size and high-torque applications. Diameters range from 1-1/4 to 3.53 in. There are a total of 21 different standard gear-box ratios available—from 3.81:1 through 19,841:1—with maximum torque capacities to 1250 oz-in. for continuous duty. Voltages range from 3 to 50 V dc. Both 1-1/4 and 1-7/16-in. square mounting flanges are available with a choice of either a 1/4 or 5/16-in. diameter output shaft. Both commercial and MIL-M-8609 versions are available.

CIRCLE NO. 277

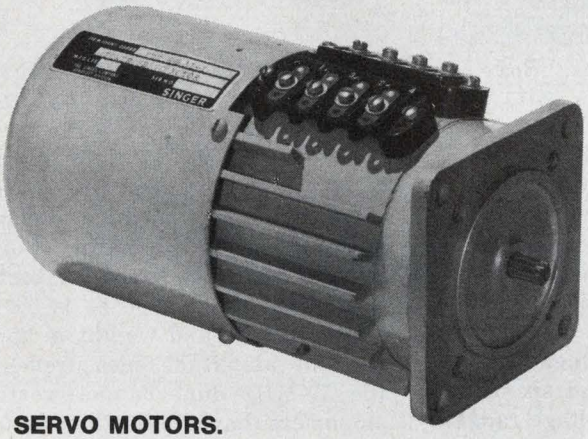
Rotary switch handles 900 circuits

Cole Instrument Corp., 2034 Placentia Ave., Costa Mesa, Calif. 92627. (714) 642-8080.

A specialized precision rotary switch with nine decks and 900 usable circuits has static shields between decks and a removable cover to protect the switch from dust and outside interference. All connections are brought out to prewired terminal boards for fast and easy wiring. Ball bearings are provided in both end plates to keep the rotational torque at a minimum and to allow the use of solenoid or motor drive for remote or automatic operation. Each deck is individually adjustable to ensure deck-to-deck alignment. An important feature is the switch's constant contact resistance and lack of thermal or contact potentials. Fully bifurcated brushes maintain contact and prevent open circuits while switching.

CIRCLE NO. 278

Singer is here to Servo you.

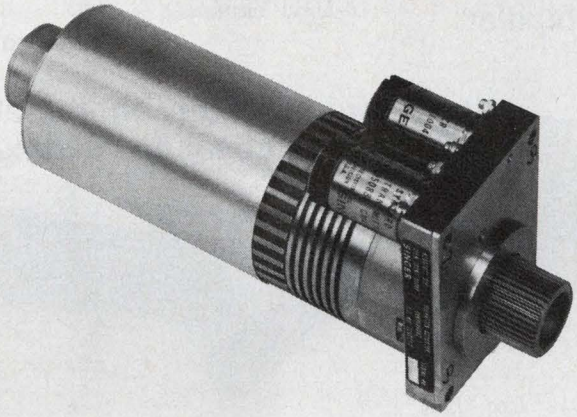


SERVO MOTORS.

Kearfott offers you a complete line to fit just about any application. From a ¾″ diameter motor with an acceleration of 150,300 rad/sec² to units such as the 7″ diameter 1 HP Servo Motor shown above.

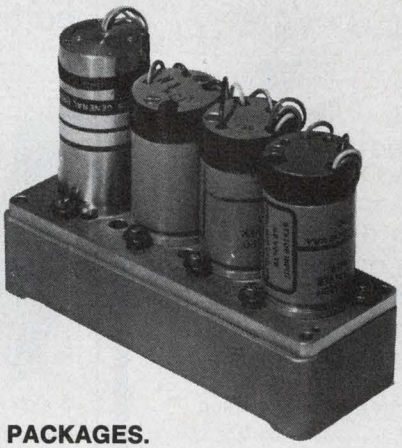
SERVO AMPLIFIERS.

Choose from 1.4 watt output amplifiers to the new 2200 watt unit above. Only 10″ long and weighing just 7 lbs., the XA-2200 is a highly-efficient solid-state amplifier that furnishes output required by 1 HP motors.



PRECISION POWER SERVO DRIVES.

Our broad line of Servo Motors (to 1 HP) are the primary drive source for our Power Servo Drives. Typical units give you: accurate positional feedback information; low backlash; highest performance/pound.



SERVO PACKAGES.

We can give you the "tightest" job, the lowest price and meet your delivery dates. How? We make thousands of Servo components, from motors to clutches. We design and build all associated electronics, from Servo amplifiers to switching networks.

We can meet almost any Servo requirement you may have from a single source—Singer's Kearfott Division.

For nearly 30 years Kearfott has been a pacesetter in the development of small motors and their associated electronics. Today we can offer you a wider variety of Servo components than any other single supplier.

All components are built to the highest order of precision, both in concept and construction. In addition, we'll design and produce units to your special requirements.

To learn more about Kearfott Servos and capabilities, mail the coupon now, for our information-packed 24-page brochure "Servo Motors". We'll rush it to you. The Singer Company, Kearfott Division, 1150 McBride Avenue, Little Falls, New Jersey 07424.

SINGER
AEROSPACE & MARINE SYSTEMS

The Singer Company, Kearfott Division
1150 McBride Avenue
Little Falls, New Jersey 07424 ED-10

Gentlemen:

Please send me your 24-page booklet on Servo Motors.

Name_____

Title_____

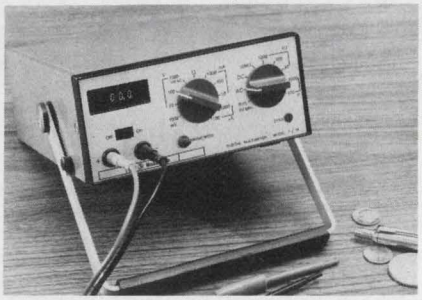
Company_____

Address_____

City_____ State_____ Zip____

INFORMATION RETRIEVAL NUMBER 68

Portable 3-digit DMM costs under $200

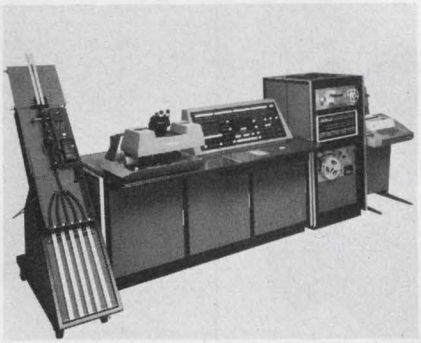


Ballantine Labs, P.O. Box 97, Boonton, N.J. 07005. (201) 335-0900. $195.

Model 3/24 digital multimeter offers a full three digits (1000 counts) for just $195. The unit weighs two pounds, complete with internal battery. Dimensions are 5 × 2-1/2 × 7 in. Model 3/24 has five functions with 24 ranges: four of ac and dc voltage; five of ac and dc current, and six of resistance. On the dc voltage ranges, accuracy is typically 0.2% ±1 digit.

CIRCLE NO. 279

Test system handles both MOS and bipolar

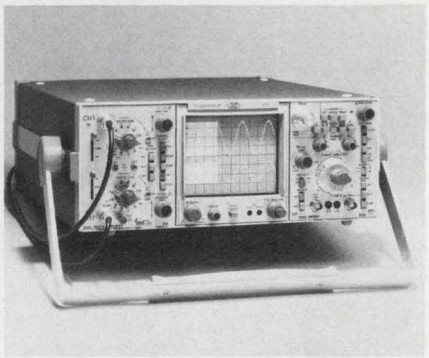


Western Digital, 19242 Red Hill Ave., Newport Beach, Calif. 92663. (714) 557-3550. $55,500.

SPARTAN 780 MOS and Bipolar tester is a successor to the SPARTAN 770 and features functional and dc parametric testing of all bipolar, p-channel and n-channel MOS and CMOS LSI devices including random and sequential logic, as well as RAMs, ROMs and shift registers. The basic unit features a mainframe to which memory channels, test heads and other options may be added for specific test requirements. The unit can be easily expanded to three 48-pin, 40-channel test stations.

CIRCLE NO. 280

50-MHz, portable scope sells for $1375



Tektronix, P.O. Box 500, Beaverton, Ore. 97005. (503) 644-0161. $1375; 2 wk.

TELEQUIPMENT D75 is said to be one of the lowest priced dual-trace, 50-MHz, portable, delayed sweep scopes on the market. Portability is optimized in the horizontal-configured package—size is 5.4 × 15 × 18.6 in. and weight is 25 lb. For low-amplitude measurements, the 50-MHz dual-channel, vertical amplifiers have deflection factors starting at 5 mV/div, accurate within 3%. For measuring even lower amplitude signals, a gain control (X5) extends the minimum deflection factor to 1 mV/div with 15-MHz bandpass.

CIRCLE NO. 281

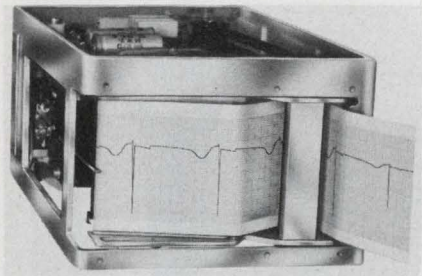
Radiometer/photometer gives absolute readings

EG & G Inc., Electro-Optics Div., 35 Congress St., Salem, Mass. 01970. (617) 745-3200. $1645; 4 wk.

Model 550 Radiometer/Photometer System provides automated operation with direct, absolute readings in any of 10 distinct optical units and two electrical units. The instrument contains a 3-1/2-digit panel meter and a digital display of the decade exponent. Autoranging is included over seven full decades. Provision is also available for compensation of unwanted ambient light and analog output for a recorder.

CIRCLE NO. 282

Recorder meets AHA and UL requirements

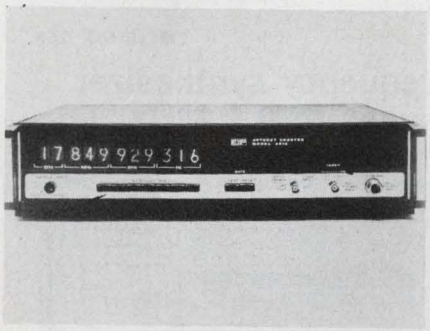


Gulton Industries, Gulton Industrial Park, East Greenwich, R.I., 02818. (401) 884-6800. $300 (100); 4 wk.

MED 100, an EKG recorder building block, comes in a unitized "U" frame construction. Frequency response is 140 Hz at 5 divisions pk-pk. An important feature of the new recorder is that it is designed specifically to meet UL 544 leakage-current requirements for Type A grounded equipment. It also conforms to AHA frequency and voltage specifications, which are 95 to 135 V ac, dc to 100 Hz (−3 dB).

CIRCLE NO. 283

18-GHz counter offered for systems use



EIP Inc., 3130 Alfred St., Santa Clara, Calif. 95050. (408) 244-7975. $5100; 2 wk.

The EIP 351C offers automatic frequency measurement from 20 Hz to 18 GHz using an electronically tuned YIG comb generator. Under remote control, microwave measurements to 100-Hz resolution can be made at a 30 per second rate. Four system-oriented, TTL-compatible options are available: BCD output ($100), remote programming of range ($350), i-f offset ($400), and YIG-filter tuning ($200). To simplify the data presentation, an 11-digit display, with constant decimal placement, is used.

CIRCLE NO. 284

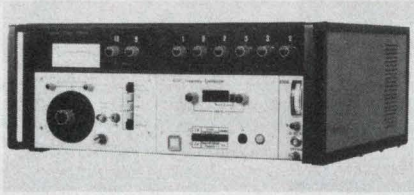
50-MHz counter offers 50-mV sensitivity

John Fluke Manufacturing Co., P.O. Box 7428, Seattle, Wash. 98133. (206) 774-2211. $445.

Model 1950A is a new multifunction counter, offering five functions over a 50-MHz range: frequency, period, multiple period averaging, ratio and totals. A six-digit LED display with automatic annunciation functions as the readout. Model 1950A weighs only 5 lb and operates on 115 or 230 V, 50 to 60 Hz or 12 V dc at 16 W.

CIRCLE NO. 285

110-MHz synthesizer offers spectrum analysis



Adret Corp., 1887 Lititz Pike, Lancaster, Pa. 17601. (717) 569-7059. Basic price: $8500; Dec., 1973.

Series 6000 is a family of programmable synthesizers with frequency range extending to 110 MHz. The series comprises a group of mainframes and plug-in output modules that determine the instrument's fundamental function, frequency range, and operating modes, and a series of plug-in auxiliary-function modules that implement the desired operational characteristics of the instrument.

CIRCLE NO. 286

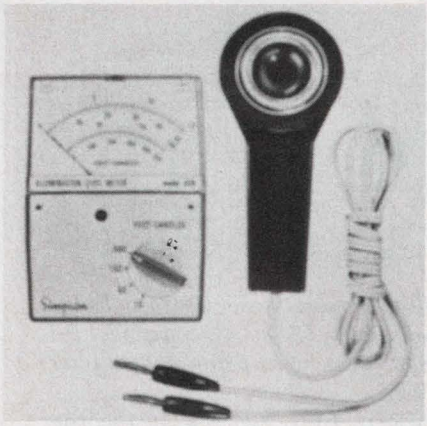
Current source programs digitally

Hewlett-Packard, 1501 Page Mill Rd., Palo Alto, Calif. 94304. (415) 493-1501. $2900; 8 wk.

Model 6145A dual-range, digitally programmable current source provides outputs from −9.999 to +9.999 mA (X1 range) and from −99.99 to +99.99 mA (X10 range) at compliance voltages up to 100 V dc. In the X1 range, resolution is 1 μA, accuracy is 1 μA and programming speed is 300 μs. The unit can be programmed from a remote four-digit 8421-BCD source, or locally using front-panel thumbwheel switches.

CIRCLE NO. 287

Illumination meter matches eye response

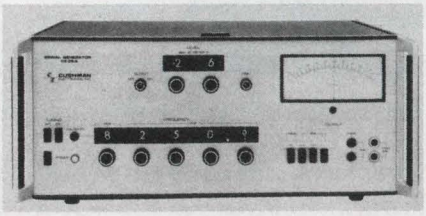


Simpson Electric, 5200 W. Kinzie St., Chicago, Ill. 60644. (312) 379-1121. $125.

Model 408 illumination-level meter has a spectral sensitivity closely matched to the response of the human eye. The instrument can also be used as a light meter (by referring to an exposure table on the back of the case) or to make luminance measurements (using a slip-on luminance measuring tube). The unit provides four basic ranges, 0 to 15/50/150/500 foot candles, which can be extended to 0 to 1500/5000/15,000/50,000 foot candles with a X100 extension filter.

CIRCLE NO. 288

Frequency synthesizer ranges to 9.1 MHz

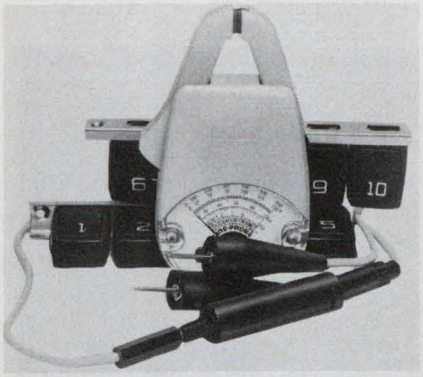


Cushman Electronics, 830 Stewart Dr., Sunnyvale, Calif. 94086. (415) 941-8860. $2675.

The CE-26A frequency synthesizer provides a flat, precisely tunable signal over a frequency range of 4 kHz to 9.1 MHz. The instrument also features settable output levels from −70 to +10 dBm. Resolution is 1 kHz on the four digital frequency dials, and 25 Hz with a fine tuning control. Harmonic distortion referred to the fundamental is greater than 40-dB down at signal levels below 0 dBm, and intermodulation distortion is greater than 50-dB down.

CIRCLE NO. 289

Clamp-on V/I/Ω meter also traces conductors



Amprobe Instrument, 630 Merrick Rd., Lynbrook, N.Y. 11563. (516) 593-5600. $49.50; stock.

This clamp-on volt/amp/ohmmeter, the LINE-PROBE ALP501, performs five important testing functions. It measures current on a 0 to 100-A ac scale, measures voltage on either of two ranges, 0 to 150/600 V ac; measures resistance on a 1000-Ω midscale range; checks continuity; traces and identifies up to 10 pairs of conductors at one time.

CIRCLE NO. 290

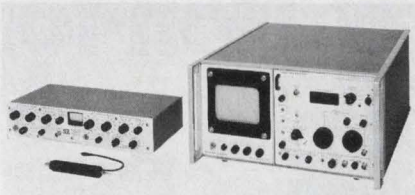
Portable instrument tests a/d converters

C-O Manufacturing Co., 646 Summer St., Brockton, Mass. 02403. (617) 584-4710. $4400; stock.

Model ADT-1A tests analog-to-digital and digital-to-analog converters. The unit measures and displays both converter accuracy, monotonicity and noise. Analog inputs and outputs are displayed on a precision zero-centered meter. Direct error readings are also displayed with a 2-bit full-scale sensitivity. A set of LED indicators provides a digital display of inputs and outputs. Dynamic operation may be displayed as a two-dimensional CRT presentation of input vs output or input vs error.

CIRCLE NO. 291

Spectrum analyzer tests communication signals

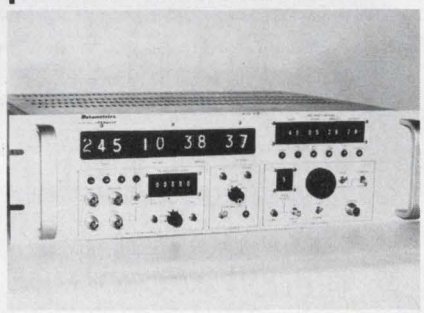


Nelson-Ross, 5 Delaware Dr., Lake Success, N.Y. 11040. (516) 328-1100. $4950.

Model CSA-290 Communications Spectrum Analyzer System provides graphic, quantitative analysis of SSB, AM, FM, baseband and other communications signals from audio through rf, 10 Hz to 40 MHz. Analysis at higher frequencies is also feasible, with somewhat degraded specifications. A built-in frequency counter provides highly accurate center frequency calibration and can be used for measurement of other inputs from 0.5 to 100 MHz.

CIRCLE NO. 292

Unit generates precise time codes



Datametrics, 340 Fordham Rd., Wilmington, Mass. 01887. (617) 658-5410. $2595; 60 days.

Model SP-125 Universal Time Code Generator serves as a Master Time Reference for distributing precision time code indices to index recording mediums such as magnetic tape, camera film and oscillographs. The unit can also be slave synchronized to within ±20 μs of an external received IRIG-B time code that is derived from another Master Time Code Generator. The unit has an internal time base oscillator to assure continuous operation in the event of input code drop-out during slave sync operation, as well as a fail-safe power supply.

CIRCLE NO. 293

Rf test set synthesizes, measures frequencies

Cushman Electronics, 830 Stewart Dr., Sunnyvale, Calif. 94086. (408) 739-6760. Basic Unit: $5100.

A portable, rf test set, Model CE-6, combines synthesized signal generation with precise frequency measurement. The new instrument generates signals from 10 kHz to 1000 MHz, with cw, AM and FM, and measures frequency from 20 to 1000 MHz. Through the use of optional plug-in modules, the CE-6 can also be used as a sensitive AM and FM receiver; an FM peak-deviation meter; and AM modulation meter; and/or an audio oscilloscope and waveform monitor. Weight is 40 lb., without plug-ins, and the unit takes up only one square foot of bench space.

CIRCLE NO. 294

Angle position indicator is ruggedized

Transmagnetics, Inc., 210 Adams Blvd., Farmingdale, N.Y. 11735. (516) 293-3100. $895; stock to 5 wk.

These rugged, industrial Absolute-Angle Position Indicators consist of a transducer and a digital readout receiver having an accuracy of 0.1 degree. The receiver converts the transducer information into digital form and presents a digital display that is readable in direct sunlight conditions. Simultaneously, BCD outputs are available at the rear of the receiver. Output formats of ±179.9°, 0 to 360° or 0 to 9999, with floating decimal point, are available.

CIRCLE NO. 295

Your A/D or D/A application can win the

GRAND CONTEST [$1000]

Never before an application contest like this.

GRAND PRIZE...

A $1000 GOVERNMENT BOND.

HERE'S HOW.

Send in your application that includes one or more A/D or D/A converters.

Win the $1,000 Grand Prize or one of the many second prizes of valuable Bowmar Calculators. Handy technical pocket calendars given to all entries.

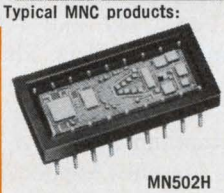
The rules are simple . . .

1. Your design application must include one or more A/D or D/A converters. Need not be Micro Networks converters.
2. Entries will be judged on originality, completeness, and usefulness of application.
3. Entries become property of Micro Networks Corporation, which reserves right to publish, in whole or in part, any entry at its discretion. An honorarium will be given for those entries published by MNC.
4. MNC personnel, their families, and personnel and families of affiliates are ineligible.
5. Entries judged by 5 impartial judges, whose decisions are final. For anonymity entries will be coded for judging.
6. Contest closes February 15, 1974. Void where prohibited.
7. Each entry must include circuit diagram with description of circuit operation. Include if possible a statement of the significance of the application.
8. Submit all entries to P.O.Box 308 Worcester, Mass. 01601.

A design contest like this may be an industry "first". But then, firsts are a way of life at Micro Networks Corporation . . . first 12 bit dip package D to A . . . first 8 bit dip package A to D . . . first 12 bit MIL range D to A in a dip package and in a miniature module . . . plus over 12 more firsts in the last 3 years alone!

MNC offers the broadest selection of dip package standards D to A and A to D's for the avionics, instrumentation, computer and military Hi-Rel markets.

Typical MNC products:

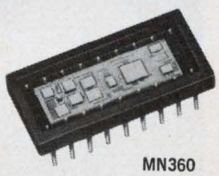


MN502H

MN502H . . . 8 bit A to D converter.
Salient Features:
- 18 pin dip . . . hermetically sealed
- Low Power . . . 600 Mw
- Fast . . . 1 μsec/bit
- Unsurpassed Linearity . . . ±½ bit (—55 to +125C)

MN515

MN515 . . . 12 bit A to D converter.
Salient Features:
- Linearity . . . ±½ bit (0 to 70C)
- Linearity (MN515H) . . . ±½ bit (—55 to +125C)
- Conversion Time . . . 50 μsec



MN360

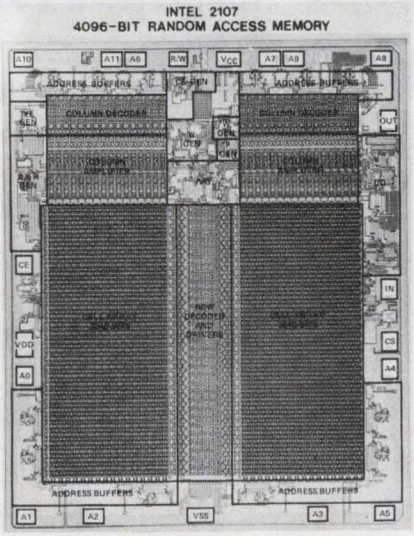
MN360 . . . 12 bit D to A converter.
Salient Features:
- 18 pin dip . . . hermetically sealed
- Linearity . . . ±½ bit (0 to 70C)
- Settling Time . . . 5 μsec

Send in Your Entry Soon!

Micro Networks Corporation
5 Barbara Lane • Worcester, Mass. 01604 / Tel: (617) 753-4756

INFORMATION RETRIEVAL NUMBER 77

4 k n-channel RAM introduced



Intel Corp., 3065 Bowers Ave., Santa Clara, Calif. 95051. (408) 246-7501. P: See below; stock.

A 4096-word-by-1-bit n-channel silicon-gate RAM, called the 2107, comes with all decoding on the chip, a single high-level clock and is TTL compatible. The dynamic RAM dissipates power only during chip enable. Refresh of all the bits is done in 64 read cycles. Presently priced at $64 (100-999), the company projects an eventual price of 0.1¢ per bit for the 2107.

CIRCLE NO. 296

Stud mounted SCRs can handle 1000 A peak

General Electric, Bldg. F. Mail Drop 49, Electronics Park, Syracuse, N.Y. 13201. (315) 456-2021. For 10 up: $9.25 (147), $12.75 (149); stock.

The C147 and C149 SCRs can handle 63 A rms. The C147 is rated at 63 A rms max and up to 1200 V. Its dv/dt is 200 V/μs and can withstand a 1000 A peak one-cycle on current. Applications include dc motor control, power supplies, and ac motor, temperature and lighting controls. The C149 is a high speed version for inverter applications. It has a 10 μs turn-off time and is rated at 63 A rms max at 95 C case temperature, and up to 600 V. It can also handle a 1000 A peak one cycle on current. Both the C147 and C149 are available in a 1/4-28 stud mount package.

CIRCLE NO. 297

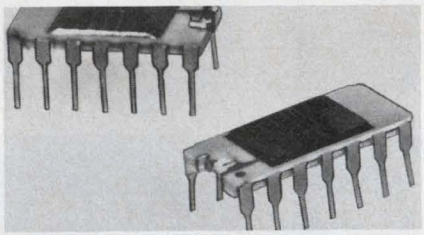
Schottky decoders feature 9-ns delay

Signetics, 811 E. Arques Ave., Sunnyvale, Calif. 94086. (408) 739-7700. $5.40 (100).

A binary-to-octal decoder, the 82S50, and a BCD-to-decimal decoder, the 82S52, both use Schottky-clamped TTL for a typical propagation delay of 9 ns. Maximum input load currents for the gate arrays are 400 μA (logic ZERO) and 25 μA (logic ONE). Minimum output currents are 20 mA at 0.5 V (ZERO) and 1 mA at 2.7 V (ONE).

INQUIRE DIRECT

SOS multiplexer switches in 75 ns



Inselek, Inc., 743 Alexander Rd., Princeton, N.J. 08540. (609) 452-2222. $19.50 (100-999); stock.

An 8-channel TTL-compatible multiplexer switch uses SOS technology for a 75-ns channel-to-channel switching time. Called the L05, the multiplexer features a low data-channel ON resistance of 15 Ω and a 150-mW power dissipation level. The L05 comes in a 16-pin DIP.

CIRCLE NO. 298

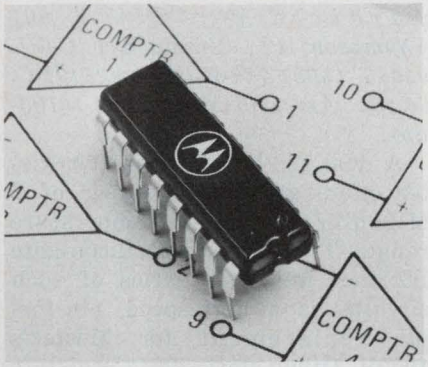
IC multiplier holds errors to 0.5%

Analog Devices, Route 1 Industrial Park, Norwood, Mass. 02062. (617) 329-4700. AD533JH: $5.95; stock.

A family of IC multipliers guarantees 0.5% maximum multiplying errors. Called the AD533, it provides a ±10 V, 5 mA output without the need for an external op amp. The AD533 multiplies in four quadrants with a transfer function of XY/10. It also divides in two quadrants with 10Z/X transfer function, and square roots in one quadrant with a transfer function of $-\sqrt{10Z}$. The devices provide typical small signal bandwith of 1.0 MHz, full power bandwith of 750 kHz and slew rate of 45 V/μs.

CIRCLE NO. 299

Quad comparator uses one supply



Motorola, P.O. Box 20912, Phoenix, Ariz. 85036. (602) 244-3466. $1.50 (100 up); stock.

The MC3302 IC packs four independent voltage comparators into a single plastic DIP package. The comparators can operate from a single power supply ranging anywhere from 2 to 28 V dc. Total current drain is only 1.5 mA max at voltages of 5 to 28 V. The comparators feature a voltage gain of 30,000, an input bias current of about 30 nA and an input offset voltage of 3 mV. The outputs are TTL compatible and can sink 2 mA minimum at $V_{OL} = 0.8$ V.

CIRCLE NO. 300

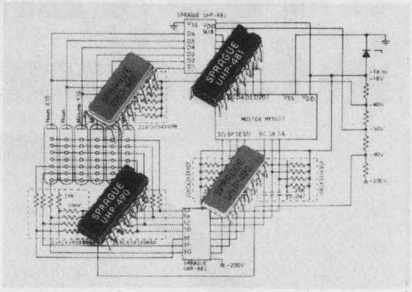
IC diode arrays offer design flexibility

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. LM-3019: $1.18; LM3039: $1.17 (100); stock.

Two monolithic ICs—the LM-3019 and LM3039—contain diode arrays that are grouped for convenient use. The LM3019 contains six diodes; four are connected in a full-wave bridge configuration and two are completely uncommitted. Each diode has a 20-mW power dissipation. Typical reverse breakdown voltage is 6 V per diode and 80 V between any diode and the substrate. The LM3039 contains six fast, low capacitance diodes. Five are independently accessible, and the sixth shares a common terminal with the substrate. Reverse recovery time is typically 1 ns, and the dc forward voltage of the diodes is matched within 5 mV. Power dissipation is 100 mW each, and the diodes have a typical reverse breakdown voltage of 7 V.

INQUIRE DIRECT

Gas-display drivers simplify interfacing

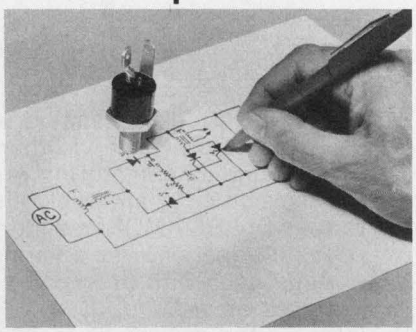


Sprague Electric, 551 Marshall St., North Adams, Mass. 01247. (413) 664-4411.

Two series of monolithic high-voltage display drivers interface MOS or other low-voltage circuitry and high-voltage gas discharge displays. The Series 480 and 481 drivers feature 130-V breakdown and can be used as cathode drivers for both Burroughs Planaplex and Sperry SP300 displays. The Series 480 ICs have five switches per DIP while the Series 481 contain seven switches in each DIP. The Series 490 and 491 anode drivers can also replace most of the discrete components usually required for interfacing. Series 490 devices have five drivers per DIP while the Series 491 contain six drivers per package.

CIRCLE NO. 301

Thyristors rated for 80-A operation



Motorola, P.O. Box 20924, Phoenix, Ariz. 85036. (602) 244-3465. $9.65 to $31.75 (10-99); stock.

A line of 80-A rms isolated-stud thyristors—called MCR82—include nine repetitive peak-reverse blocking voltage ratings from 50 to 800 V. Peak nonrepetitive surge current for all ratings is 1000 A. The units use glass-passivated junctions with center-gate firing for uniformity and stability.

CIRCLE NO. 302

128-bit static register guarantees 2-MHz speed

Advanced Micro Devices, 901 Thompson Pl., Sunnyvale, Calif. 94086. (408) 732-2400. Am2810DC: $6.50; Am2810DM: $13.00 (100-up).

A dual 128-bit static shift register offers guaranteed speeds of 2 MHz over the full MIL temperature range. The p-channel silicon-gate IC, the first in a series of such circuits, is a high-speed, pin-for-pin replacement for Mostek's 1002P. Other static shift registers to follow in the series include quad 128-bit, dual 256-bit, 512-bit and 1024-bit devices.

CIRCLE NO. 303

Static shift register buffers card images

Texas Instruments, P.O. Box 5012, M/S 308, Dallas, Tex. 75222. (214) 238-3741. $4.68, plastic; $6.16, ceramic (100); stock.

A 4 × 80 MOS/LSI static shift register—the TMS3120—can be used as a read or punch buffer for 80-column-card applications. Three TMS3120s can buffer one standard IBM card image. The TMS3120 features dc-to-2.5-MHz operation, recirculate logic and feedback path on the chip, a single TTL-compatible clock and TTL-compatible inputs and outputs.

CIRCLE NO. 304

Precision timer avoids triggering problems

National Semiconductor, 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. $2.50 (100); stock.

The LM122 IC timer provides accurate, repeatable timing without concern for input trigger conditions. The input circuitry reacts only to the rising edge of the trigger signal. Thus, it is immune to any trigger voltage that might occur during the timing period. The input has a threshold of 1.6 V independent of power supply voltage and it is fully protected from inputs as high as ±40 V, even when using a 5-V supply. The output of the LM122, a floating transistor with built-in current limiting, can drive either ground referred or supply referred loads up to 40 V at 50 mA.

INQUIRE DIRECT

the standard power supply is a minor consideration... until it fails!

OEM's are getting a little tired of 'power failures'. And many have decided it's better to pay the difference to be sure their products are powered reliably. The cost isn't that much more -- and it may save some valuable reputations.

This concept puts North Electric squarely in the picture, because reliability is our stock in trade.

We've been the leading custom power producer for more than 40 years -- and our modular power supplies follow the same quality standards . . . including rugged Life Tests, EMI analysis, shock, vibration, humidity and temperature tests -- and most are UL recognized.

Another point - if you are presently making your own power, let us show you (through a make or buy analysis) why it might be to your advantage to have North handle this specialized area of production.

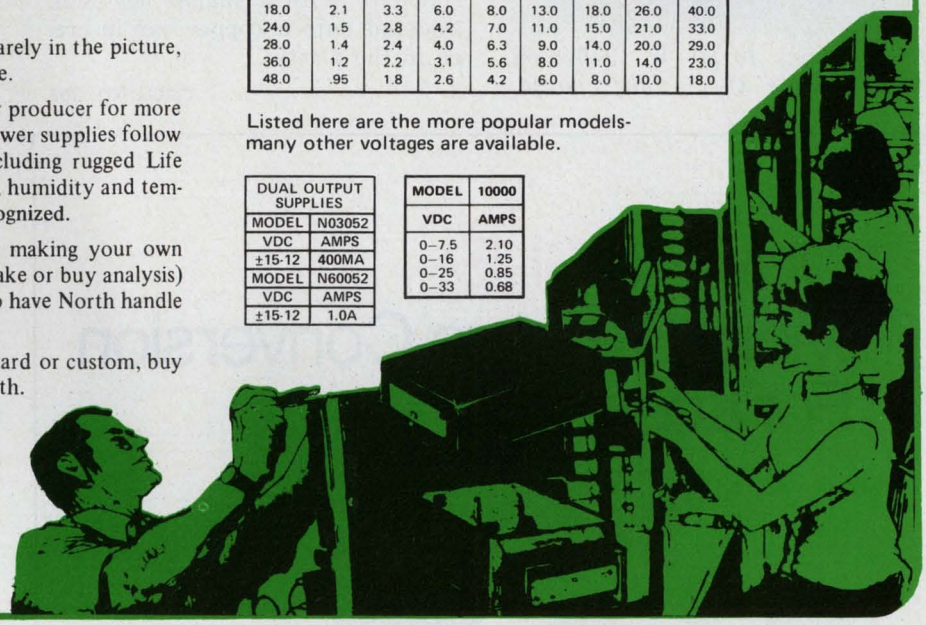
When you buy power supplies, standard or custom, buy from the one big name that makes both.

MODEL	11000	12000	13000	14000	15000	16000	17000	18000
VDC	AMPERES							
5.0	3.9	5.3	11.3	13.0	20.0	32.5	49.0	82.0
12.0	2.8	4.2	8.0	10.5	15.0	23.0	36.0	58.0
15.0	2.4	3.7	7.5	9.5	14.0	20.5	27.0	47.0
18.0	2.1	3.3	6.0	8.0	13.0	18.0	26.0	40.0
24.0	1.5	2.8	4.2	7.0	11.0	15.0	21.0	33.0
28.0	1.4	2.4	4.0	6.3	9.0	14.0	20.0	29.0
36.0	1.2	2.2	3.1	5.6	8.0	11.0	14.0	23.0
48.0	.95	1.8	2.6	4.2	6.0	8.0	10.0	18.0

Listed here are the more popular models- many other voltages are available.

DUAL OUTPUT SUPPLIES	
MODEL	N03052
VDC	AMPS
±15-12	400MA
MODEL	N60052
VDC	AMPS
±15-12	1.0A

MODEL	10000
VDC	AMPS
0–7.5	2.10
0–16	1.25
0–25	0.85
0–33	0.68

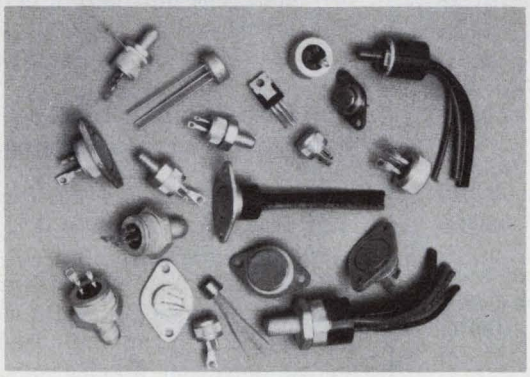


NORTH ELECTRIC COMPANY

Electronetics Division/Galion, Ohio 44833
A United Telecommunications Company
419/468-8874
Ask for Product Manager/Standard Power

INFORMATION RETRIEVAL NUMBER 81

HUNT: THE CASE PLACE



Need thyristors (triacs and SCR's) in a variety of cases? You can get 'em at the case place. Write Hunt for a brochure, or call toll-free 800-645-9200.

HUNT ELECTRONICS
2639 Mañana, Dallas, Texas 75220
(214) 350-5571

oem

INFORMATION RETRIEVAL NUMBER 82

now...you can test digital IC's... economically... to manufacturer's specs

New Kurz-Kasch Model IC-590 is the first economically priced digital IC analyzer for accurate testing in the lab, shop, inspection, production, field or any other location.

The Model IC-590 is a completely portable, battery powered digital IC tester for use in conjunction with published IC specification sheets for static and dynamic testing of all 14 and 16 pin dual in-line IC modules of the DTL and TTL, 5 and 15 volt families. Flat pack and TO-5 modules may also be tested by using appropriate adapters. Price $169.95.

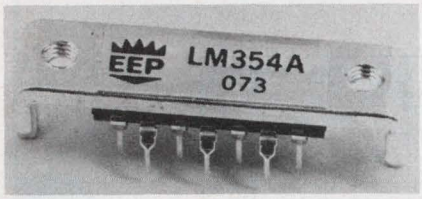
A unique sister Model IC-591 is also available. It comes complete, as IC-590 above, internal power supply for highly regulated 5 volt, 1 amp operation and adapter cable for firing-up complete card units containing as many as 15 or more mounted IC's. Price $295.00.

For complete technical data, write or call now: Tom Barth, Marketing Manager

Kurz-Kasch, Inc.
Electronics Division
2876 Culver Avenue
Dayton, Ohio 45429
(513) 296-0330

INFORMATION RETRIEVAL NUMBER 83

Audio amp IC handles wide voltage spread

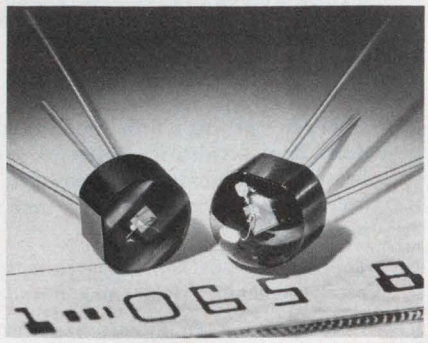


EEP Corp., 10180 W. Jefferson Blvd., Culver City, Calif. 90230. (213) 838-1912. $2.20 (100 up).

The LM354A is a monolithic IC designed for use as an audio amplifier. Special features of the circuit include self-centering bias for operation from 6 to 24 V, direct-coupled input, high input impedance (> 100 kΩ) and high supply voltage rejection ratio (52 dB). It is assembled in a 14-pin plastic split-DIP with a shaped heat-sink soldered onto a copper bar inserted in the plastic.

CIRCLE NO. 305

Phototransistors have light currents to 25 mA



Sensor Technology, 21012 Lassen St., Chatsworth, Calif. 91311. (213) 882-4100.

The STPT 100, 110, 120 and 130 series of npn silicon photodetectors offers a total of 12 models. Series 100/110 have light-current ranges from 0.2 to 4 mA and the 120/130 series covers 2 to 25 mA. The designer can specify either a convex lens for wide angular response, or a flat lens suitable for flush mounting. The units are packaged in a three lead plastic transistor case.

CIRCLE NO. 306

Npn transistor boasts 3.5 dB noise figure

Sprague Electric, 347 Marshall St., North Adams, Mass. 01247. (413) 664-4411.

The Type TN-3200 silicon npn planar transistor has a typical noise figure of 3.5 dB at 45 MHz. Power gain is 22.5 dB min at 45 MHz. The max BV_{CBO} is 40 V and the total power dissipation is 150 mW max. The unit is in a hermetic TO-72 case.

CIRCLE NO. 307

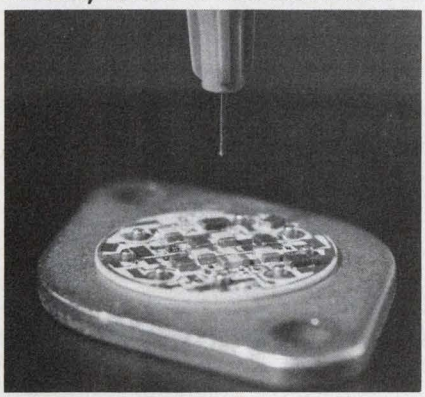
N-channel MOSFET becomes smoke detector

Motorola, P.O. Box 20924, Phoenix, Ariz. 85036. (602) 244-3465. $1.85 (100 up); stock.

The MFE824 depletion-enchancement mode (Type B) n-channel MOSFET can be used for smoke detection applications. The reverse gate current, I_{GSS}, is 1 pA max at V_{GS} of 10 V. Typical operating temp range is −65 to +200 C. The unit is available in the TO-18 package and can dissipate 300 mW of power at 25 C. Max drain current I_D is 30 mA with a max V_{DS} of 20 V.

CIRCLE NO. 308

Conducting epoxy is all solid, needs no solvent

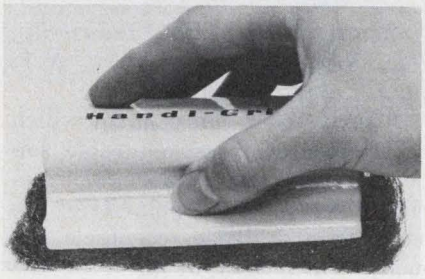


Epoxy Technology, Inc., 65 Grove St., Watertown, Mass. 02172. (617) 926-0136.

Epo-Tek H31D, a 100% solids, electrically conductive epoxy that normally requires no refrigeration, is suitable for machine-dispensing and screen-printing operations. When used with dispensing equipment, it eliminates problems with resin bleed or separation. Epoxy dots as small as 4 mils can be deposited. At the same time, H31D can be left in dispensers for months at a time without the necessity of refrigeration because of its solvent-free formulation. Volume resistivity and thermal resistance ratings are 0.0001 to 0.0005 Ω-cm and 11.3 to 12.6 C/W, respectively. Curing takes place in just 30 min. at 150 C. No significant outgassing occurs to 190 C and a vacuum of 10^{-7} to 10^{-8} torr.

CIRCLE NO. 309

Protect your hands when you use steel wool

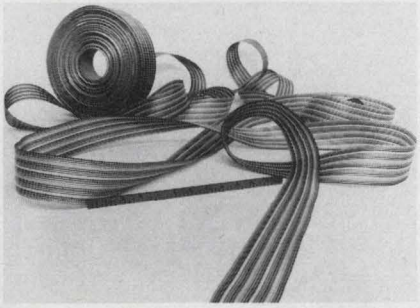


Industrial-Home Products, P.O. Box 1138, Temple City, Calif. 91006. $1.49 (unit qty).

No more cut fingers or dirty hands from handling steel wool. You can do a professional job polishing or cleaning by using the unbreakable Handi-Grip steel wool holder. Use it wet or dry.

CIRCLE NO. 310

Flat cables offered in width to 100 wires

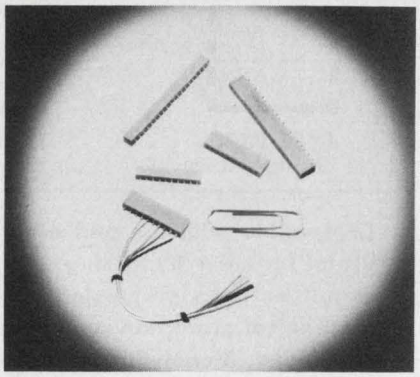


Hughes Aircraft Co., 500 Superior Ave., Newport Beach, Calif. 92663. (714) 548-0671.

Hughes new ribbon cable is offered in widths from two to 100 conductors. Conductors are round and either solid or stranded with color-coded PVC insulation and in sizes 22-28 AWG. Multiple twisted-pair conductors are also available.

CIRCLE NO. 320

Tiny connectors fit small PC boards



Microtech, Inc., 777 Henderson Blvd., Folcroft, Pa. 19032. (215) 532-3388. $2.25 (unit qty); stock.

Miniature PC-board connectors allow you to construct a small instrument with small removable PC boards rather than with captive ones. The old problem of having no choice but to use connectors larger than the PC board itself is now solved. The standard board-connector line consists of 10 and 20 feed-through contacts with 0.075-in. spacing in phenolic strips of 1/8 H × 1/8 W × 3/4 L in. for wave soldering to the board. The mating connectors are only 1/4 H × 1/8 W × 3/4 L in. The pins and sockets are made of gold-plated brass. Units with up to 50 contacts are available on special order.

CIRCLE NO. 321

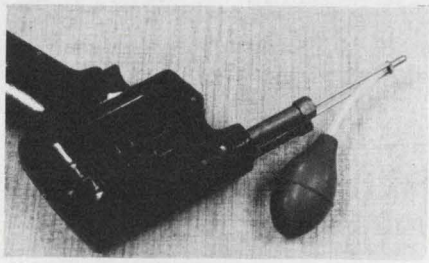
Conductive paint metalizes insulators

Tecknit, 129 Dermody St., Cranford, N.J. 07016. (201) 272-5500. $0.01/in²/mil; 1 wk.

Electrically conductive silver/acrylic paint is a one-component, air drying, electrically conductive coating that may be applied by conventional spray, brush or dip method. It can be used in many areas including: EMI shielding, to coat nonconductive enclosures, flanges or seams; for reflection, to paint plastic antenna forms, nonconductive surfaces and inflatables; for grounding, to spray ground planes or grounding surfaces on insulating materials; as a preplate, to accept electroplating; and for static prevention.

CIRCLE NO. 322

New solder-gun element can desolder



Gunmaster Universal Industries, P.O. Box 743, Kings Park, N.Y. 11754. (516) 269-0797.

A new solder-gun element which accommodates interchangeable soldering tips and solder removers should restore the popularity of the solder gun. A basic receptacle element, which will fit most of the popular solder guns, is permanently installed. Then either a unit, called the Slug, fits the receptacle element for general soldering or another unit called the Dum-Dum removes solder by capillary action. For heavy solder deposits, a solder sucker may be attached to the back end of the Dum-Dum.

CIRCLE NO. 323

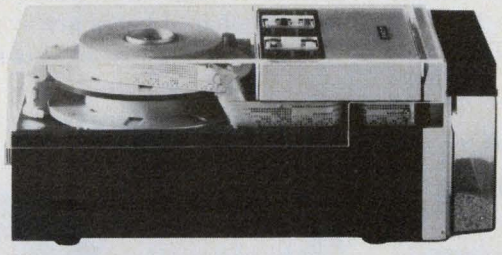
Free

Bead's New Electronic Components Buyers Guide

Here's "must reading" for design engineers and buyers of electronic components. Complete specs on contact pins, terminals, straight pins, cord tips, eyelets, spacers, special pins, wire leads, 4-slide wire products and Wire Wrap® pins. And it's yours for the asking. Just call or write.

BEAD ELECTRONICS
58 Mountain Grove St.
Bridgeport, Connecticut
06605 (203) 334-4124

INFORMATION RETRIEVAL NUMBER 87



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- 75 cps
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- Automatic tape monitoring system
- Back spacing for accuracy control
- Includes control and drive electronics
- Modular construction
- Powered, wired and space provided for extra PC board
- Built in tape supply and take-up spools
- No routine lubrication necessary
- Very quiet—54 db.
- Lightweight
- Low power consumption
- Immediate delivery from stock

Facit-Addo Inc.
501 Winsor Drive
Secaucus, N.J.

ED-11

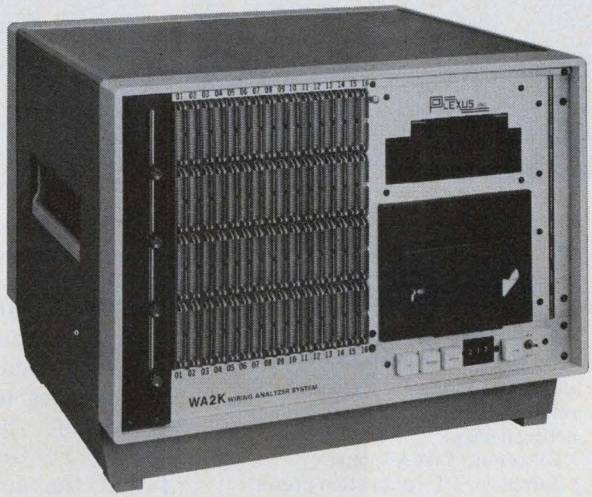
FACIT-ADDO, INC.

Gentlemen:
I am interested in receiving detailed data on your Tape Punch

Name _____ Title _____
Phone _____
Company _____
Address _____
City _____ State _____ Zip _____

INFORMATION RETRIEVAL NUMBER 88

NOW... a self-progamming wiring analyzer system



for under $12,000

Plexus now offers the WA2K Self-Programming Wiring Analyzer System for testing backplanes, printed circuit cards, and cable harnesses. There are no sophisticated computer programs to establish or debug. And, the system can be operated by non-non-technical personnel after only a few minutes of instruction. All that is needed is a network that is known to be good, some simple fixturing and connector information, and the WA2K does the rest. It programs itself in minutes and stores the program on reliable cassette tape. A paper tape printer output clearly identifies network errors and simplifies subsequent repairs.

The compact WA2K System can test up to 1,024 points and is easily expandable to 2,048 points by plugging in an expander card for each additional 128 points needed. The 1,024 point WA2K System is priced at $11,900... a price well below comparable systems. Expander cards are priced at just $320.00 each.

Other quality Plexus Wiring Analyzer Systems are available for testing networks of from 4,000 to over 65,000 points. For further information, circle this publications reader service card or phone Plexus to discuss your particular requirements.

PLEXUS inc.

Plexus, Incorporated
7345 E. Evans Road
Scottsdale, Arizona 85260
Telephone: (602) 948-3150

INFORMATION RETRIEVAL NUMBER 89

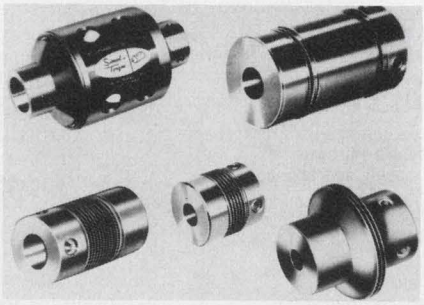
Mag recording tape withstands —65 to 400 F

Graham Magnetics Inc., Jacksboro Hwy., Graham, Tex. 76046. (817) 549-4500.

Thermo-465 is claimed to be the first magnetic recording tape which retains high-performance properties in the extremes of heat and cold that range from 400 to —65 F. Graham Magnetics says that the new tape has performed after exposure to 800 F with no loss of operability or signals recorded on the tape prior to exposure. Thermo-465 will record in either a digital or analog format. The tape is now offered in 1/4 and 1/2-in. widths and 1000-foot lengths. Other sizes are available upon request.

CIRCLE NO. 324

Flexible-shaft coupling reduces side loads

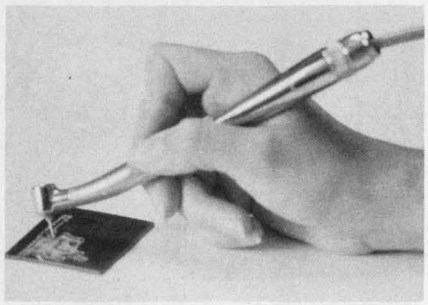


Metal Bellows Co., 1075 Providence Hwy., Sharon, Mass. 02067. (617) 668-3050.

These flexible-shaft couplings for low torque applications have extremely soft side rates. This reduces side loads on bearings. Other features include low wind-up, zero backlash, high torque carrying capability and a long axial stroke. Five basic models can meet most requirements.

CIRCLE NO. 325

High-speed air-driven tool cuts PC layouts



Electro-Dent, Inc., 120 Haddontowne Ct., Cherry Hill, N.J. 08034. (609) 429-1256.

ED-1000 is a high-speed, ball-bearing, air-turbine tool that rotates in excess of 300,000 rpm. It enables you to directly produce a PC board layout from a pencil sketch on copper clad material. You simply remove the undesired copper with an appropriate burring bit. The same tool can be used to cut mounting and throughholes. Also odd holes, rectangles and keyways are easily produced. In addition, this instrument readily lends itself to cutting and drilling in tight places that are inaccessible to other tools. Materials that can be cut include plastics, glass epoxy and most metals. A wide assortment of differently shaped burrs are available.

CIRCLE NO. 326

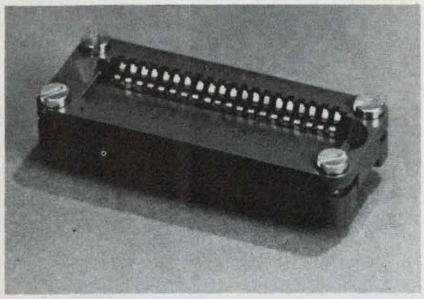
Formula kills static and bacteria

Analytical Chemical Laboratories, 9270 Evenhouse, Rosemont, Ill. 60618. (312) 696-3244.

A new antistatic formula, Staticide, eliminates all static on clear plastic, film, records and all other materials. It is easy to apply and safe to use in regular and FDA approved formulas. Staticide is invisible, long lasting, and doesn't deteriorate for long periods.

CIRCLE NO. 327

Insert DIPs with no force; locks in place

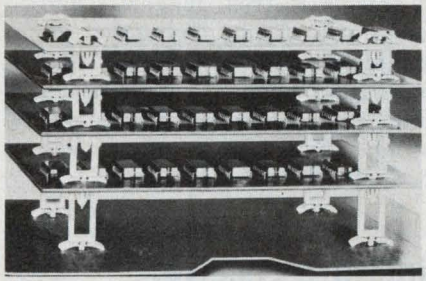


Cambridge Thermionic Corp., 445 Concord Ave., Cambridge, Mass. 02138. (617) 491-5400.

Zero-force sockets, Series 703-1009, accept DIPs with 0.6 in. pin alignment and 24, 28, 36 or 40 pins. Up to five 8-pin DIPs can also be handled. With the cover open, DIP leads are inserted without restraint or contact pressure. As the cover is closed, contacts engage and wipe along both sides of each DIP lead.

CIRCLE NO. 328

Handy spacers stack circuit boards

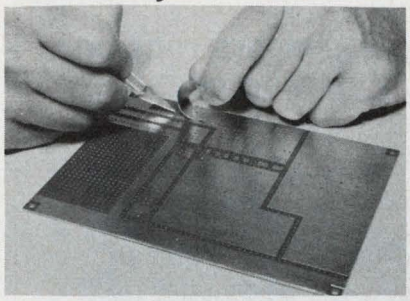


Richco Plastic Co., 5825 N. Tripp Ave., Chicago, Ill. 60646. (312) 539-4060. $0.02 to $0.04 each (OEM qty).

The Model CBSS spacer system can be used to stack circuit boards in any number of vertical tiers or side-by-side rows. The system has only two simple parts—a locking spacer for each tier and a capping button to top-off and lock the stack. The spacers are available in 1/2, 5/8, 3/4 and 7/8-in. heights. A barbed-arrow locking tip snaps through a 0.156-in. D. hole in the board and into the top of the adjacent spacer. The system is completed by inserting a capping button through the top board. The capping button protrudes only 0.18 in. above the top board for a compact assembly. The spacers and capping button are made of rigid natural nylon. Free samples are available.

CIRCLE NO. 329

Cut and peel this PC board to your needs

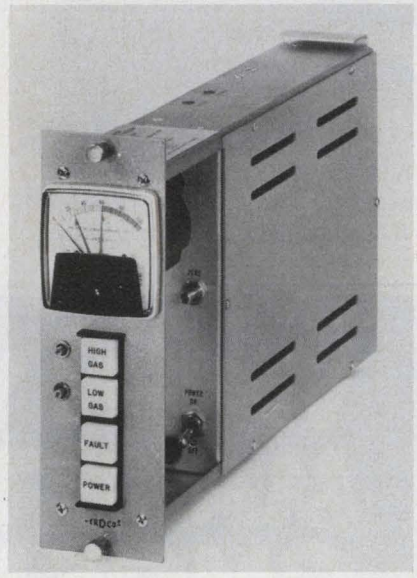


Circuit-Stik Inc., 24015 Garnier St., P.O. Box 3396, Torrance, Calif. 90510. (213) 530-5530.

Cut & Peel circuit boards are a new idea in keeping with Circuit-Stik's adhesive backed subelements. The boards consist of electrodeposited copper foil laminated to epoxy-glass with a pressure-sensitive adhesive. This allows engineers and technicians to cut breadboard circuits and ground planes and peel away the unwanted copper foil. Off-the-shelf boards are offered in 38 combinations of sizes and styles.

CIRCLE NO. 330

Vapor sensors runs on 24 V dc line or battery

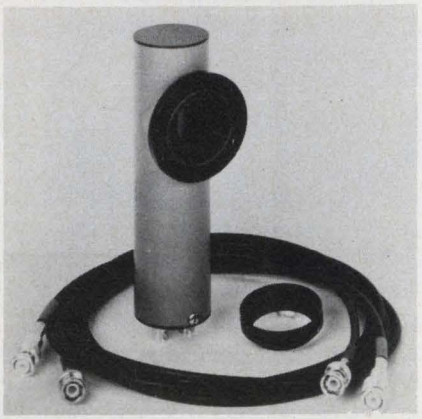


Erdco Engineering Corp., 136 Official Rd., Addison, Ill. 60101. (312) 543-6733.

The single station, diffusion type TOX-EX 017D-CGA operates from a 20 to 35 V dc line or battery. It can detect concentrations of carbon monoxide, acetylene, hydrogen, hydrogen-sulfide, hydrocarbons or mono-halogenated compounds. The units use MIL-grade components and have a two year warranty. Each module has its own constant voltage control, relay circuits, automatic or manual reset, single or dual set points and lower flammable limit meter. Set point(s) may be adjusted on the scale between 5% and 100% of lower flammable limit. Channels may be added without affecting operation of adjacent modules within the chassis and control console. Detection sensitivity is maintained in ambient temperatures from −40 to 200 F and humidity levels of 100% RH. The TOX-EX 017D-CGA system can meet or exceed the requirements of Factory Mutual and Canadian Standard Association. MIL-grade components meet hazardous area requirements of Class 1, Division 2, Groups C and D. The explosion-proof sensor meets Class 1, Division 1, Group A, B, C and D requirements. Size of plug-in modules is 2-7/8 by 8-3/4 by 14-11/16 in.

CIRCLE NO. 331

Photomultiplier housing includes voltage divider

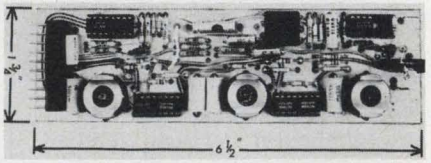


Pacific Photometric Instruments, 5745 Peladeau St., Emeryville, Calif. 94608. (415) 654-6585.

Model 50B photomultiplier tube housing is designed to accommodate side-window tubes such as RCA 1P21, Hamamatsu R-446 and EMI 9781. Model 50B comes ready for use. It contains a low-loss socket with precision voltage divider built from 1% metal-film resistors. A mu-metal cylinder with side port encases the photomultiplier tube and shields it from magnetic and electrostatic fields. A series of mechanical options (circular and square filter holders, optical bench mount, etc.) makes the Model 50B adaptable to a variety of systems and applications.

CIRCLE NO. 332

Miniature receiver sorts out WWVB signals



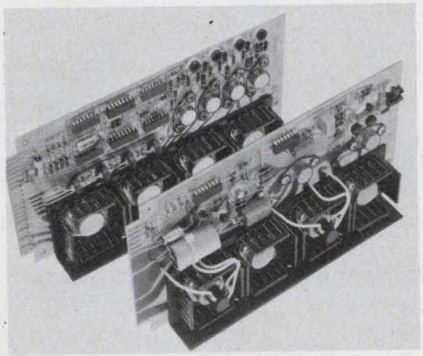
True Time Instrument Co., 2255 Melbrook Way, Santa Rosa, Calif. 95405. (707) 528-1230. $390 (T), $490 (TR).

Designed to recover the WWVB timing code, the Model 60-T receiver measures only 1-3/4 by 6-1/2 in. All IC construction gives the unit a high sensitivity of 0.5 μV. It is guaranteed to operate anywhere within 1800 miles of WWVB. A rack-mounted version, Model 60-TR, is mounted on a standard 1-3/4 in. rack panel, and utilizes the same circuitry and features, and includes a regulated power supply.

CIRCLE NO. 333

MODULES & SUBASSEMBLIES

Driver cards offer versatile motor control



Warner Electric Brake and Clutch Co., 36 Main St., Madison, N.J. 07940. (201) 377-4800.

The MCS-1800 series of solid-state driver cards converts serial command pulses into sequenced high-current motor excitation signals for both open and closed-loop variable-reluctance step motor control systems. They are designed for either three or four phase motors that draw a maximum current per phase of 1.5, 3 or 8 A. The printed-circuit board drivers fire either one or two motor phases at a time. User-supplied pulse source, logic power (5 V dc) and motor power supply complete the basic control system. Six of the 18 cards operate with an additional overexcitation power supply. All have DTL/TTL compatible input logic which accepts separate clockwise and counterclockwise pulse trains or a single step pulse source and separate direction signals. Fly-back diode suppression with provisions for additional suppression resistors is standard. Driver cards mate with 22-pin, 0.156-in. center edge connectors.

CIRCLE NO. 334

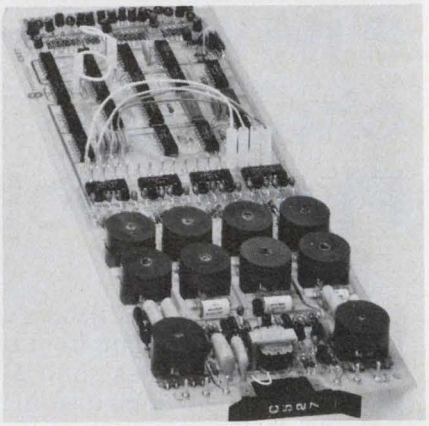
V/f converters span 0 through 100 kHz

North Hills Electronics, Inc., Glen Cove, N.Y. 11542. (516) 671-5700.

The DF-20 Series of voltage-to-frequency converters are printed-circuit plug-in modules. The seven standard models cover output frequency ranges from 0 to 1 kHz through 0 to 100 kHz. Linearity for all models is specified as ±0.02% maximum and power requirement is 10 mA from ±15 V regulated dc.

CIRCLE NO. 335

Telephone tone decoder performs 15 functions

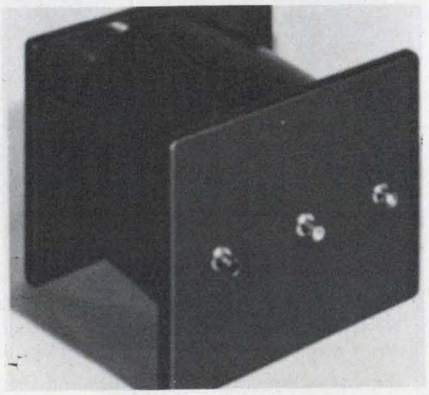


Speedcall, 2020 National Ave., Hayward, Calif. 94545. (415) 783-5611.

The Speedcall 527 tone decoder allows specific sites to be individually addressed and up to 15 functions performed at any fixed or mobile site. This unit is offered with momentary, latched and interlocking outputs and is addressable with up to four digits. It has an operating temp range of −35 to +85 C and a power supply requirement of 16.3 V ±20%. The input range is 20 mV to 6 V (each tone) and −32 to +18 dBm. Outputs are open collectors capable of sinking 50 mA at 24 V dc.

CIRCLE NO. 336

Trigger generator gives 50 kV fast-rise pulses

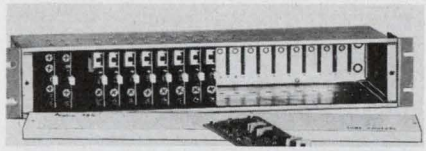


The Condenser Products Corp., P.O. Box 997, Brooksville, Fla. 33512. (904) 796-3562. $395.

The CP-50 fast-rise, low jitter, 50 kV pulse generator delivers long duration pulses. Almost no protective isolation is required for the trigger device (only 100 Ω up to 25 kV and only 4 Ω per kV thereafter) allowing positive, low-jitter performance.

CIRCLE NO. 337

Tone repeater panel can handle 18 separate tones



Alpha Electronic Services Inc., 8431 Monroe Ave., Stanton, Calif. 90680. (714) 821-4400.

The RCP-780 is a multifrequency repeater tone panel. The unit is capable of handling up to 18 separate tone-controlled functions utilizing a modular plug-in card for each function. System "A" will respond to a received tone, either sub-audible or pulse tone, by keying and modulating the transmitter with the same tone, filtered and regenerated. System "B" removes the received tone from the audio and keys and modulates the transmitter with the received signal minus the tone. A new tone is generated for the transmit carrier which can be the same tone frequency as the received tone or may be a different frequency if desired. System "C" utilizes any number of pulse-tone combinations to accomplish the same action as System "B." Plug-in cards are also available for any of the following special tone combinations: pulse-tone decode with sub-audible encode, sub-audible decode with pulse-tone encode, pulse-tone decode of one tone frequency with pulse-tone encode of another or any combination of sub-audible and audible tone can be employed simultaneously.

CIRCLE NO. 338

Lamp flasher handles inrush currents of 120 A

SSAC Precision Products, P.O. Box 395, Liverpool, N.Y. 13088. (315) 699-2551. $25.33.

The Model FS154 Flasher measures 2 by 2 by 3/4 in. and operates on 120 V ac, ±15%. Maximum voltage drop is 1.5 V and the 90 per minute flash rate is consistent within ±15 flashes, from unit to unit. Added features of the FS154 are full-wave ac power circuitry, zero voltage switching for minimum radio frequency interference, longer lamp life, capability of 120 A inrush current and a steady state current of 12 A.

CIRCLE NO. 339

MODULES & SUBASSEMBLIES

Multichannel oscillator switches in under 10 μs

Greenray Industries, Inc., 840 W. Church Rd., Mechanicsburg, Pa. 17055. (717) 766-0223. $1145; 8-9 wk.

The Model M-398 multiple-channel oscillator can switch between four customer specified channels in the 20 to 125 MHz range in less than 10 μs. Frequencies are remotely selected by a standard TTL code. Intermodulation between channels is down at least 40 dB. The M-398 has a frequency stability of ±0.003% over the temperature range of 0 to +50 C. Output power is 10 mW with an input supply voltage of 28 V dc.

CIRCLE NO. 340

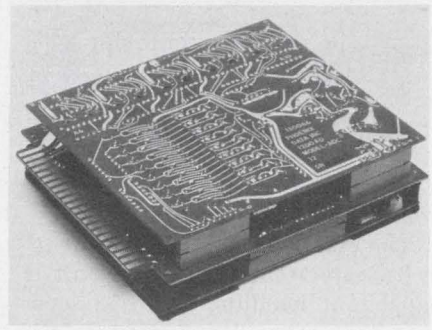
Voltage/current alarm has 100% deadband

Rochester Instrument Systems, 275 N. Union St., Rochester, N.Y. 14605. (716) 325-5120.

Model ET-1218, solid-state alarm, accepts current or voltage inputs and provides a DPDT relay output. The unit has a deadband adjustability of 0 to 100% via a multiturn potentiometer. The 1218 accepts all standard process inputs: 1 to 5, 4 to 20, 10 to 50 mA dc, or 1 to 5 V dc. External shunt resistors are used to convert the voltage range for current activation on any of the milliamp ranges, with an input resistance of 5 MΩ minimum at 5 V dc. The basic range of the unit is 0 to 5 V dc, but the input stage is fully surge-protected against potentials as high as 115 V ac to guard against wiring errors. Three standard power supplies are available with the ET-1218—117 V ac, 24 V dc, or 48 V dc—with ±20% voltage regulation furnished as standard with any supply. The output of the sensor is a DPDT relay rated at 10 A, 117 V ac resistive. Trip set adjustability is by means of a multiturn potentiometer and accuracy is 0.1%. Response time is less than 30 ms. Trip point stability and drift is ±0.5% of span for a 50 F change in ambient temperature maximum, with a drift of ±0.2% typical.

CIRCLE NO. 341

A/d converter resolves 15 bits in 4 μs



Phoenix Data, Inc., 3384 W. Osborn Rd., Phoenix, Ariz. 85017. (602) 278-8528. $1495; 2 to 4 wk.

The ADC1215F a/d converter resolves 15 binary bits and has a total conversion time of 4 μs. It uses a fold-back conversion technique in which two 9-bit successive approximation conversions are combined with a high-speed, high accuracy DAC and a fast settling differential amplifier. Accuracy is 0.005% of full scale ±1 LSB and resolution is 0.003%, both guaranteed along with monotonicity. The analog dynamic range of the ADC-1215F is in excess of 86 dB. It also offers an overrange bit, an output buffer register and a high impedance input buffer amplifier or an optional differential input buffer amplifier. Mechanically, the ADC1215F measures 4.5 by 5 by 1.5 in. Power requirements are ±15 V at 150 mA and +5 V at 1 A maximum.

CIRCLE NO. 342

Three-axis rate sensor resolves 0.01°/sec

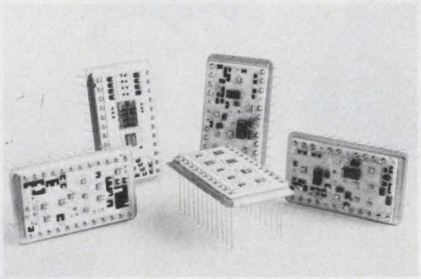
Humphrey Inc., 9212 Balboa Ave., San Diego, Calif. 92123. (714) 565-6631.

Model RT02-0201-1 is a solid-state three-axis angular rate sensor. It provides ±60°/sec range for pitch and yaw, a ±360°/sec range for roll and operates on 28 V dc using less than 10 W. This hermetically sealed unit has no moving parts and comes in a package capable of withstanding 100 g shock and 10 g vibration. Input resolution is 0.01°/sec., and output impedance is 2 kΩ. The ruggedized unit has a 200 ms startup and is guaranteed for 10,000 hours. It weighs less than two pounds and is 3.75 by 4.62 by 3 in.

CIRCLE NO. 343

MODULES & SUBASSEMBLIES

Hybrid s/d and d/s converters consume 1 W



ILC Data Device Corp., 100 Tec St., Hicksville, N.Y. 11801. (516) 433-5330. $1800 to $2000; 6 wk.

The synchro tracking converters of the H-Series are thick-film hybrid devices. A 16-bit s/d converter can be assembled with as few as five double dual-in-line modules. CMOS logic reduces power consumption to less than 1 W. Single or multispeed, high (90 V L-L) or low level (11.8 V L-L), synchro or resolver, and wideband systems are available. Processing to MIL-STD-883 level C is standard procedure with processing to level B available. These devices use the Type II servo loop approach and have high resolution (up to 16 bits), high accuracy (up to ±2′) and fast tracking (0 to 1440°/sec, full accuracy. They also have small size (six DIPs for a s/d, four DIPs for a d/s).

CIRCLE NO. 344

BCD coded keyboards include encoder IC

Key Tronic Corp., Bldg. 14—Spokane Industrial Pk., Spokane, Wash. 99216. (509) 924-9151.

A 16-key BCD encoded keyboard includes the 20-0165 keyboard encoder—a 16-line to four-bit parallel encoder in a 24-pin hermetic DIP. The keyboard operates over the temperature range of 0 to +75 C. The encoder provides strobe and two-key rollover protection as well as BCD encoded data. Full typewriter keyboard encoding up to eight bits can be accomplished using two encoder packages. Outputs of the package interface readily with all popular DTL and TTL logic families. The 16-key keyboard requires only +5 V input and prior to shipment is cycled 50,000 times and undergoes a minimum 24 hour burn-in.

CIRCLE NO. 345

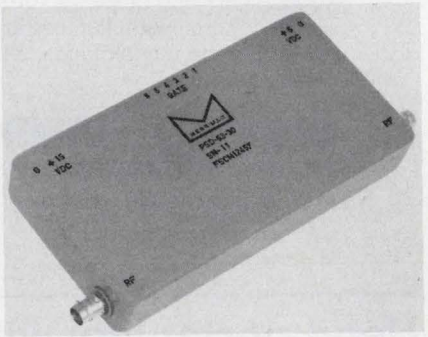
Proportional servo speed control has many uses

Automated Servo Control, Lindenwood, Ill. 61049. (815) 393-4471.

A proportional servo speed control system can interface with mobile or industrial hydraulic drive systems. This closed-loop control consists of a solid-state comparator-amplifier, rotary control actuator and photoelectric speed detector. The basic control function is speed synchronization of two rotating devices. However, the design flexibility offers automatic control relative to pressure, G.P.M., temperature, torque, position and ac/dc voltage or current, etc.

CIRCLE NO. 346

Phase shifter controlled by a six-bit signal



Merrimac Industries, Inc., 41 Fairfield Pl., West Caldwell, N.J. 07006. (201) 228-3890. $525.

The PSD Series of digital phase shifters is available for center frequencies from 21.4 to 160 MHz. Phase can be shifted in binary increments using a six-bit binary word. The least-significant bit is 3 degrees for Model PSD-63-30 and 5.75 degrees for Model PSD-64-30, while the most-significant bit for these two models is 96° and 354.25°, respectively. Other specifications include a center frequency of 30 MHz, a bandwidth of 5%, a 50 Ω impedance, a VSWR of 1.5:1, an insertion loss of 3 to 4 dB, a maximum input power of −10 dBm and phase shift accuracy from 2.7 to 5.2 degrees. Model PSD-63-30 has a nominal phase shift range of 0 to 180 degrees; the model PSD-64-30 covers a nominal 0 to 360 degrees. BNC female connectors are used for the rf ports, and solder pins are used for control terminals. Both models weigh 10 oz.

CIRCLE NO. 347

Four-quadrant multiplier offers high accuracy

Teledyne Philbrick, Allied Dr. at Route 128, Dedham, Mass. 02026. (617) 329-1600. Model 4454: $85; Model 4455: $125; stock.

Models 4455 and 4454 modular four quadrant multipliers deliver pretrimmed accuracies of 0.25% and 0.5%, respectively. Temperature drifts are 0.01%/°C for the 4454 and 0.02%/°C for the 4455. Small signal bandwidth for both units is 600 kHz. Both units are housed in 1.5 by 1.5 by 0.6 in. encapsulated modules and are rated for operation from 0 to 70 C.

CIRCLE NO. 348

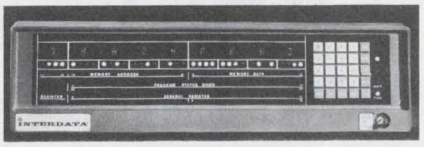
A/d converter offers 10-MHz throughput

Datel Systems, Inc., 1020 Turnpike St., Canton, Mass. 02021. (617) 828-6395. $1295.

The ADC-VH video a/d converter uses a parallel/serial conversion scheme. It can deliver a 5-MHz throughput rate for eight-bit words or 10 MHz for four-bit words. First the four most-significant bits are determined through a four-bit parallel converter. These four bits in turn control an ultra-high speed d/a converter whose output is subtracted from the input signal and the remainder is fed to a second four-bit parallel converter which determines the four least-significant bits. The total propagation delays and settling times involved are less than 200 ns. The eight digital outputs can each drive up to four TTL loads. The converter will operate within specifications from 0 to +70 C. Long term stability is specified at ±0.25%/year and the temperature coefficient is +50 ppm/°C. Power requirement is ±15 V dc at 75 mA, +5 V dc at 1.2 A and −5 V dc at 225 mA.

CIRCLE NO. 349

Modular mini handles up to 255 devices



Interdata, 2 Crescent Pl., Oceanport, N.J. 07757. (201) 229-4040. See text; Feb.

Model 7/16, a microprogrammed minicomputer, consists of a two-board CPU packaged in an eight-slot RETMA chassis. A CPU plus 8-k bytes of core costs $3200 in single units. The computer provides 16 general registers, a set of 100 instructions and provides for 255 I/O interrupts with automatic vectoring to service routines. Data-word length is 8, 16 or 32 bits; instruction-word length is 16 or 32 bits. Typical time for a 16-bit register-to-register add is 1.5 μs. The computer handles up to 255 devices at rates up to 2-M byte/s—with an optional selector channel. Core modules, mounted on 15-in. PC boards, are available in capacities 8, 16 or 32 k bytes with 1 μs cycle time. The 32-k boards are also available with 750 ns cycle times.

CIRCLE NO. 350

Punched-tape emulator requires no interface

Remex, 1733 Alton St., Santa Ana, Calif. 92705. (714) 557-6860. From $2395; stock.

The punched tape emulator (PTE) converts equipment that uses paper tape to digital-cassette operation without the need for interface devices or software modifications. The unit provides asynchronous operation at speeds from zero to 300 char/s. A single cassette stores the equivalent of ten 130-foot punched tapes. A dial-controlled file search allows access to 10 or more programs on a single cassette. A single PTE handles two independent cassette drives.

CIRCLE NO. 351

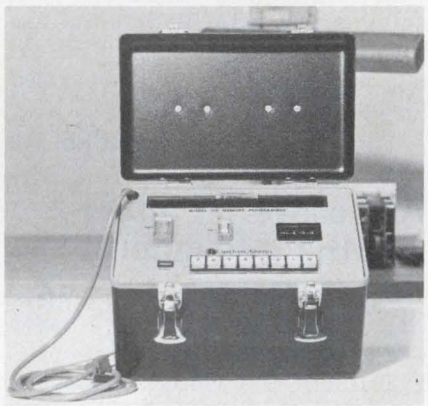
Portable video recorder has 3.5-MHz bandwidth

Ampex Corp., 401 Broadway, Redwood City, Calif. 94063. (415) 367-4151. MS-1: $39,000; MX-1: $120,000.

A portable video recorder, the MS-1, weighs less than eight pounds with battery pack attached. The recorder has a 3.5-MHz bandwidth and a dynamic range of 32 dB. Recording time is 20 min. with the 1-in. wide tape and helical-scan wrap used. A companion unit, the MX-1, provides for playback of the recorded data.

CIRCLE NO. 352

Manual programmer can handle 1000×8 pROMs



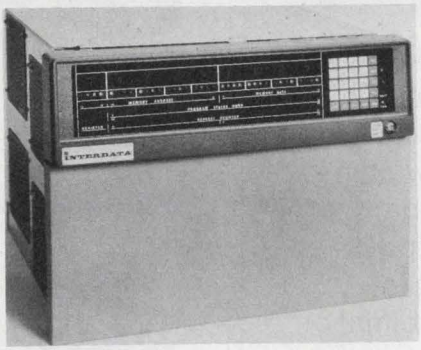
Spectrum Dynamics, 1320 W. McNab Rd., Fort Lauderdale, Fla. 33309. (305) 974-9500. $900; 90 days.

According to the manufacturer Model 310 pROM programmer handles any field-programmable ROM. The unit, intended for manual use, programs and verifies both bipolar and MOS pROMs—including fusible-link, MOS erasable and avalanche migration types. A single plug-in card adapts the unit to any manufacturer's pROM. Operation is simple: pROM words are addressed decimally with a three-digit thumbwheel switch. Depressing any one of eight switches programs the corresponding bit. And the buttons light up to verify the programmed bit. PROMs up to (1000×8) can be handled by the basic unit; an available option allows expansion to a 10,000 × 8 capacity.

CIRCLE NO. 353

DATA PROCESSING

Industry's first 32-bit mini heads product list



Interdata, Inc., 2 Crescent Pl., Oceanport, N.J. 07757. (201) 229-4040. See text.

Model 7/32, the first minicomputer priced under $10,000, can directly address up to 1-Mbyte of memory as well as perform 32-bit arithmetic and logic operations. Memory for the computer (750-ns core) comes in 32-k byte modules mounted on 15-in. PC boards and costs $4500. The three-board processor has hardware multiply/divide and two sets of 16, 32-bit registers. A 32-bit register-to-register add requires one microsecond. I/O capabilities include DMA: 2.6 M byte/s, programmed data transfer: 26 to 150 k and automatic transfer: 50 k. The latter mode permits microprogrammed decoding of data without the use of software interrupt routines. The price includes 8-k bytes of memory. Delivery is scheduled for the first quarter of 1974.

CIRCLE NO. 354

Production programmer handles most pROMs

Spectrum Dynamics, 1302 W. McNab Rd., Fort Lauderdale, Fla. 33309. (305) 974-9500. See text.

At the push of a button, the Model 520 pROM programmer "blank-checks," programs and verifies field-programmable ROMs. A preprogrammed ROM, inserted in the "master socket" provides the pattern. Plug-in modules permit the 520 to program most pROMs now on the market. The unit can provide program voltages up to 60-V at one ampere. Programming time varies from a few ms to 20 min., depending on the device type used.

CIRCLE NO. 355

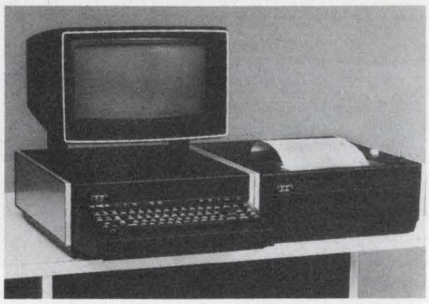
Time-code generator has decimal readout

Thiem Industries, 1918 N. Artesia Blvd., Torrance, Calif. 90540. (213) 321-1911. $690.

Output of the series M time code generator is in IRIG B serial format. The display—either Nixie or Sperry seven-segment—shows decimal digits representing seconds, minutes and hours from 00:00:00 to 23:59:59. The time base, a crystal-controlled oscillator, is available with accuracies up to 25 ppm. Stand pulse rates include 1000, 100, 10 and 1 Hz as well as 1 or 6 pulse/hr.

CIRCLE NO. 356

Modular terminal system includes diagnostics



Teletype Corp., 5555 Touhy Ave., Skokie, Ill. 60076. (312) 982-2500.

The Model 40 terminal system includes a CRT display, ASCII keyboard and medium speed impact printer. The display screen has a capacity of 1920 characters (24 lines × 80 characters); the display memory accommodates 24 lines, expandable to 48 or 72 lines. All data can be entered on the screen, edited and corrected if necessary then transmitted at speeds up to 1200 baud (other speeds optional). The printer speed is 80 cols. at 314 lines/min—with a single-case character set. The system is modular—the user can chose the desired combinations of keyboards, printer and CRT. To minimize downtime, self-contained diagnostic circuits provide display patterns and activate lights on individual circuit cards.

CIRCLE NO. 357

Terminal handles ASCII or APL character set

Anderson Jacobson, Inc., 1065 Morse Ave., Sunnyvale, Calif. 94086. (408) 734-4030. $4250; Nov.

A printer-keyboard terminal, the AJ630 A, can be switched locally or remotely between the standard ASCII character set and the APL-ASCII system. The terminal operates at the rate of 10, 15 or 30 char/s and provides a 140-column thermal printout. The character set consists of APL, plus standard upper and lower case characters. Options include an internal modem or an acoustic coupler.

CIRCLE NO. 358

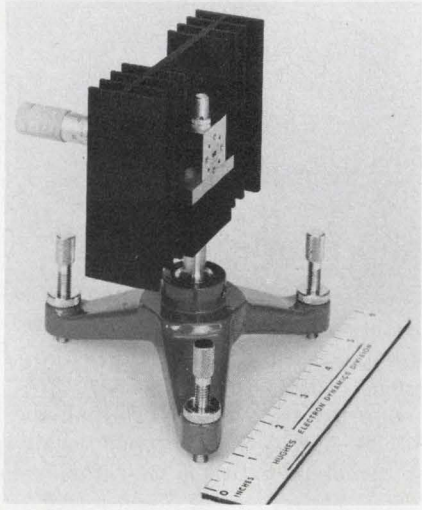
Low-cost calculator has 8-LED display

Litronix, Inc., 19000 Homestead Rd., Cupertino, Calif. 95014. (408) 257-7910. $39.95 (retail).

Three penlight batteries power the Litronix 1100, a four-function calculator, that can perform chain computation. The calculator uses a single MOS/LSI circuit and an 8-LED display. A switch selects two-or-four decimal place operation; the "clear-entry" key permits erasure of the last-entered number without erasing the results of previous calculations. An optional ac adaptor is available at a suggested retail price of $4.95.

CIRCLE NO. 359

Mm-wave sources deliver up to 50 mW



Hughes Aircraft, P.O. Box 90515, Los Angeles, Calif. 90009. (213) 670-1515. $1050 to $2950; 90 days.

A series of solid-state millimeter-wave power sources are tunable over broad frequency bandwidths by means of a built-in micrometer. The new oscillators—Models 44101H through 44103H—are offered in three models: two have center frequencies from 33 to 40 GHz, while the third spans the 50-to-75-GHz band. Minimum output powers range from 10 to 50 mW, and minimum bandwidths are 4 to 5 GHz. The sources consist of Impatt diodes mounted in special high-Q cavities.

CIRCLE NO. 360

Measure time delays from 20 MHz to 18 GHz

Rantec Div., Emerson Electric, 24003 Ventura Blvd., Calabasas, Calif. 91302. (213) 347-5446.

The ET-300 series of time-delay instruments permits tests over the frequency range of 20 MHz to 18 GHz by the use of interchangeable modulators and detectors. The ET-300 can resolve delay changes as small as 0.1 ns, and the rf and output signals may be in different frequency bands. Ten linear delay scales provide readability from 0.1 to 5000 ns. Selectable 200-kHz and 1-MHz modulation frequencies allow indicator optimization with respect to the bandwidth of the device under test.

CIRCLE NO. 361

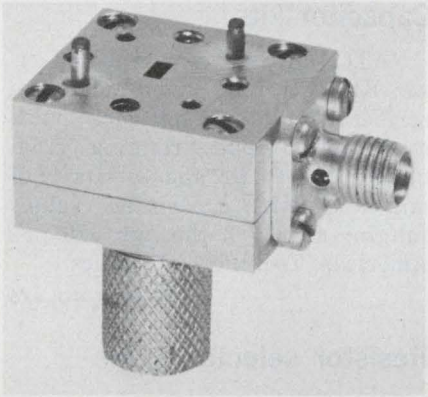
Power attenuators handle 10 kW

Radiall, 101 rue Philibert Hoffmann, Zone Industrielle Ouest, 93116-Rosny S/Bois, France.

Coaxial fixed power attenuators, type ACO, offer attenuation values of 3, 6, 10 and 20 dB over a 2-to-18-GHz frequency range. Average power handling is 50 W and peak power handling is 10 kW. VSWR is less than 1.3 from 2 to 10 GHz and less than 1.2 from 10 to 18 GHz. Also available are type AFP waveguide attenuators that provide attenuation values of 3 to 6 and 10 dB, from 3.3 to 18 GHz over seven bands. Average power handling is 50 W and peak power is 10 kW. Max VSWR is 1.10.

CIRCLE NO. 362

Thermistor heads measure mm power



EMI-Varian Limited, Hayes, Middlesex, England.

Variable and fixed tuned thermistor heads, series MMC, measure mean power output from 20 to 110 GHz. Each waveguide unit consists of a mount containing a tunable short-circuit and a plug-in waveguide wafer in which the thermistor is mounted. The tunable head offers an instantaneous bandwidth of 10%. Power handling of all units in the series is typically 14 mW at 200 Ω with a 2.3 VSWR. Heads are self-heating from the rf power. At room temperature, their resistance falls by approximately 4% for every degree C increase in temperature. Each thermistor head is supplied with an individual calibration certificate specifying minimum and typical efficiency within each band.

CIRCLE NO. 363

application notes

Film resistors

A bulletin describes the use of Bulk Metal-film resistors in TV color encoders to eliminate the basic problem of drift and instability in TV color transmission. Schematics and descriptions of the matrix and modulator circuits are included. Vishay Intertechnology, Malvern, Pa.

CIRCLE NO. 364

Tests for plastics

"Standard Tests on Plastics," a 32-page brochure, contains over 30 ASTM tests commonly used to describe the characteristics of plastics. The illustrated brochure separates tests into six categories: mechanical, thermal, optical, permanence, analytical and electrical. Also included are conditioning procedures and 11 conversion charts and reference tables. Celanese Plastics Co., Newark, N.J.

CIRCLE NO. 365

Low-noise preamplifiers

A 16-page brochure entitled "Low-Noise Preamplifiers" provides information on weak-signal amplification in the 0.01-Hz to 1-MHz range. Included is information on 30 preamplifiers and notes on noise and other factors affecting preamplifier selection and use. Ithaco, Ithaca, N.Y.

CIRCLE NO. 366

Programmed logic systems

A 130-page book, Designers Guide to Programmed Logic, includes theory, specific designs and applications using 4-bit programmed logic systems. Pro-Log Corp., Monterey, Calif.

CIRCLE NO. 367

Dual-gate MOSFETs

Details on the performance of dual-gate MOSFETs in rf and i-f amplifiers are provided in a four-page brochure. Special consideration is given to agc functions, biasing, distortion and stability. General Instrument Corp., Semiconductor Components Div., Hicksville, N.Y.

CIRCLE NO. 368

evaluation samples

Linear motion sliders

A family of linear slide controls, the 1-1/4-in. slim-line series 440, complements the existing line of 1-3/4-in. and 2-in. potentiometers. The new series features smooth resistance adjustment over the full 1-1/4 in. of mechanical travel, a power rating of 1/4 W at 55 C, and resistance values from 200 Ω through 5 MΩ. Top, side or bottom twist tab mountings are provided with straight PC, snap-in PC or solder-lug terminals. Operating force in either direction is 5 to 15 oz. CTS of Elkhart Div.

CIRCLE NO. 370

Stacking spacer system

The CBSS spacer system is comprised of two simple nylon components, which can be used to stack circuit boards in any number of vertical tiers or side-by-side rows. The spacers are available in 1/2, 5/8, 3/4 and 7/8 in. heights. The system is completed by inserting a capping button through the top board to secure it to the spacer below. The capping button protrudes 0.18 in. above the top board for a compact assembly. Richco Plastics.

CIRCLE NO. 371

PC card ejectors

Electro-Flex card ejectors are molded of UL-approved, 20V nylon. The ejectors attach to cards of 1/16, 3/32 and 1/8 in. thickness. Drive pins are included. Standard colors are white and red; other colors are available. Electro-Space Fabricators.

CIRCLE NO. 372

Thin-line bushing

A thin-line strain-relief bushing for chassis thicknesses of 1/16 in. and less accommodates SJT, SJO and SJ 18/2 cable. It securely anchors, insulates and protects cables at chassis point-of-entry and is approved for high-temperature applications. Heyman Manufacturing.

CIRCLE NO. 373

design aids

IR-emitting diode chart

A brochure/wall chart compares solid-state GaAs infrared emitting diodes and GaAs and GaAlAs laser diodes. RCA.

CIRCLE NO. 374

Slide rule

A pocket-size platinum resistance vs temperature slide rule enables users to convert platinum resistance to degrees celsius or fahrenheit and to determine the nonlinearity error when using platinum, nickel or balco resistance temperature transducers. Genisco Technology Corp., Instruments Div.

CIRCLE NO. 375

Capacitor kits

"ATC UHF/Microwave Capacitor Kits," a four-page folder, describes six kits (55 mil cube) with capacitance values ranging from 0.3 through 91 pF and 10 kits (110 mil cube) with capacitance values ranging from 0.3 through 620 pF. American Technical Ceramics.

CIRCLE NO. 376

Resistor selector guide

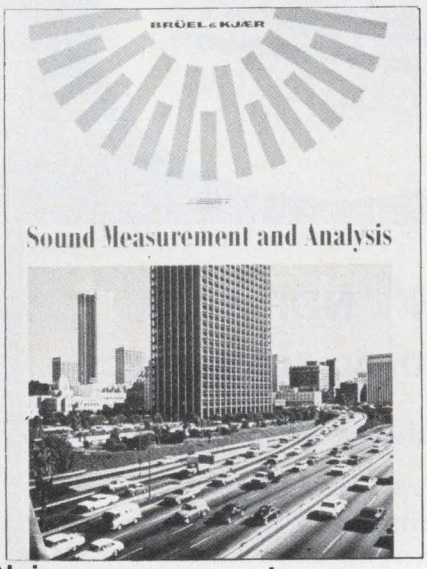
The fired resistor properties, sensitivity to processing variables and effects of subsequent processing steps on the company's thick-film resistor compositions are described in a selector guide. Resistivity, thermal coefficient of resistance, noise, stability and fired print definition are among the properties delineated by the pamphlet. Du Pont.

CIRCLE NO. 377

Mercury switch kit

A 19-piece design kit permits engineers to investigate a new family of rugged all-position mercury switches, series LC2. Self-healing mercury film contacts provide over 250-million bounce-free operations switching contact loads to 2 A. The design kit lists for $45. Fifth Dimension, Box 483, Princeton, N.J. 08450.

new literature



Noise measurements

Instruments described in the Sound Measurement and Analysis brochure are all easy to operate and use. As an aid to the correct selection of instruments for a certain noise reduction problem, the brochure summarizes what noise is and how it can be measured. B & K Instruments, Cleveland, Ohio.

CIRCLE NO. 378

Low-frequency oscillators

Low-frequency oscillators spanning from less than 1 Hz to 100 kHz are described in a series of technical bulletins. Bulova Watch Co., Woodside, N.Y.

CIRCLE NO. 379

Wafer dicing saw

Features, specifications and capabilities of the model 602 dicing saw are contained in a brochure. Tempress, Div. of Sola Basic, Los Gatos, Calif.

CIRCLE NO. 449

EMI ceramic filters

A "how-to-select" section in catalog FC-73 helps specifiers to narrow the choice of the right ceramic filter for the job. Charts show typical full load attenuation vs temperature and insertion loss vs frequency. Part numbers of filters and their AVX equivalents are listed. AVX Ceramics, Braintree, Mass.

CIRCLE NO. 450

Measurement instruments

A two-color, six-page brochure describes products for measurement, signal conditioning and control. Moxon/SRC Div., Irvine, Calif.

CIRCLE NO. 451

Power supplies

A 120-page dc power supply catalog makes it easy for the user to find exactly what he wants without having to interpret pages of complicated tables. First, this catalog lists all of its power supplies in order of ascending voltage. Then, within each voltage rating, current ratings are listed in ascending order. The catalog is divided into five categories: low-cost lab supplies, general-purpose, special-purpose, modular and digitally programmable power supplies. Hewlett-Packard, Palo Alto, Calif.

CIRCLE NO. 452

Interconnectors

A data sheet describes conductive elastomeric liquid crystal interconnectors and carbon-filled or silver-filled elastomeric materials. Technical Wire Products, Cranford, N.J.

CIRCLE NO. 453

Dc testers

Four series of portable high-voltage dc insulation testers and four types of fault locators are illustrated and described in a 12-page catalog. Design and safety features, specifications, instrumentation data and optional equipment are included. Hipotronics, Brewster, N.Y.

CIRCLE NO. 454

Telecommunications LSI

A four-page, full-color brochure introduces the company's LSI test system, the MD-154, and goes into detail explaining how to use the system to test complex LSI telecommunication devices. The brochure is complete with specifications, photos and block diagrams. Macrodata, Woodland Hills, Calif.

CIRCLE NO. 455

Precision potentiometers

Six 2-page, two-color data sheets describe low-cost, single-turn, conductive plastic precision potentiometers. Photographs, dimensional drawings, specifications and ordering information are given. Spectrol Electronics Corp., City of Industry, Calif.

CIRCLE NO. 456

Thermocouples

A 16-page brochure of Enclad sheathed thermocouples describes the use of precious metal and selected base metal sheaths and thermocouple wires. Engelhard Industries, Murray Hill, N.J.

CIRCLE NO. 457

Computer peripherals

An OEM product sheet lists computer peripheral product lines and describes typical models, including chain and drum printers, reel-to-reel and cartridge tape transports, disc drives, card readers, digital lister printers and paper-tape equipment. Mohawk Data Sciences, King of Prussia, Pa.

CIRCLE NO. 458

Modems

Modem 4600/48, a 4800 bps data set featuring a simplified type of manual equalization, is described in an eight-page catalog. The illustrated data sheet includes a description of the unit's remote control test feature and other functional and interface data. International Communication Corp., Miami, Fla.

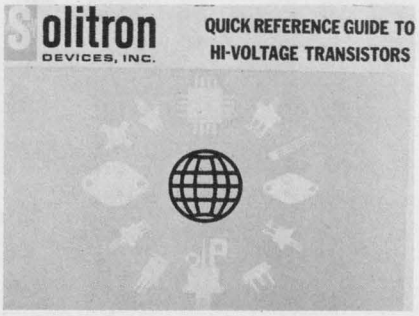
CIRCLE NO. 459

High-purity materials

A 116-page catalog contains complete product information, including available forms of analytical data, prices, ordering information and definitions of commercial and technical terminology dealing with high-purity metals, alloys and ceramics. Also included are coated and uncoated filaments, evaporation boat sources, coated and uncoated Superstrate and ceramic substrates and opto-electronic materials such as gallium arsenide and gallium phosphide for LEDs and microwave devices. Materials Research Corp., Orangeburg, N.Y.

CIRCLE NO. 460

NEW LITERATURE



High-voltage transistors

A 24-page book provides a condensed listing guide to more than 160 high-voltage power transistors. Device series numbers, breakdown voltages, current gains, saturation voltages, leakages, and thermo resistance as well as JEDEC package types are included. Solitron Devices, Riviera Beach, Fla.

CIRCLE NO. 461

Logarithmic amplifiers

A brochure describes characteristics of logarithmic amplifiers and includes features of ac and dc-coupled logarithmic video amplifiers and rf log detectors. American Astrionics, Costa Mesa, Calif.

CIRCLE NO. 462

Integrated circuits

Advanced linear integrated circuits for industrial and communications equipment are described in a short-form catalog. It includes ICs originally developed and introduced by the company as well as second-source devices. Exar Integrated Systems, Sunnyvale, Calif.

CIRCLE NO. 463

Fasteners

High-performance, quarter-turn fasteners are described in a 12-page catalog. In addition to specifications, performance data and ordering information, the catalog gives instructions on installation and field adjustments. The Paneloc Corp., Colinsville, Conn.

CIRCLE NO. 464

Rf switches

Series EE940 and series EE950 rf inductive proximity switches with fail-safe features are the subject of an eight-page brochure. Namco Controls, Cleveland, Ohio

CIRCLE NO. 465

VCOs

Varactor-tuned solid-state sources for applications from 0.2 to 20 GHz are described in a 12-page brochure. Curves depicting typical power output/tuning voltage characteristics, package outline drawings and specifications are included. Watkins-Johnson, Palo Alto, Calif.

CIRCLE NO. 466

Permanent magnets

Characteristics of ceramic permanent magnets and specific features and applications for nonoriented, fully oriented and partially oriented magnets are given in a four-page brochure, Stackpole Carbon Co., Kane, Pa.

CIRCLE NO. 467

Thermometers

Specifications, prices and ordering data for thermistor thermometers and temperature controllers for precise measurement and control through −80 to +150 C are described in a four-page catalog. Yellow Springs Instrument Co., Yellow Springs, Ohio.

CIRCLE NO. 468

Rf semiconductors

A 16-page catalog and selection guide on rf semiconductors describes hyperabrupt tuning diodes, chips for hybrid circuits and LIDs for hybrid circuits. The catalog contains a description of all type numbers and is illustrated with electrical characteristics and application information. A complete cross-reference chart is included. KSW Electronics, Burlington, Mass.

CIRCLE NO. 469

Sockets and connectors

A four-page short-form catalog features key socket and connection products and comes complete with technical data and pricing. Robinson-Nugent, New Albany, Ind.

CIRCLE NO. 470

Carbon-film resistors

Performance characteristics of carbon-film resistors are described in a data sheet. A wide range of resistance values are available and standard EIA color coding is used. Sakata International, Elk Grove Village, Ill.

CIRCLE NO. 471

Power systems

Static uninterruptible power systems (UPS) and sine-wave static inverters are described in a brochure. Schematics illustrate four types of UPS available: basic continuous, manual transfer, automatic transfer and redundant parallel systems. NIFE, Copiague, N.Y.

CIRCLE NO. 472

Transformers

A 24-page brochure provides information for the specification and selection of dry-type transformers. The bulletin includes a question-and-answer section, proper transformer sizing and problem applications. Acme Electric, Cuba, N.Y.

CIRCLE NO. 473

Hybrid components

Standard and custom hybrid components including oscillators, comb generators, bite modules, i-f amplifiers and i-f systems are featured in an eight-page catalog. Specifications are given on each model with curves where necessary. Trak Microwave Corp., Tampa, Fla.

CIRCLE NO. 474

Digital timers

Programming instruments and controls, timers, clocks, counting and measuring devices are featured in a six-page catalog. Also included is a list of modular display units for custom digital instrumentation and a section outlining digital clocks, multimeter and frequency counter kits. E S Enterprises, Inglewood, Calif.

CIRCLE NO. 475

Service monitor

A six-page color brochure describes many features that make the Model S-1327A series service monitor the answer to FM servicing needs. Motorola, Schaumburg, Ill.

CIRCLE NO. 476

Male/female standoffs

A selection of precision male-to-female standoffs is found in a 12-page catalog. Tables, illustrations and schematics give details on metal and plastic materials, platings and finishes, standard lengths, diameters and thread sizes. Unicorp, Orange, N.J.

CIRCLE NO. 477

NEW LITERATURE

Circuit assemblies

A four-page rectifier bridge cross-reference shows replacement capability of a line of molded low power circuit assemblies. The cross-reference lists over 250 devices including the competitive part number, the IR part number and the IR case style. Also shown is a photograph of the various devices. International Rectifier, El Segundo, Calif.

CIRCLE NO. 478

Half-dip reed relays

A two-page illustrated bulletin gives design information on a half-dip reed relay. The bulletin tabulates coil characteristics, contact ratings and life expectancy. It gives socket diagrams as well as full dimension drawings. Options, including clamp diodes, are discussed. Struthers-Dunn, Pitman, N.J.

CIRCLE NO. 479

Die cutting

Custom die cutting of films and pressure sensitive materials for use in a broad range of applications is described in a six-page brochure. Webtek Corp., Los Angeles, Calif.

CIRCLE NO. 480

Indicators

LED indicators, lamps, switches and panel displays; incandescent, neon and LED digital readouts in heights from 0.27 to 3 inches; conventional and transistorized switches and indicators; plus lamps and displays are featured in eight-page brochure. TEC, Tucson, Ariz.

CIRCLE NO. 481

Industrial adhesives

Typical end uses of 11 versatile industrial adhesives are described in a two-color, two-page bulletin. Overlap shear strengths, T-peel strengths and 180° peel strengths at various operating temperatures and cure times are listed for the adhesives in easy-to-read table form. Another table lists application methods, color, solids content, consistency, coverage and bonding range. 3M Co., St. Paul, Minn.

CIRCLE NO. 482

Data sets

An eight-page short-form catalog describes 300, 1200, 2400 and 4800 bps data sets that are compatible with Bell models, and includes other specialized data-communications products. Tele-Dynamics, Fort Washington, Pa.

CIRCLE NO. 483

Data-conversion equipment

A 12-page short-form catalog covers data conversion and high-speed signal conditioning equipment. Included are specifications for d/a and a/d converters, synchro converters, hybrid synchro converters, instruments, operational amplifiers and an outline of the company's total data conversion systems capability in commercial and MIL-grade specifications. ILC Data Device Corp., Hicksville, N.Y.

CIRCLE NO. 484

Position transducers

Linear variable differential transformer precision gauge heads for position transducers are described in a catalog. Outline drawings and specifications for over 30 different models are shown. Tabular data, cutaway sketches and wiring diagrams are used to describe the theory of operation and typical gauging systems. Schaevitz Engineering, Camden, N.J.

CIRCLE NO. 485

Dc control motors

Five 4-page illustrated publications include features and applications of dc control motors. Modular selection guides with characteristics as well as intrinsic and derived parameters, listings of analog and digital tachometer characteristics, frequency response charts, thermal data graphs, mounting dimensions and suggestions on securing application assistance are included. Micro Switch, Freeport, Ill.

CIRCLE NO. 486

Electronic calculator

The 1145 compact electronic printing calculator is detailed in a four-page brochure. A detailed step-by-step diagram gives examples of calculations that can be performed on the machine. Facit-Addo, Secaucus, N.J.

CIRCLE NO. 487

Heat pipes

"Heat Pipe Technology for Industry" explains what a heat pipe is, different types of heat pipes, and how they may be applied to a variety of industrial uses. Numerous illustrations show applications in which heat pipes are already proven useful. Hughes Electron Dynamics Div., Torrance, Calif.

CIRCLE NO. 488

Portable recorders

Features, photos and specifications on portable recorders are given in a 12-page catalog. Full specifications are provided on all plug-in preamps presently available, and a general discussion of the company's concept of recorder design is included. Gulton Industrial Systems Div., East Greenwich, R.I.

CIRCLE NO. 489

Feed-thru filters

Updated to include new configurations and improved performance, data sheet 73-133 describes the physical and electrical characteristics of series 55 miniature feed-thru filters. Capitron Div. of AMP, Elizabethtown, Pa.

CIRCLE NO. 490

Rf capacitors

The Rf Capacitor Handbook details specific design considerations and criteria to further knowledge in the field of circuit design. The handbook is divided into four main categories: topic locators, design equations and explanatory text, test data for circuit design and additional design aids. American Technical Ceramics, Huntington Station, N.Y.

CIRCLE NO. 491

Instrumentation head

A specification sheet describes a 2-MHz 14-channel wideband head assembly. Infomag, Pomona, Calif.

CIRCLE NO. 492

Pushbutton switches

The series D200 heavy duty momentary switches is described in a two-page catalog. Dimensional diagrams, schematics and pertinent data are contained in easy-to-follow tabular form. Control Switch, Folcroft, Pa.

CIRCLE NO. 493

bulletin board

A computer system for scientific calculations, having twice the speed of systems costing five times as much, has been announced by **Digital Equipment Corp.'s Education Products Group.** FORTRAN ENGINE is based on the company's EduSystem-25 configuration, with a floating point processor, OS/8 FORTRAN IV software and a RK8-E disc cartridge system. System prices begin at $37,085.

CIRCLE NO. 494

A software program, DATACOM, enabling computer-output-microfilm users to convert print tapes or raw data files to microfilm or microfiche without any programming effort or post-processing of computer-generated tapes, has been announced by the **Business Systems Div. of Pertec Corp.** Designed for use with the Pertec 3700 COM system, DATACOM is a fully programmed software program for IBM 360/370 systems that use parameter cards. The cards define formatting requirements for an application including report page layout and film format.

CIRCLE NO. 495

Eight **CMOS ICs** for military applications have been introduced by **Texas Instruments.** Six of these circuits are pin-for-pin replacements for Series 4000 and 14000 equivalents. Offered in hermetic dual-inline packages, these circuits feature low-power dissipation of 50 nW typ, 3 to 15 V operation, noise immunity of approximately 45% of the supply voltage, high-input impedance, and up to 10 MHz operation.

CIRCLE NO. 496

The **E series of miniaturized power modules** manufactured by **Acopian Corp.** has been expanded to provide outputs ranging from 1.5 to 28 V at current ratings to 1.5 A. Duals offer ±12 or ±15 V outputs at current ratings of 300 and 350 mA.

CIRCLE NO. 497

Bowar Instrument Corp., has introduced a line of **calculator keyboards** in new colors and new sizes for manufacturers of hand-held calculators.

CIRCLE NO. 498

Motorola Semiconductor Products is supplying 13 **MECL 10,000 integrated circuits in small flat-packs.** These devices have high packaging density, meet MIL-temp range of −55 to +125 C, are hermetically sealed and weigh less than previously available packages.

CIRCLE NO. 499

Two new **transistor arrays,** the SG3081 and SG3082, from **Silicon General** are suited for driving all types of seven-segment displays. The devices are electrical and pin-for-pin equivalents to the RCA CA3081 and CA3082.

CIRCLE NO. 500

Fairchild Camera & Instrument Corp. has announced it is raising distributor cost on **TTL and DTL SSI products** by an average of about 15% across SSI product lines.

CIRCLE NO. 501

Iomec has announced the first deliveries of its **Iodisc Series 3000 minicomputer cartridge disc drive** with 200 track-per-inch recording capability. The 200 tpi technology allows the user to effectively double the storage capacity of a cartridge disc drive from 48 to 96 megabits, using four disc surfaces.

CIRCLE NO. 502

An integrated-circuit timer with an output capable of sourcing or sinking up to 200 mA is available from **National Semiconductor Corp.,** 2900 Semiconductor Dr., Santa Clara, Calif. 95051. Called the LM555, the monolithic integrated circuit may be employed as a monostable one-shot time delay or as an astable oscillator.

Six **TTL integrated circuits** for use in data-processing equipment are now available in quantity from **Signetics Corp.,** 811 E. Arques Ave., Sunnyvale, Calif. 94086. Each of the circuits is completely compatible with most TTL and DTL families.

Carter Semiconductor has entered the LED market with a new **gallium-phosphide red diffused LED** in a molded-plastic package. It is a direct replacement in applications where Monsanto, Litronix and Fairchild LEDs are now used.

CIRCLE NO. 503

Ferrite cores from **Magnetics** have made it possible to reduce the size of oscilloscopes. The cores are used in two circuits in the Tektronix Model 212—a gapped ferrite pot core is used in the dc-dc inverter main power transformer and an ungapped ferrite pot core is used in a rejection transformer for a two-way line filter.

CIRCLE NO. 504

ITT Semiconductor has introduced 12 **LED display drivers**—six segment drivers and six digit drivers—designed to interface between MOS and LED displays. The segment/digit drivers range from 9 to 18 V and 3.8 to 250 mA operation.

CIRCLE NO. 505

TEL-1, a software package that allows an 810 programmable terminal processor controlling up to four of the company's printers to operate with Bell's BISCOM system, has been announced by **Sanders Data Systems.**

CIRCLE NO. 506

A family of junction **field-effect transistor high-speed switches** from **Intersil** has been qualified to JAN-TX specifications. The JAN-TX 2N4091, 2N4092 and 2N4093 are n-channel FETs with maximum ON resistances from 30 to 100 Ω, leakage current of 200 pA and switching speeds of 40, 60 and 80 ns, respectively.

CIRCLE NO. 507

American Electronic Laboratories, Inc., Product Assurance Div. has announced a **service that provides functional and parametric testing** of all families of digital integrated circuits.

CIRCLE NO. 508

Omnitec Corp. has announced a **coupler subassembly** to meet terminal manufacturers' circuit specifications and PC-board configurations.

CIRCLE NO. 509

Mirco, Inc. has announced that its **FLASH II software package,** used in the generation of test programs to determine and identify faulty components on printed-circuit boards, is now available for the first time on a lease, purchase or lease-buy basis.

CIRCLE NO. 510

Improved materials and processes allow **Sprague** to offer a new series of extended capacitance ratings in its type **150D hermetically sealed solid-electrolyte Tantalex capacitor** lines. These capacitors meet MIL-C-39003C.

CIRCLE NO. 511

Price reductions

Inter-Computer Electronics Inc., a subsidiary of American Electronic Laboratories, Inc., has reduced the price of its **pulse transient recorder,** model PTR 9200, to $9300 from $9850.

CIRCLE NO. 512

RCA Solid State Div. has added a new series to its **sensitive-gate SCRs.** The 4-A SCRs have types with voltage ratings of 15, 30, 50, 100, 200, 300, 400, 500 and 600 V and use the standard JEDEC TO220AB package. The dc gate-trigger current for this series is 2000 μA, maximum, at a case temperature of 25 C.

CIRCLE NO. 513

Berkey Photo, Inc., Keystone Div. has reduced prices on its **electronic pocket calculators.** The Model 350 has been reduced to $94.95 from $119.95; Model 370 reduced to $99.95 from $139.95 and Model 390 reduced to $119.50 from $159.95.

CIRCLE NO. 514

Burr-Brown has cut prices 20% on its **16-bit/4-digit integrating a/d converter.** Prices for the ADC100 now start at $175.

CIRCLE NO. 515

Litronix has announced price reductions ranging up to 23% for six **IL-series opto-isolators.** The IL-1 has been reduced to $1.20 from $1.55; IL-5 reduced to $1.40 from $1.75; IL-12 reduced to 95¢ from $1.19; IL-15 reduced to $1.05 from $1.25; IL-16 reduced to $1.25 from $1.50; IL-74 reduced to 90¢ from $1.

CIRCLE NO. 516

vendors report

Annual and interim reports can provide much more than financial-position information. They often include the first public disclosure of new products, new techniques and new directions of our vendors and customers. Further, they often contain superb analyses of segments of industry that a company serves.

Selected companies with recent reports are listed here with their main electronic products or services. For a copy, circle the indicated number.

Spar Aerospace Products Ltd. Mechanical subsystems and ground-support equipment, hf and vhf antennas, and gearbox dual-propeller transmission systems.

CIRCLE NO. 517

ARINC Research Corp. Design and analysis.

CIRCLE NO. 518

Solid State Scientific Inc. CMOS, semiconductors, oscillators, counters, shift registers, static CMOS memories, rf transistors and displays.

CIRCLE NO. 519

Burroughs. Business machines, computers, terminal systems, data storage and peripherals and components.

CIRCLE NO. 520

Storage Technology Corp. Tape and disc drives and semiconductor memory systems.

CIRCLE NO. 521

Western Union International. International communications, radio paging and mobile radio services.

CIRCLE NO. 522

Systems Engineering Laboratories. Computer systems, automotive electronics, telemetry, simulators and defense support equipment.

CIRCLE NO. 523

Computer Optics, Inc. Computer-related products.

CIRCLE NO. 524

Universal Instruments Corp. Components, electronic assemblies, contract instrumentation and metalworking.

CIRCLE NO. 525

Mohawk Data Sciences Corp. Data-entry and dedicated data-processing systems.

CIRCLE NO. 526

Advanced Micro Devices, Inc. Monolithic integrated circuits, linear ICs, MSI, computer-interface circuits, MOS/LSI and bipolar memories.

CIRCLE NO. 527

On-Line Systems Inc. Computer time-sharing services.

CIRCLE NO. 528

Gates Learjet Corp. Aircraft electronics and aircraft.

CIRCLE NO. 529

ARi Industries, Inc. Cable, heaters and antipollution products.

CIRCLE NO. 530

Ampex. Computer peripheral equipment, magnetic tape, professional video products, on-line tape mass-memory storage systems and instrumentation recorders.

CIRCLE NO. 531

North American Philips Corp. High-intensity discharge lighting, components, motors, switches, keyboards, LEDs, information and data systems, electro-optics, medical electronics, instrumentation, materials and consumer products.

CIRCLE NO. 532

Sperry Rand Corp. Aerospace, semiconductor wafer processing, laser holography, planar gas-discharge displays, computers and consumer products.

CIRCLE NO. 533

Morse Electro Products Corp. Stereo and quadraphonic systems, switches and cabinets.

CIRCLE NO. 534

Informatics. Computer systems and software.

CIRCLE NO. 535

Computer Sciences Corp. Nationwide remote data-processing network and computer systems.

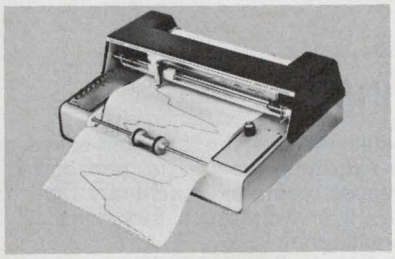
CIRCLE NO. 536

Aeronautical Radio, Inc. (ARINC). Air-ground-air communication service, electronic switching systems, intercity communications and weather wire service.

CIRCLE NO. 537

quick ads

New and current products
for the electronic designer
presented by their manufacturers.

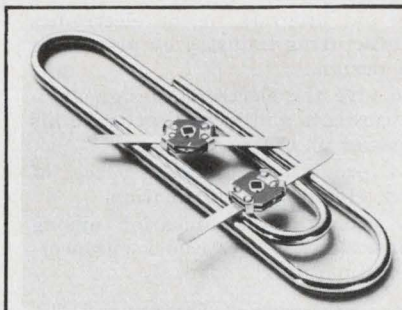


OmniScribe™ Strip Chart Recorder provides low cost, high quality for industrial, chemical, medical. biochemical, physiological and university laboratories. Prices start at $395 which is half of competition. Features include multi-speed chart drive, sprocketless paper feed and a re-balance element to replace the potentiometer. Houston Instrument, 3950 Terminal Ave., Bellaire, Texas 77401. (713) 667-7403

INFORMATION RETRIEVAL NUMBER 151

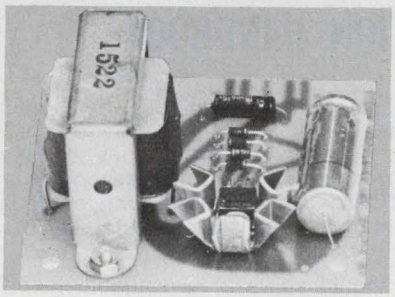
New free catalog containing specifications for over 60 models of single, dual and triple output AC to DC power modules. MIL Electronics, Inc., Lowell, Mass. 01854. (617) 453-4142.

INFORMATION RETRIEVAL NUMBER 152



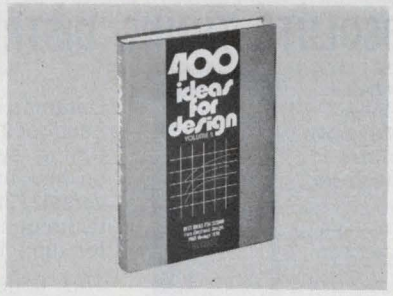
Thin-Trim variable capacitors provide a reliable means of adjusting capacitance without abrasive trimming or interchange of fixed capacitors. Series 9401 has high Q's and a range of capacitance values from 0.2-0.6 pf to 3.0-12.0 pf and 250 WVDC working voltage. Johanson Manufacturing Corporation, Boonton, New Jersey (201) 334-2676.

INFORMATION RETRIEVAL NUMBER 153



5 watt regulated power supplies. Low cost power supplies designed around 7800 series of voltage regulators, these units are available in 5, 6, 8, 12, 15, 18, and 24 volts with a 5 watt output rating. Short circuit protected. $9.75 in unit quantity. ELCOM Industries, Inc., Civil Air Terminal, Bedford, Ma. (617) 274-6656.

INFORMATION RETRIEVAL NUMBER 154

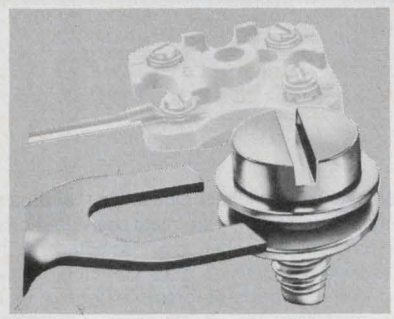


400 Ideas for Design, Vol. 2, Edited by Frank Egan. Ready to borrow, modify, or adapt, the top recent contributions to Electronic Design's popular "Ideas for Design" column range from amplifiers to switching circuits. 288 pp., illus., cloth, $11.95. Circle below for 15-day examination copies. Hayden Book Co., New York, N.Y. 10011.

INFORMATION RETRIEVAL NUMBER 155

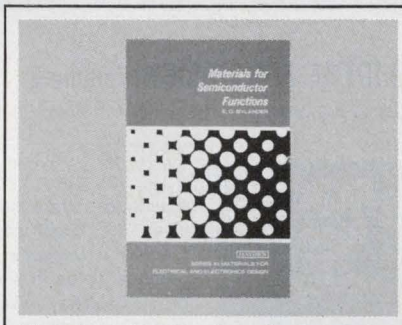
The Pulsecom Model 461-6 Automatic Message Numbering Device electronically inserts station identification and message numbers. This device saves operator time, and prevents mistakes. The 461-6 operates at 45-1200 Baud with most terminals. PULSECOM, 5714 Columbia Pike, Falls Church, Va. 22014. 703-820-0652.

INFORMATION RETRIEVAL NUMBER 156



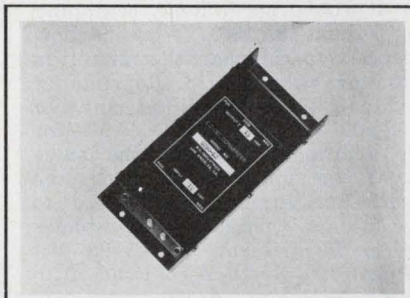
Spade-Sert by Sems simplifies electrical connections with 2 washers which automatically space themselves for easiest insertion of spade connector or wire. Close tolerance eliminates troublesome wire cutting. Washer surfaces are precision beveled, free from rough edges and burrs. Sems Div. Camcar Srew & Mfg. 1818 Christina, Rockford, Ill. 815-226-2400

INFORMATION RETRIEVAL NUMBER 157



Materials for Semiconductor Functions, by E. G. Bylander. Practical handbook for selecting materials for diodes and transistors for applications in amplifiers, generators, and multi-junction devices. 220 pp., 6 x 9, illus., cloth, $13.50. Circle number below for 15-day examination copy. Hayden Book Company, Rochelle Park, N.J. 07662.

INFORMATION RETRIEVAL NUMBER 158



30 watt DC/DC converter. ±15 vdc output at 1 amp load with external heat sink. Short circuit protected. 10 mv line/load regulation. Filtered input and output. 12 V to 28V input models. Protected against input over-voltage. Size 2.7 x 5.8 x 1.2 inches. $119 ea (1 to 9). B. H. INDUSTRIES, Los Angeles, CA, 213-479-8278.

INFORMATION RETRIEVAL NUMBER 159

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CIRCLE NO. 174

PRINCETON APPLIED RESEARCH CORPORATION
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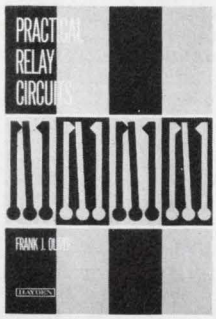
PRACTICAL RELAY CIRCUITS

By Frank J. Oliver



Uniquely groups various relay circuits according to the functions they perform, enabling the systems designer to quickly select the best circuit for his specific purposes. Includes arc and RFI suppression systems; time delay function; audio tone control and resonant-reed relays; sequential relays; protective functions of relays against overload overvoltage, and overcurrent, pulse generation and detection; logic circuits; and more. Particularly important is coverage of pulse-operated relay systems now extensively used with automated control systems. Illustrated with many circuit diagrams using the latest American National Standard graphical symbols. 363 pp., 6 x 9¼, illus., cloth, $14.95. **Circle the reader-service number to order a 15-day examination copy.**

CIRCLE NO. 175

HAYDEN BOOK COMPANY, INC., 50 Essex St., Rochelle Park, N.J. 07662

NEW, GENERAL PURPOSE, LOW-NOISE AMPLIFIER

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- 1 V RMS at 1 ma.
- Less than 0.1% distortion.
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The Model 206 C is powered by two internal mercury batteries, with a life expectancy of 2000 hrs. A front panel pushbutton and lamp provides a check on battery condition. Always ready, the Model 206 C can be added to test instrumentation when additional gain is required, without introducing more problems than benefits.

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recruitment and classified Ads

equipment for sale

product index

Information Retrieval Service. New Products, Evaluation Samples (ES), Design Aids (DA), Application Notes (AN), and New Literature (NL) in this issue are listed here with page and Information Retrieval numbers. Reader requests will be promptly processed by computer and mailed to the manufacturer within three days. *Appears in the International Technology Section outside the USA.

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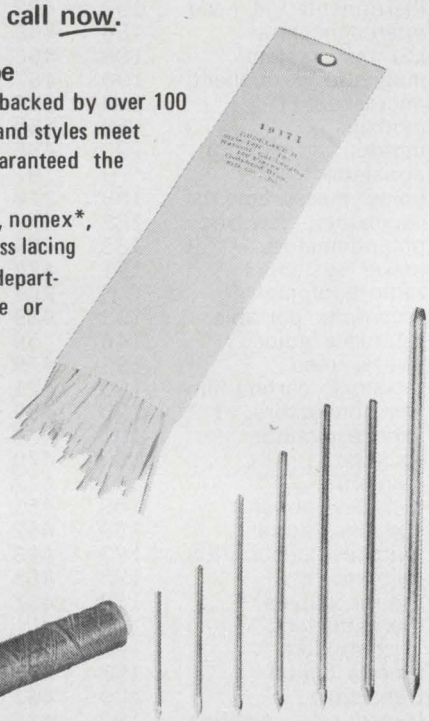

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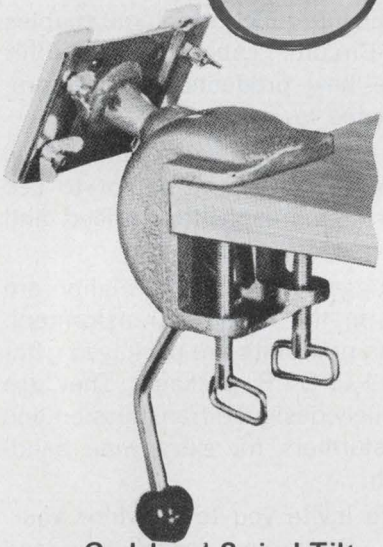

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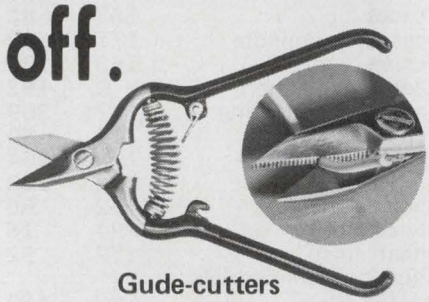

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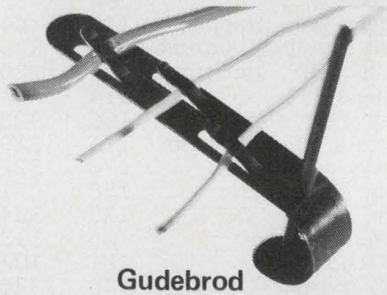

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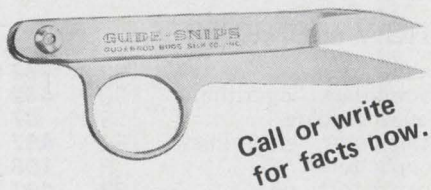

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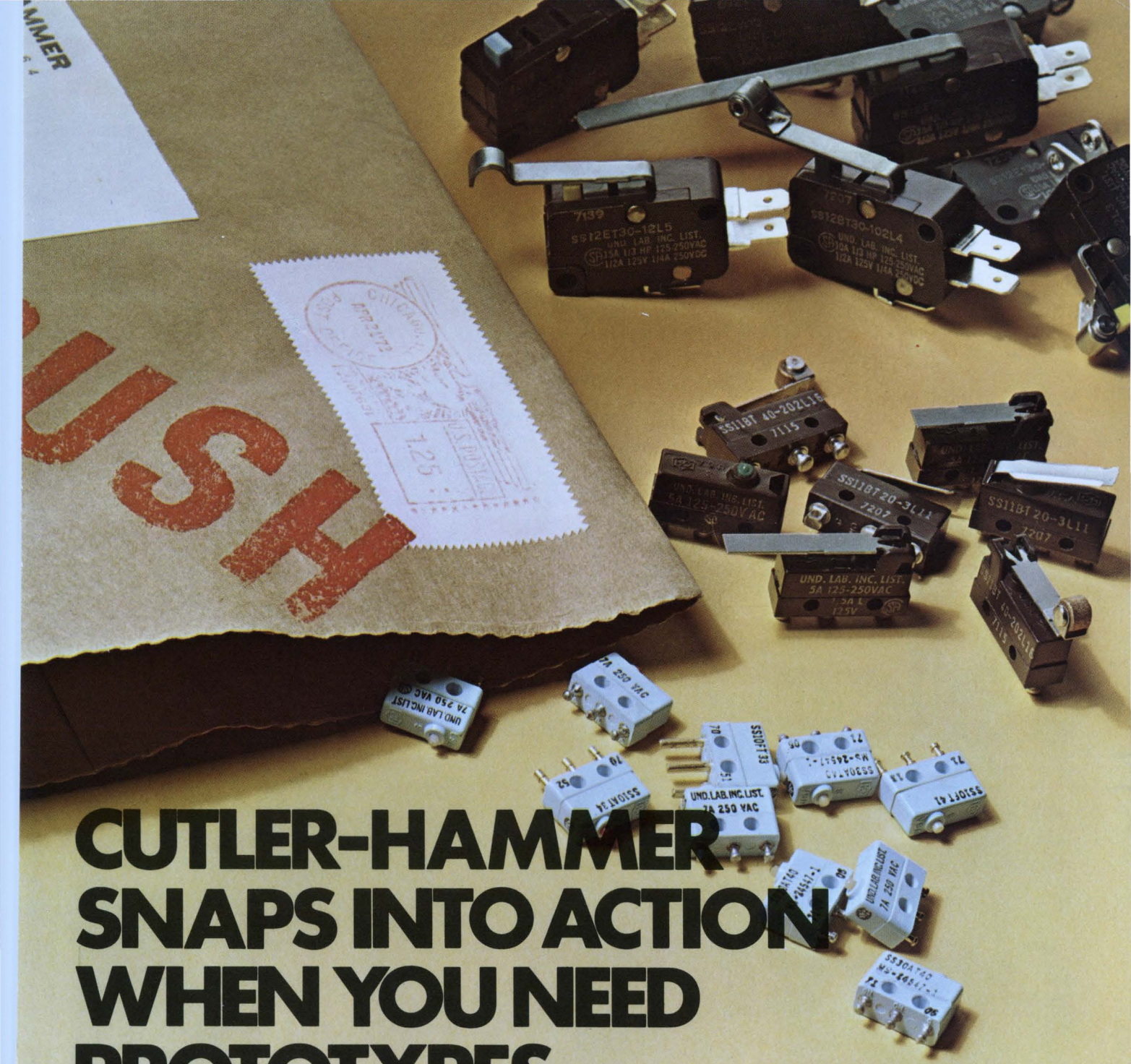

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PANEL DISPLAYS

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