

Electronic Design 16

VOL. 20 NO.

FOR ENGINEERS AND ENGINEERING MANAGERS

AUG. 3, 1972

Consumer electronics is hot. An industry of innovation--it's turning out new items and revolutionizing older ones. Video-tape and disc recording, home-security systems,

quadrasonics, the all-electronic kitchen--these are some of the developments that are opening new opportunities for designers. For a special report, see page 24



Do you face a make or buy decision on power supplies?

BUY LAMBDA'S NEW LOW COST LQ 5000 SERIES

ferroresonant dc power supplies
up to 25 amps...up to 48 volts...from \$100 to \$125

LQ 5000 SERIES

Regulated voltage

regulation, line . . . 2% for line changes from 105 to 132 VAC for any load between 25% and 100% of full load.

regulation, load . . . 5% from 1/2 load to full load or full load to 1/2 load (LQS-DA-5106 is 0.5V).

ripple and noise 2% RMS (LQS-DA-5106 is 500mV).

Frequency coefficient

2.4%/ cycle max.

Accuracy

±2% at 25°C, 115 VAC, 60Hz input and 100% load.

AC input

line 105 to 132 VAC; 59 to 61 Hz.

Size

5" X 7 1/2" X 10".

Ambient operating temperature range

0°C to 60°C; consult factory for operations above 40°C.

Overvoltage protection

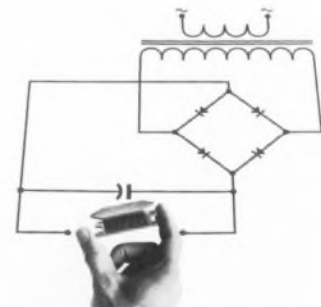
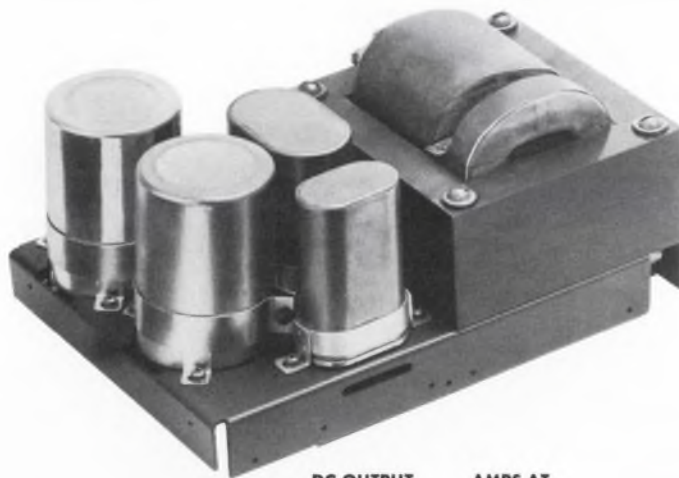
supply is inherently overvoltage protected; any internal component failure results in loss of power supply output voltage at power supply terminals.

Overload protection

all units automatically limit output current upon external overloads, including short circuit, protecting load as well as supply.

Mounting


one mounting surface (three mounting positions) designed to mount in the following Lambda standard rack adapters: LRA-10, LRA-6, LRA-11, LRA-7.



LQ 5000 SERIES	MODEL	DC OUTPUT VOLTAGE	AMPS AT 40° C	PRICE
Single output voltage models 5" x 7 1/2" x 10"	LQS-DA-5124	24	5	\$100
	LQS-DA-5128	28	5	100
	LQS-DA-5148	48	2.5	100
	LQS-DA-5106	6	25	125
	LQS-DA-5324	24	10	125
	LQS-DA-5328	28	10	125
	LQS-DA-5348	48	5	125

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INFORMATION RETRIEVAL NUMBER 246

Discover the value of power...



and how it saves you money on your mini.

Discover the all-new SPC-16 family of minicomputers. The first minis to save you substantial money in system implementation. They're from General Automation... the fast-growing, pace-setting mini maker.

If you compare SPC-16's with those other two much-ballyhooed brands of minis, you'll discover it's no contest. In overall performance, SPC-16's win every time. And no wonder. The SPC-16's ultra-fast interrupt response system for multilevel interrupt response is one winning feature. Another is base relative addressing. Another is a unique one-word Load All Registers/Store All Registers capability. Plus eight (16 optional) true general purpose registers that can save you up to 4K (about \$2500 worth) of core. And much more.

Including the right price, the best quantity discounts in the industry and the easiest OEM buying policy of all.

SPC-16's are available as I/O and memory-integrated models for dedicated in-house applications. Or as unbundled versions for OEM users or large system applications requiring up to 65K of memory. Six models in all, in three speeds.

No other minis come close to SPC-16's in giving you so much performance for your money. Give us a benchmark, we'll prove it. Meantime, send today for a detailed brochure.



GENERAL AUTOMATION, INC. 1055 So. East Street, Anaheim, Ca. 92805 (714) 778-4800 TWX 910-591-1695
'Discover The Value Of Power'

INFORMATION RETRIEVAL NUMBER 2

100% ac testing of consumer ICs

Is it really necessary? Is it practical? Is it available?

Sample testing of TV and radio parts is no way to ensure a good night's sleep. Ideally, both makers and users of consumer ICs should test every device for ac characteristics.

But 100% ac testing sounds expensive, so what do people do? They compromise.

They tighten up on AQL specs.

They make dc correlations instead of true ac tests.

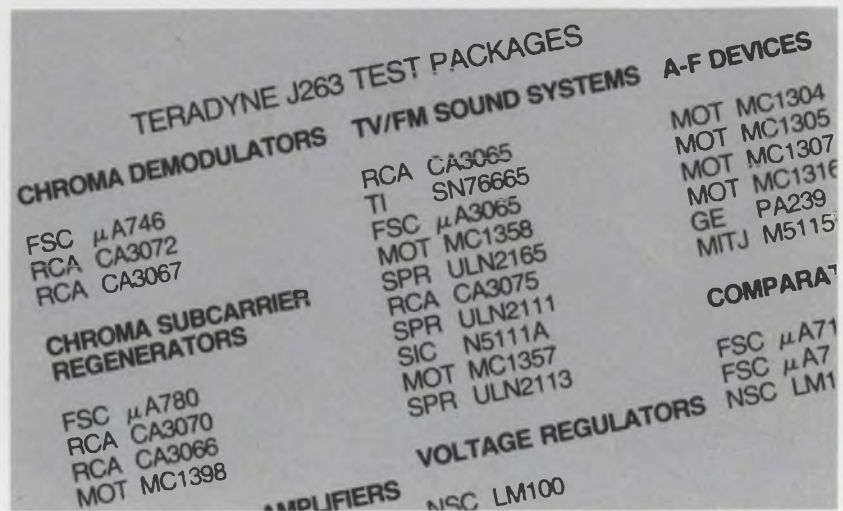
If the return rate climbs, or if bad parts show up in the finished product, they shout a little louder at the vendor or the inspector or the QC manager.

There's a better way.

Our J263 will automatically test for every ac spec from stereo channel separation to chroma demodulation angle to video i-f gain. And it will do it so fast that 100% testing is economically practical.

On an IC production line, the J263 will even wafer probe, and it will multiplex to as many as seven stations.

In incoming inspection, the J263 will datalog chapter



and verse on all your suppliers, so you'll know who's shipping you what.

Backing up the J263 is a long list of test packages. They include the applications hardware and software for just about any consumer IC on the market. All the tests have already been worked out with the key producers and users, so you start off with a thoroughly proven, debugged installation.

If the alternatives to 100% ac testing are getting you down, tell us to rush you a J263 brochure. It illustrates again that in testing, the best solution is always an honest one.

Write: Teradyne, 183 Essex St., Boston, Mass. 02111.

TERADYNE

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Cover: Photo by Camera Assoc., Courtesy of General Electric

Delco's
TO-66 silicon
transistors for

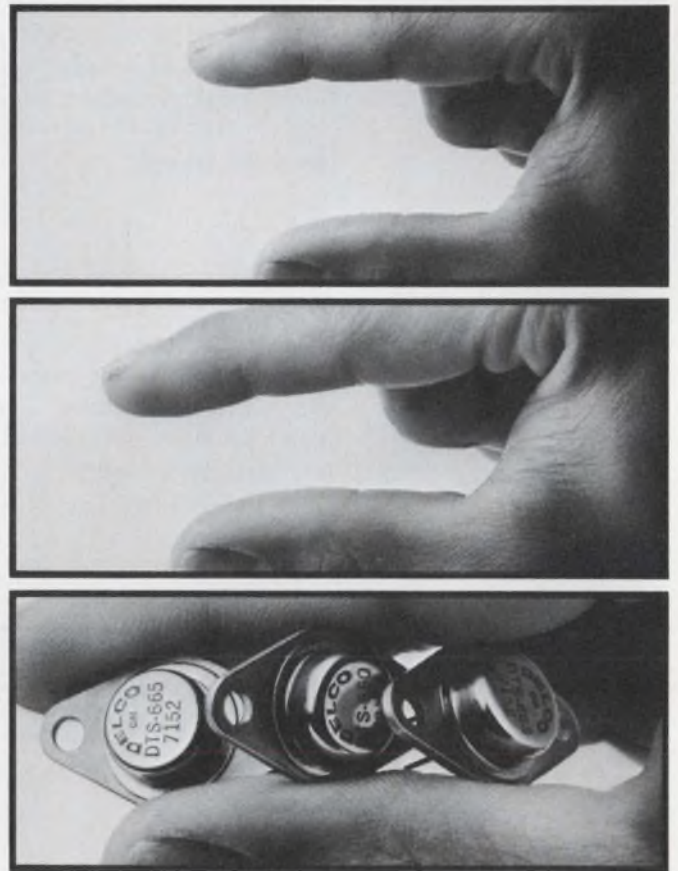
BIG POWER

Now the high-energy capability of Delco's silicon power transistors is available in the TO-66 package.

Like all the Kokomoans' silicon power transistors, they're triple diffused and built to survive the most rugged applications. Their high-voltage ratings make it practical to operate them directly from rectified 117-volt or 220-volt ac line. This allows lower weight and smaller circuit size because fewer, less bulky components are required than with low-voltage higher current systems. And, their energy capability is backed by the surest rating in the business—Pulse Energy Testing.

Use the new DTS-660 series when you need the high-voltage capability of our DTS-410, DTS-423 or DTS-425 but, in TO-213MA (TO-66) size.

They're in stock at Delco distributors now. For additional information, prices, and complete data, give yours a call or contact us at our nearest regional office.



Type	$I_c(\text{Cont})$ 1 Peak	V_{CE0}	h_{FE} @ $I_c=1.0A$ min./max.	$V_{CE0}(\text{sus})$ min.	P_D min.	Suggested resale price 1-99 quantity
DTS-660	3.5A 10.0A	200V	30 90	200V	60W	\$5.93 ea.
DTS-663	3.5A 10.0A	400V	30 90	325V	60W	\$9.57 ea.
DTS-665	3.5A 10.0A	500V	30 90	400V	60W	\$14.94 ea.

NPN triple-diffused silicon transistors in JEDEC TO-213MA (TO-66) packages.

IN SMALL SPACES



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DIVISION OF GENERAL MOTORS CORPORATION, KOKOMO, INDIANA

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INFORMATION RETRIEVAL NUMBER 4

Our Bill Shuart doesn't work for Power/Mate.



**He works only for you...
and that's the way the new Power/Mate
wants it.**

Bill is the Power/Mate Quality Assurance Manager and he has 34 supervisors and perfectionists under him.

They also work for you.

The result is unexcelled and consistent quality that we at Power/Mate are genuinely proud of.

Bill does a lot more than making sure our products are produced in accordance with his high standards of workmanship. (He wrote the book on that too.)

Bill has developed a series of courses for all our employees on soldering techniques and workmanship standards.

□ He has developed a computer failure analysis program to insure that our vendors also maintain the consistent high quality you should expect when you use our power supply in your product.

□ He oversees the continuing MTBF studies (by computer of course) and worst case calculations on all our power supplies to insure the long life and trouble free performance you should expect.

□ He has developed a thermally cycled burn-in rack in which we subject *all* of our power supplies for 24 hours before shipment to insure there are no premature field failures.

□ He oversees the random sampling of all production-run power supplies. These are subject to a continuous night and day life test . . . for your continued assurance of a long-lived trouble free product.

We could go on . . . but we at Power/Mate are glad he works for you. That's why we can give a five year no-holds warranty.

THE NEW **P/M/C**
POWER/MATE CORP.

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across the desk

A WOM from Signetics

We normally don't cover important new products in this section of ELECTRONIC DESIGN. But a new Signetics WOM, we felt, deserves special attention. It is described in a recent data sheet for the 25120, a fully encoded 9046 X N, random-access, write-only memory. Signetics points out that this is a final specification—and adds the footnote, "until we get a look at some actual parts."

The product is sufficiently unusual to merit substantial abstracting from the data sheet with only slight modification. It follows:

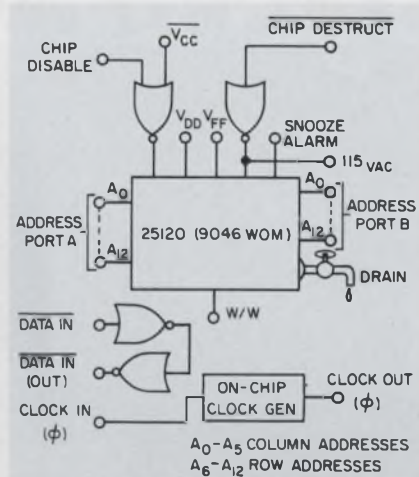
DESCRIPTION

The Signetics 25000 Series 9046 X N Random-Access Write-Only Memory employs both enhancement and depletion mode, p-channel, n-channel and neu¹ channel MOS devices. Although a static device, a single TTL-level clock phase is required to drive the on-board multiport clock generator. Data refresh is accomplished during CB² and LH² periods. Quadri-state outputs (when applicable) allow expansion in many directions, depending on organization.

The static memory cells are operated dynamically to yield extremely low power dissipation. All inputs and outputs are directly TTL compatible when proper interfacing circuitry is employed. Device construction is more or less SOS³.

FEATURES

- Fully encoded multiport addressing
- Write cycle time 80 ns (max. typ.)
- Write access time⁴
- Cell refresh time 2 ms (min. typ.)



- TTL/DTL compatible inputs⁵
- Available outputs, n
- Clock capacitance 2 pF max.⁶
- V_{CC} = +10 V
- V_{DD} = 0 V ± 2%
- V_{FF} = 6.3 V ac

APPLICATIONS

- Don't care buffer stores
- Least-significant control memories
- Post-mortem memories (Weapons systems)
- Artificial-memory systems
- Non-intelligent micro controllers
- First-In Never-Out (FINO) asynchronous buffers
- Overflow register (bit bucket)

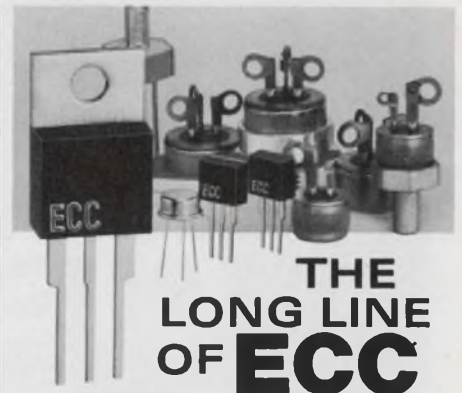
PROCESS TECHNOLOGY

The use of the unique SEX⁷ process yields V_{th} (var.) and allows the design and production⁸ of higher performance than can be obtained with competitors' techniques.

BIPOLAR COMPATIBILITY

All data and clock inputs plus applicable outputs will interface directly or nearly directly with bipolar circuits of suitable character-

(continued on p. 10)



THE LONG LINE OF ECC

Sensitive and Standard Gate

SCR's

Fast delivery and competitive prices make ECC's extensive line of SCR's your best buy.

SENSITIVE GATE SCR's

TO-5 Metal; 5/8" Hex Stud; THERMOPAK* and THERMOTAB® Packages

- I_{T(RMS)} 0.8 - 10 amps
- I_{GT} 50, 200, 1500 μamps max
- I_{TSM} 50, 100 amps min
- V_{DOM} 30 - 600 volts min

STANDARD GATE SCR's

TO-5 Metal; 5/8" Hex Stud; THERMOPAK and THERMOTAB; 1/2" Press-Fit and Stud; 3/4" Press-Fit, Stud and TO-3 Packages

- I_{T(RMS)} 0.8 - 35 amps
- I_{GT} 10, 25 ma max
- I_{TSM} 50 - 325 amps min
- V_{DOM} 30 - 800 volts min

5/8" Hex Stud; THERMOPAK and THERMOTAB; 3/4" Press-Fit, Stud and TO-3 Packages are electrically isolated.

All ECC SCR's feature heavily glass passivated junctions for high reliability. They are available from your nearest ECC Sales Representative or Authorized Distributor.

*trademark of ECC



New Condensed Catalog contains technical data on these and other ECC semiconductors. To receive your copy, circle No. 240.

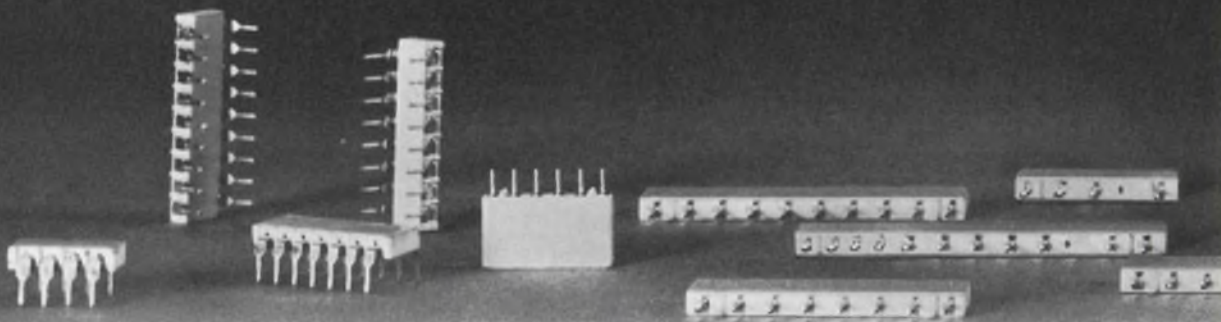
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Electronic Design welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to Managing Editor, Electronic Design, 50 Essex St. Rochelle Park, N. J. 07662. Try to keep letters under 200 words. Letters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

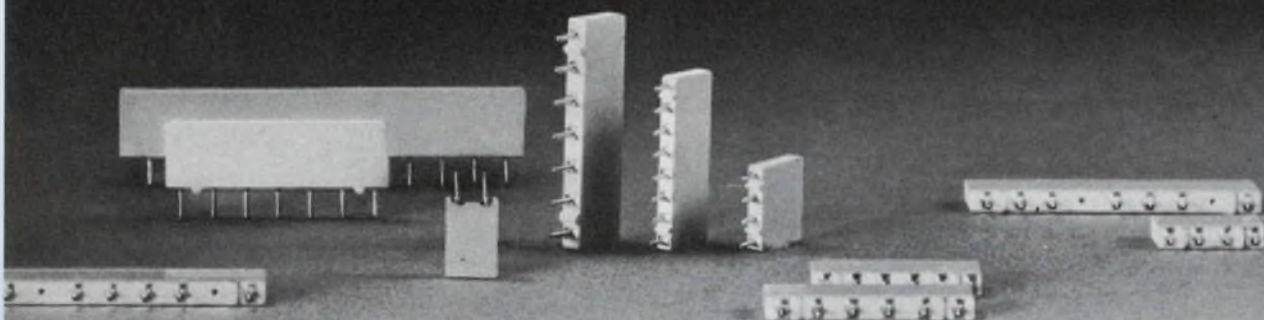
CTS has the answer in



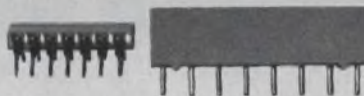
You name it—we have the exact cermet resistor network size and characteristics you need. Here's the choice you get right now: our *750 line* includes: .100" centers with 4, 6 & 8 pins; .125" centers with 2, 4, 6 & 8 pins; and .150" centers with 4 through 13 pins. And we're working on new designs right now!

All compact, extremely stable and highly reliable. Recently we packed even more circuitry into our *760 series*, giving you a choice of four popular space-saver packages: 8, 14, 16 and 18 flat lead styles. Packed with up to 17 resistors per module with flat leads standard (round leads on request).

cermet resistor networks. So ask us!



Our broad line provides an infinite number of circuit combinations, all with excellent TC, load and temperature characteristics supported by millions of hours of reliability testing. Ask your CTS sales engineer for data. Or write CTS of Berne, Inc., Berne, Indiana 46711. Phone (219) 589-3111.



ACTUAL SIZE



CTS CORPORATION *Elkhart, Indiana*

A world leader in cermet and variable resistor technology.



It's as current as a PDP-8.

These days, a computer has to keep up with the times.

Like PDP-8. It's still the most popular minicomputer ever made.

Because we keep thinking about our computers long after we put them on the production line.

We keep making improvements as we go along.

Keep developing new options. And new software.

Like OS/8, a 4th generation operating system with a new set of math routines that go 4-5 times faster than the system it replaces.

And COS/300 the new data management system for the PDP-8.

And DEC/X8, a totally new concept in systems exercisers.

And RTPS, the realtime FORTRAN IV that's faster than the giant computers.

Lower cost DECtape. Lower cost DECdisplays. Low cost DECwriters. Low cost DECmagtape. Low cost DECdisks.

Of course, there are some things about the PDP-8 that naturally keep it up-to-date. Like the OMNIBUS® structure that lets you plug in every-

thing. Anywhere. In any order. At any time.

And nobody is as careful as we are. Nobody tests their computers as much as we do. Nobody uses computers to build computers like we do.

Which should help to explain why PDP-8 is the most popular minicomputer ever made.

Read all about it.

Write Digital Equipment Corporation, Maynard, Mass. 01754. (617) 897-5111. European headquarters: 81 route de l'Aire, 1211 Geneva 26 Tel.: 42 79 50.

digital

ACROSS THE DESK

(continued from p. 7)

istics. In any event, use 1-amp fuses in all power-supply and data lines.

INPUT PROTECTION

All terminals are provided with slip-on latex protectors for the prevention of Voltage Destruction. (Pill packaged devices do not require protection.)

SILICONE PACKAGING

Low-cost silicone DIP packaging assures reliability by the use of non-hermetic sealing which prevents entrapment of harmful ions while allowing the free exchange of friendly ions.

SPECIAL FEATURE

Because of the employment of the Signetics proprietary Sander-son-Rabbit Channel, the 25120 will provide 50% higher speed than you will obtain.

COOLING

The 25120 is easily cooled by employment of a six-foot fan, 1/2 inch from the package. If the device fails, you have exceeded the ratings. In such cases, more air is recommended.

1. Neu channel devices enhance or deplete regardless of gate polarity.
2. Coffee Breaks and Lunch Hours.
3. Copyright U.S. Army Commissary, 1940.
4. Not applicable.
5. These inputs can somehow be driven from TTL. The method is obvious.
6. Measured at 1 MHz, 25 mV ac, 1.9 pF in series.
7. Signetics EXtra secret.
8. See "Modern Production Techniques" by T. Arrieta (not yet written).

CIRCLE NO. 365

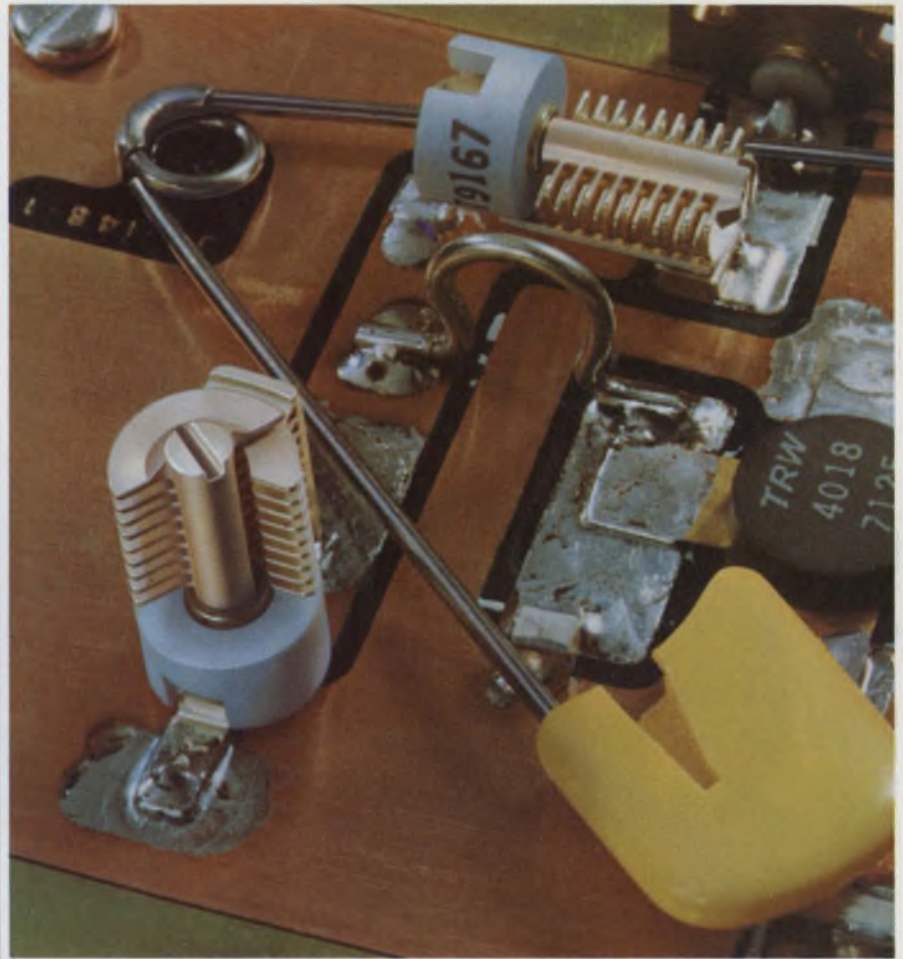
The price is right, but . . .

In our write-up of the Data Products option for the PortaCom data terminal (ED 11, May 25, 1972, p. 85), we gave the price as \$1450. That price is right—for the cassette, not for the entire terminal.

CIRCLE NO. 366

One-way delivery

When engineers at a semi house removed the back cover of a new pulse generator that wouldn't work, they found two empty transistor sockets. They also found a brief note, saying, in somewhat more colorful language: "We delivered. You didn't."



The smallest 180° tuning air variable capacitors just had babies!

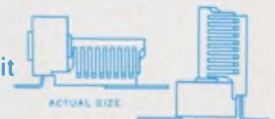
Right. Johnson's exclusive subminiature type "T" air variable capacitors (PC mounts) now come with stripline terminals for microwave applications, either vertical or horizontal tuning.

These space-savers are only about 1/3 the volume of a "U" capacitor, but they offer extraordinarily high mechanical and electrical performance for critical applications.

Rotors and stators are as stable and uniform as precision machining from solid brass extrusion can make them. A high 1 1/2 to 8 ounce-inches torque holds the rotor securely under vibration.

Temperature coefficient is very low plus 30± 15 ppm/° C. Q is high, typically 1800 at 200 MHz. Three capacitance ranges span from 1.3 pF to 15.7 pF.

Our 45 years of experience really shows up in these new capacitors. But why take our word for it when a stamp will get you a couple of freebies and you can check them out for yourself.



E. F. JOHNSON COMPANY/3306 Tenth Ave. S.W./Waseca, Minnesota 56093

Check type and range of sample(s) needed:	Capacitance range	1.3 to 5.4	1.7 to 11.0	1.9 to 15.7
	Horizontal tuning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Vertical tuning	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Name _____ Phone _____

Firm _____ Title _____

Address _____

City _____ State _____ Zip _____



E. F. JOHNSON COMPANY

INFORMATION RETRIEVAL NUMBER 9



All toroids look alike.

Our PULSE-RATEDTM toroids really are alike.

We developed the concept of *pulse rated* toroids to eliminate tedious selection problems. Now we've developed new materials. Fully proven. Component tested. So you get guaranteed performance over a temperature range of 0° to 60° C.

Pulse-rated toroids not only simplify your selection process, they practically eliminate scrap. So you get 100% yield in your pulse transformer production.

Specifications provided for every *pulse-rated* toroid include pulse in-

ductance, volt-microsecond product, and temperature behavior under pulse conditions.

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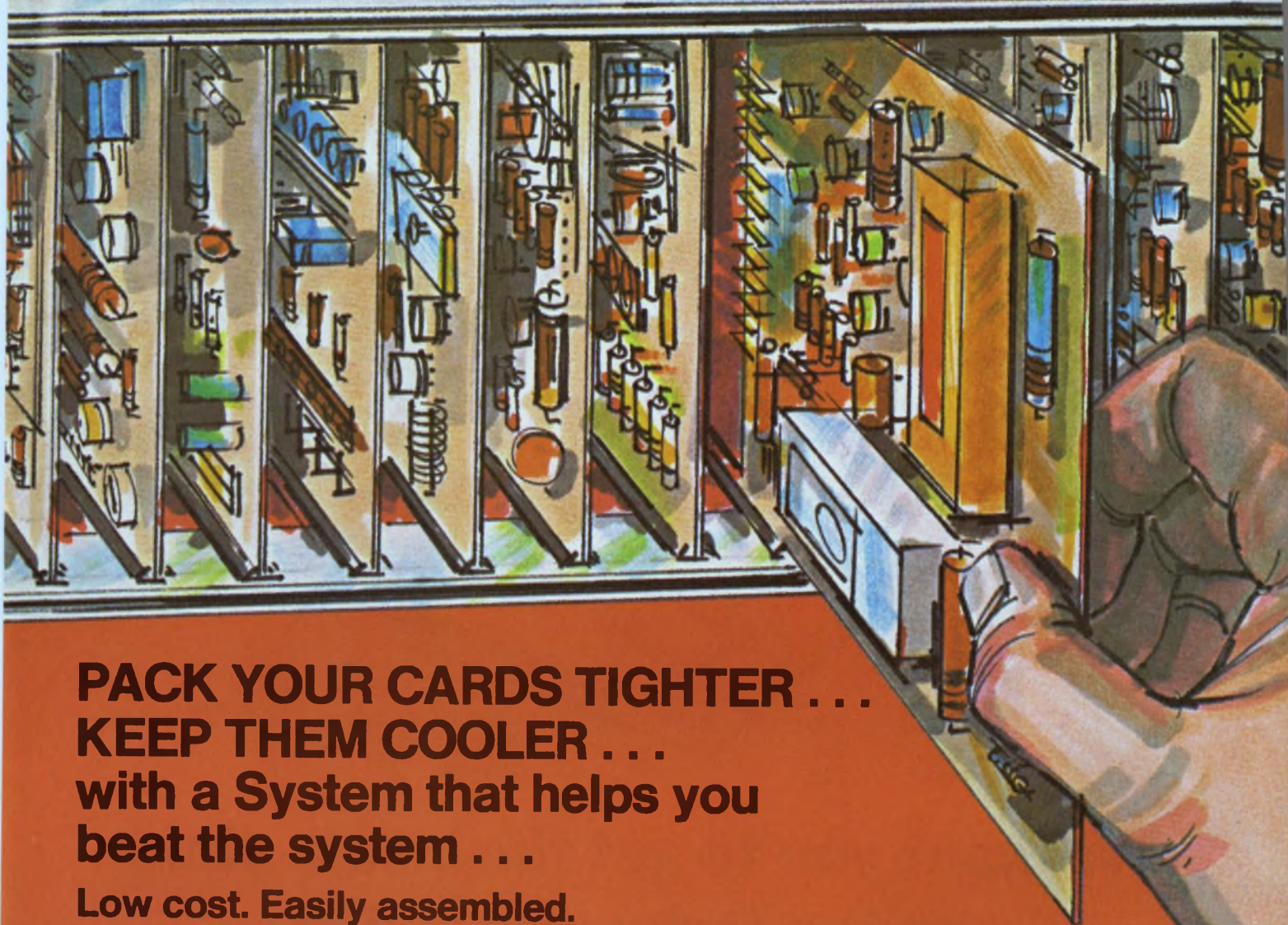
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INFORMATION RETRIEVAL NUMBER 10

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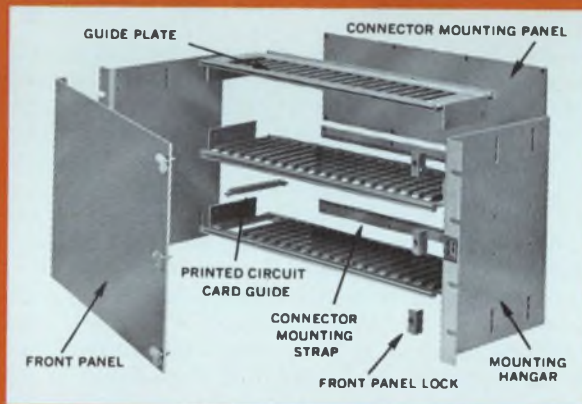
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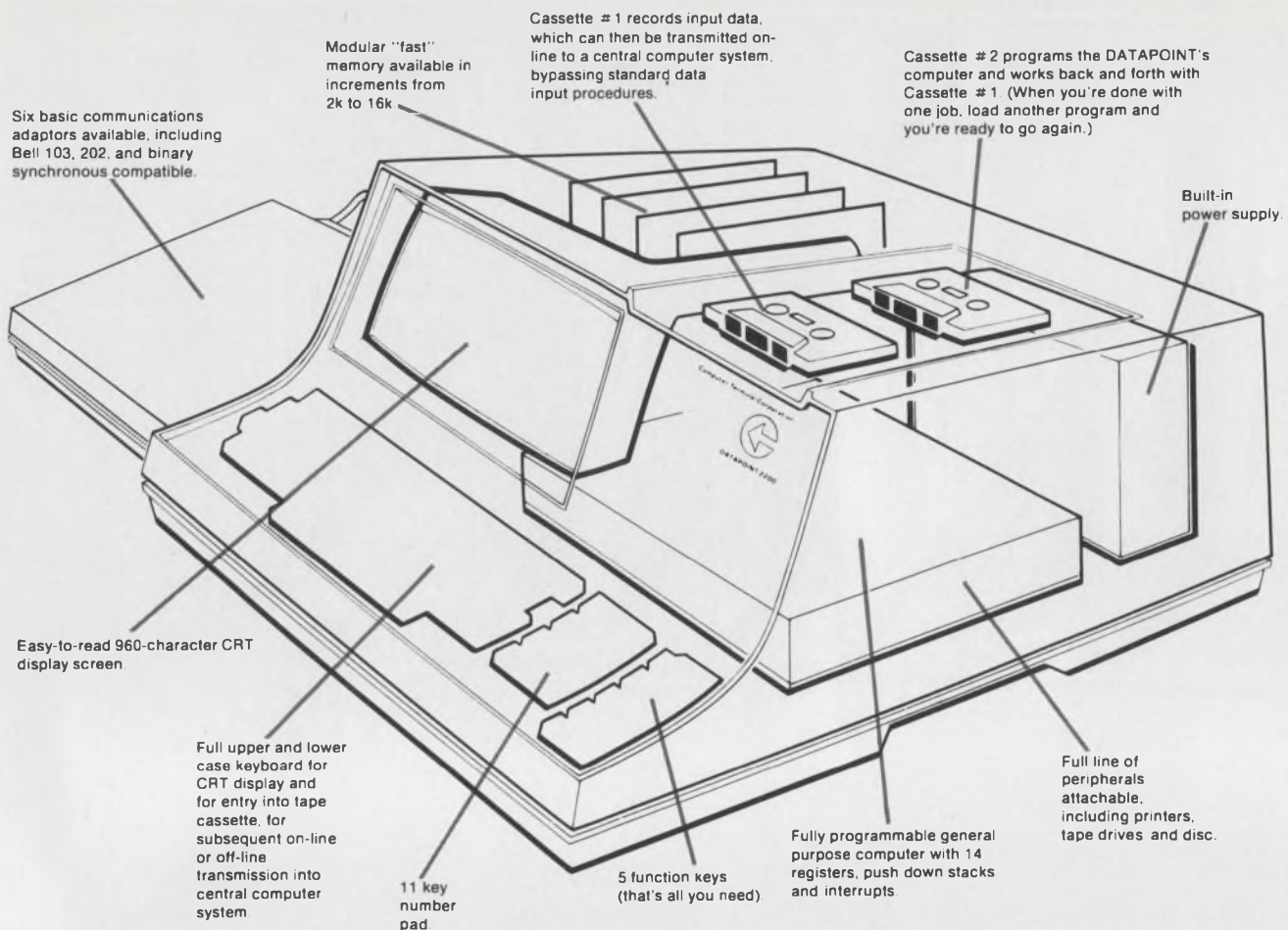


For full details on the Varipak II system from Elco, contact your local Elco representative or distributor, or:

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(215) 659-7000

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We want you to get the inside story on the Datapoint 2200

That's right—take the cover off what appears to be simply a handsomely styled terminal and you discover a world of ingenious technological innovation. The Inside Story is what makes the real difference between the Datapoint 2200 and any number of systems which it superficially resembles. The 2200 is in fact a powerful general purpose computer integrated with a CRT data terminal for either on-line or off-line duties. This unique system can be utilized by the user who needs substantial on-site, stand-alone computer power, the user who needs convenient access to a larger computer from a remote site, either for batch processing or for interactive time sharing usage, or for all these uses simultaneously.

As the illustration indicates, the Datapoint 2200 is communications oriented. It was created specifically for use in on-line environments, with the ability to handle varying data transmission rates and to interface with a variety of central computer systems. What the illustration does *not* show is the

full line of software made available with the 2200, including complete operating systems, numerous application programs and DATABUS, a comprehensive high level programming language. These, combined with a 500 nanosecond cycle time, up to 16k of "fast" memory, integral dual tape cassettes, and the full line of peripherals including printers, tape drives and a disc system render the Datapoint 2200 a formidable computer system in any league.

The more you know about the inside story of the Datapoint 2200, the more impressed you will be with the many advantages and benefits it offers as a computer, as a CRT data terminal and as a combination of the two. And it's a proven system. Over 500 Datapoint 2200's are now in daily use in the U.S. and abroad. For more information on this innovating system and for a free copy of our new Datapoint 2200 systems book, simply contact the sales office nearest you, or write or call our corporate headquarters.



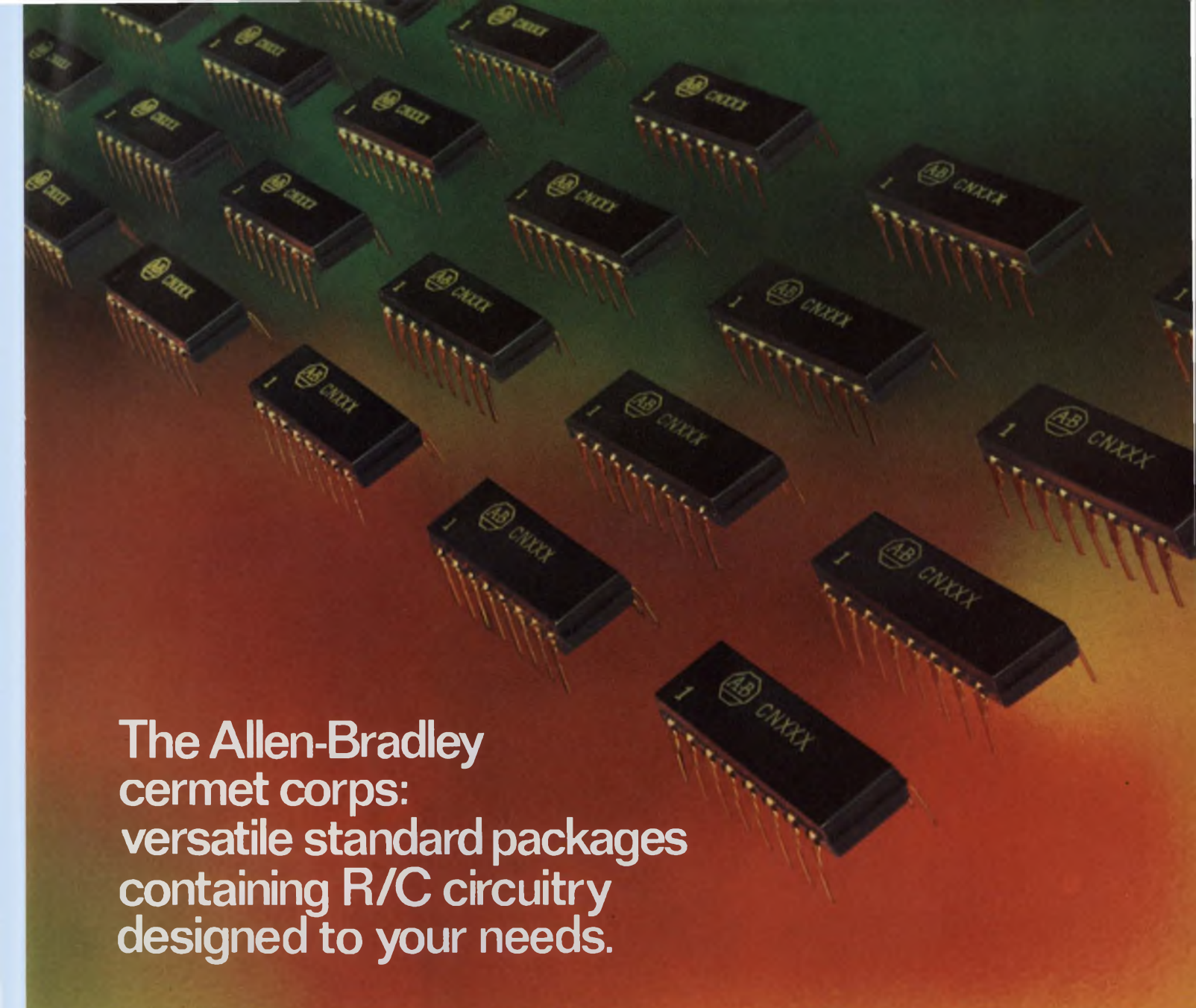
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INFORMATION RETRIEVAL NUMBER 12



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Actual Size

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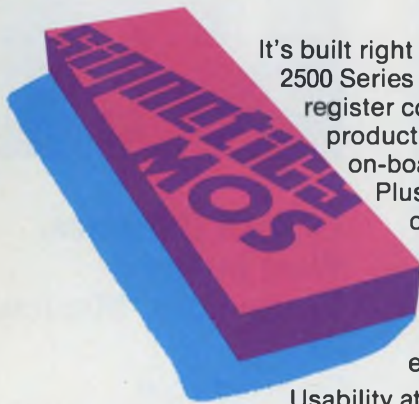
fused to a solid ceramic core. The lead wire terminations are soldered to the core in a patented process. This makes the resistive element and the terminations one continuous component ready for molding in an environmentally protective envelope.

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It's built right into the chip. Every 2500 Series MOS static shift register comes off Signetics' production line with its own on-board clock generator. Plus a real windfall of other major improvements. To help lower total systems cost, and make the parts easier to use.

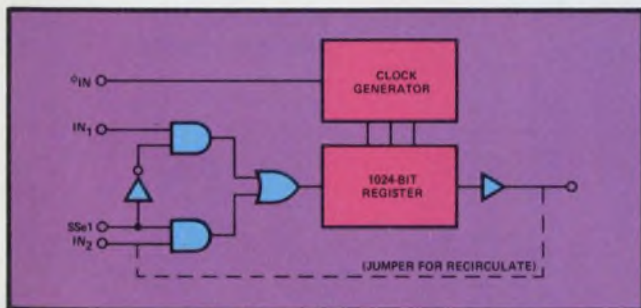
Usability at a reasonable price.

That is what you've been after. And usability runs in the family of Signetics new MOS static shift registers, the most complete collection in the field.

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And because the Signetics line can be treated like TTL itself, no level shifters are necessary at either input or output—again lowering your overall component count and cost. Just as the built-in clock generator demands no expensive high-level clock drivers.

Power requirements are standard +5V, -12V. And you recirculate data without external logic.



Signetics 1024-Bit Static Shift Register

For the first time, with the 1024-bit static shift register you can have the benefit of easy-to-use static shift registers for long bit length applications. And, a dual-128 for 128 column printers, or a quad-80 for 80 column CRTs.

Combine the on-board clock generator, with TTL compatibility and the wide range of bit density (from 50 up through 1024), and you've got more flexibility to work with, in both design and application, than you ever hoped to find in static shift registers.

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Quad 80	16 pin	2.0	4.00	2532B
Dual 256/250/240	8 pin	3.0	4.80	2527/28/29V
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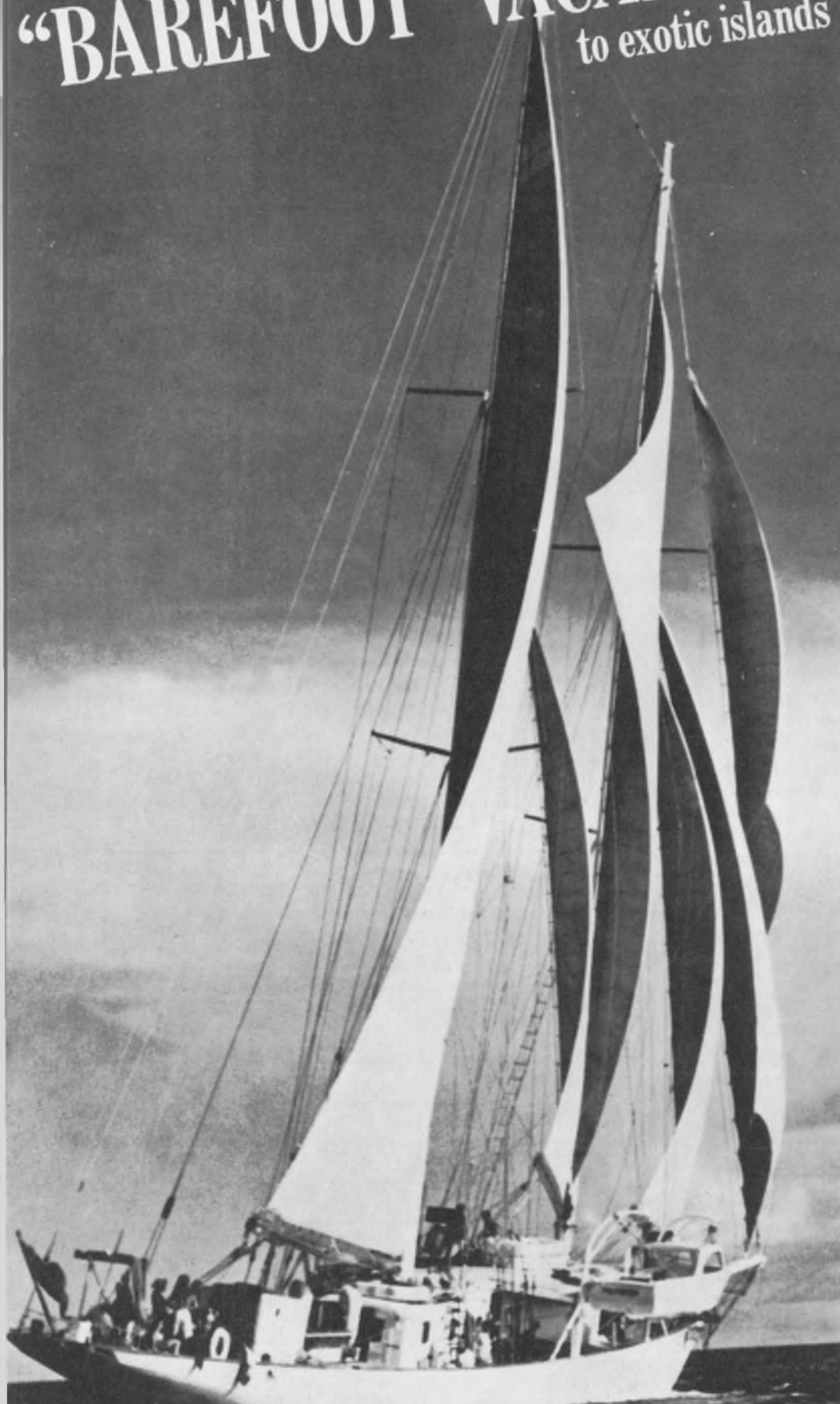
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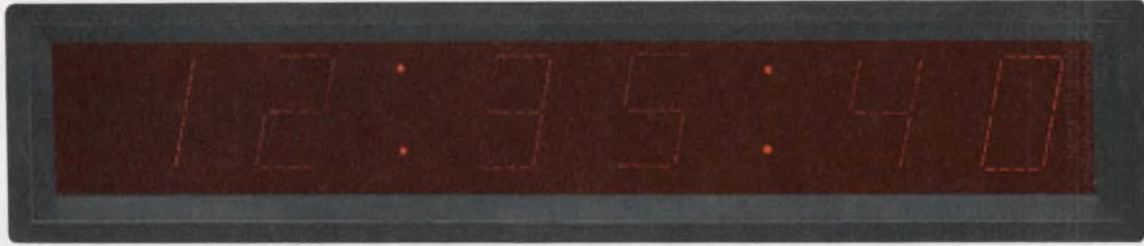
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MAN6 — .6" high, the MAN6 looks an inch high from across the room. The complete, gapless font makes all ten digits and nine letters unmistakably clear. It should find application in many instruments, consumer electronics, and cockpit displays.

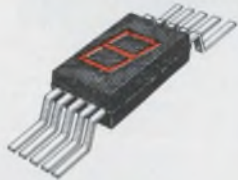
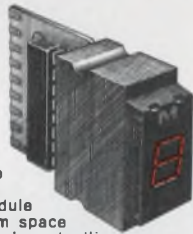


MAN1 — The standard of the industry, the .27" MAN1 is mounted on a 14-pin DIP and encapsulated in clear epoxy. Directly compatible with IC's, it is being used in a wide variety of alphanumeric display sockets. (Shown in a demonstration clock face.)

The Monsanto GaAsLITE Display display.

MDA6101 —

Typical of our modules, the MDA6101 single-digit display module requires minimum space in computer, avionic and military systems. Contains a decoder-driver circuit designed to accept four-input BCD (8, 4, 2, 1) code and to provide .27" visual readout of decimal numbers and nine distinct letters. Provides decimal point input and has ripple-blanking input and blanking input/ripple-blanking output terminals for zero suppression and intensity control.



MAN3A — Encapsulated in transparent red epoxy, this small (.115") readout is very useful in desk calculator displays, portable instruments, and film annotation sockets. Displays ten digits and nine letters.



MAN2 — A 5 x 7 light-emitting-diode matrix, the .35" MAN2 alphanumeric displays the full 64-character ASCII code. Finds application as keyboard verifier, avionics display, in computer peripherals and has 2¹⁶ bits available for film annotation work.



MAN1002 — A .27" 7-segment hexinumeric display, the MAN1002 provides all numbers and the letters A, B, C, D, E, F, H, I, J, L, O, P, S, and U for digital and cockpit readouts that require this capability. Like all our GaAsLITE displays, it is shock resistant and impervious to vibration.

We're displaying our array of light-emitting diode displays to point out the obvious: We've got them all.

Big GaAsLITEs—the new .6" MAN6.

Low-cost little MAN3's, in single-digit or multi-digit packages.

5 x 7 dot matrix MAN2's.

9-segment hexidecimal MAN1002's.

Red, green, and yellow.

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If you'd like more information on our expanding line of module display products, clip the coupon and shoot it in.

If you need more information on displays, circle the bingo card number below. And if you're smart enough already, just tuck this name into your head when you order displays: **Monsanto Commercial Products Co.,** Electronic Special Products, 10131 Bubb Road, Cupertino, California 95014.

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Dear Monsanto:

I'm curious about your new line of display modules. Do some contain complete IC driving circuits? Send me the Module Brochure, please.

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INFORMATION RETRIEVAL NUMBER 17

World's Smallest High-Performance Tape Drive.



25-125 ips, auto-threading, vacuum tape handling.

The Ampex TMA Tape Drive gives you top performance in the most compact package on the market. Only 19x24x18", it designs itself into your OEM system. Bargain priced, too, for more computer power.

Performance: 25 to 125 ips, 10½" reels, ANSI/ECMA 7 or 9 track standards, NRZI with 200, 556, 800 bpi or 9 track 1600 bpi. Diode and triac switching for all control circuits. Option of auto-threading or manual. Single capstan. Linear reel servo system with vacuum columns for tender loving care of your tape. A series of drives and electronics to meet your needs.

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Very low-light-level TV camera developed

A low-light-level closed-circuit television camera sensitive enough to satisfy many military requirements has entered the growing, highly competitive security field.

To enable the user to place the camera in a remote place—on the other side of a busy highway or railroad yard where cables could not be laid—an optical video link has been developed.

The camera and the relay link were built by Motorola Inc.'s Communications Div., Schaumburg, Ill. Designed to protect dark areas that would be too expensive to illuminate, such as parking lots, railroad yards and warehouses, Motorola's new camera uses a dual intensifier that is coupled to a fiber-optic face plate vidicon tube.

The new system is 50 times more sensitive than its predecessor, able to operate with one-eighth of a

moon—0.001 foot candles of light. The sensitivity of the previous model, using a single intensifier, was roughly comparable to that of the human eye, effective down to 0.05 foot candles of light.

The tremendous jump in sensitivity was achieved, Motorola says, by using higher voltage to the intensifier and by circuitry techniques the company considers proprietary.

Operating in the infrared region the optical video link uses an amplitude-modulated light-emitting diode for transmitting and a sensitive PIN photodiode as the receiver. Under the worst possible weather conditions—rain, fog and snow—the link is effective up to 1000 feet, the company says. In clear weather it is good for 2000 feet. Using four links back to back, the range can be extended to 8000 feet.

Device drastically cuts radio-frequency noise

An increase in the number of available radio channels and a decrease in the amount of radio frequency interference are promised by a new device known as an Interference Cancellation System.

Developed by American Nucleonics Corp., Woodland Hills, Calif., the new device will find wide application in air traffic control systems, police communications, ship-to-shore radios and car telephones, reports Ray Williams, director of marketing.

In operation, the unit is placed between a receiver and its antenna. The interfering signal is sensed by the device and subtracted from the original signal so that only the desired information is amplified and received.

The basic theory of subtracting

noise from the incoming signal is not new, admits Williams, but we have developed a proprietary technique for synthesizing a cancellation signal. The traditional phase and amplitude control techniques that have been used to date are costly and difficult to implement, he explains. In addition, notes Williams, they usually yield only a 20-db improvement.

In the new Interference Cancellation System, the time delay of the feedback signal is controlled instead of the phase thus making possible a reduction of interference of more than 60 db.

In explaining how the new system would increase the number of usable radio channels, Williams points out that with less interference, the spacing between channels could be reduced, making it possible to have more channels in the same frequency band.

Designed for use on high-frequency through S-band communication receivers, the system reduces band separation requirements to less than ± 50 kHz in the 200 to 400 MHz band.

New transponder system monitors ship traffic

A receiver-transponder system has been developed that will provide ships in congested harbors and inland waterways with precise information on their positions. In addition, the system provides digital communications and automatically identifies the ship to other ships and to shore stations. All three types of information are carried in a single signal.

Called Hatric, for Harbor Traffic Ranging Identification and Communication, the system was developed by RCA Government and Commercial Systems in Moorestown, N.J. It is based on a system RCA proposed to the U.S. Coast Guard. Hatric is intended for ships "ranging from fishing boats to the largest freighters and passenger vessels," says RCA's Staff Systems Manager, Ernest Jellinek.

Based on a non-synchronous transponding technique, a signal from a ship will be received by a shore station and by the time delay reveal the ship's distance. Information in the same signal automatically identifies the ship and, possibly, contains a message.

Position is determined by trilateration. If a ship receives range information from two shore stations at the same time, its position is easily calculated. Two shore stations in communication with each other, on the other hand, can calculate the position of a ship.

Light amplifier boosts color film sensitivity

Thanks to a new color light amplifier the broadcast and film industries can now take color movies by moonlight.

Adapting a technique now used in television cameras, CBS Laboratories, Stamford, Conn., has developed a light amplifier that attaches between the standard motion picture camera and its lens. The

amplifier increases the film sensitivity about 100 times, and works at light levels as low as 1/20 foot-lambert.

In operation, light from the scene to be photographed is separated into its three primary components by a rotating color filter wheel, explains Henry Mahler, project engineer for CBS. The separated light then goes to an image intensifier where it is amplified. After amplification the three light components are then recombined, by passing through another rotating color filter and the light is then used to expose the film.

The new unit was tested recently at the Democratic Convention in Miami and produced very good results, says Mahler. The advantage of such a device, he continues, is that it eliminates the need for external lights and increases the flexibility of the photographer.

CBS is now studying the possibility of producing these amplifiers commercially for the broadcast and movie industries. The selling price for a unit will probably be between five and six thousand dollars.

Storage scope features fastest writing speed

Never to be caught napping in the oscilloscope performance race, Hewlett-Packard has introduced a high-speed version of its Model 184A storage scope. With a 400 cm/ μ s writing speed, this reportedly makes it the industry's fastest writing scope—twice as fast as Tektronix' recently introduced 7623 (ED 14, July 6, 1972, p. 83). First deliveries are expected in September.

NASA studies orbiting solar power station

A study is under way to explore the feasibility of putting a huge solar energy collection system into synchronous orbit. The system would convert the sun's energy to electric power and transmit it via a microwave beam to earth.

The entire orbital system needed to collect, convert and transmit the power to earth is large and elaborate. The energy collected by the

solar array (possibly five miles square) would be fed through a two-mile-long transmission line to a control station. Here the solar energy would be converted into electric power and beamed down from a one-mile-square slot array microwave antenna to an earth station.

On the ground, the receiving antenna would cover an area six miles square.

The six-month study is being carried out for the National Aeronautics and Space Administration by a four-member team consisting of A.D. Little, Inc., Cambridge, Mass., Grumman Aerospace, Bethpage, N.Y., Textron Inc.'s Spectrolab Heliotek Div., Sylmar, Calif., and Raytheon Corp's Equipment Development Laboratory, Lexington, Mass.

The contract will be managed by NASA's Lewis Research Center in Cleveland.

New EIA data book shows '71 statistics

Sales of electronic equipment for 1971 reached \$27.1 billion, up \$200 million from 1970 but still down from the 1969 high of \$28.7 billion, according to information contained in the recently published 1972 Electronic Market Data Book of the Electronic Industries Association.

The book includes statistics, for the first time, on the telephone equipment market, which according to the EIA is one of the fastest growing segments of the electronics industry.

The EIA publication also reveals that the 1971 electronics market showed gains in consumer products as well as in the communications

and industrial areas. Replacement components showed a slight decline as did government sales.

The Electronic Market Data Book contains analyses, charts and tables for major segments of the electronics market and can be obtained from EIA, 2001 Eye St., N.W., Washington, D.C. 20006. The cost is \$15 each.

2-way cable TV system being built in N.J.

A two-way communication system between cable television viewers and a nearby central computer is now under construction in South Orange, N.J. Scheduled for operation in 1973, the system will permit some 2000 to 4000 viewers to make shopping selections, to be polled on events of national and local importance and to participate in making pay-TV selections.

Communication by the viewer is accomplished by pressing the proper combination of six buttons on a special control unit attached to the viewer's set.

Developed by Video Information of New York City, the system uses separate bands of the frequency spectrum for the computer's interrogating signals and the viewer's response. For example, the cable TV communications were tested last year over a seven-month period using 12 private terminals in New York City. Interrogations were sent at about 110 MHz while replies were transmitted at 10 MHz.

Joseph Beck, vice president of Video Information, says the system will also be connected to fire and burglar alarm systems on subscribers' premises. In case of an alarm, either the fire or police stations will be automatically notified.

News Briefs

The construction of a power plant to convert sunlight to electrical energy will be undertaken, in a two-year study, by joint cooperation of the University of Minnesota and Honeywell, Inc. For the first year, the National Science Foundation has awarded the University a \$446,600 grant.

Microsecond pulses in the kilovolt range can be measured using a

laser-optical technique developed at the National Bureau of Standards in Boulder, Colo. The voltage source is connected to a Kerr cell. Laser light is passed through the cell and the birefringence in the cell liquid alters the polarization of the light. The resultant electro-optical fringe pattern is a measure of the pulse shape and magnitude.

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GENERAL  ELECTRIC

Semiconductor Products Department, Syracuse, New York



As perhaps no other industry, consumer electronics is an industry of innovation, of constant change. Yesterday's massive reel-to-reel tape recorders have evolved into today's easy-to-use eight-track cassette machines. The earlier desk-top electronic calculators are being replaced by a variety of sophisticated, low-cost, hand-held "mini-computers."

In recent years most of the attention was focused on television, AM and FM radios, phonographs and audio tape recorders. Today, consumer electronics is expanding rapidly into other areas, providing a host of new products—electronic kitchen appliances, home security systems, video tape and disc recorders and so on.

The demand for high-technology kitchen products, as well as improved burglar systems could by themselves create huge markets. For example, many kitchen appliances today are unreliable, difficult to repair and servicing costs are high.

In fact, the wiring in a typical appliance has been described as looking like a "rat's nest." Solid-state controls and plug-in printed circuit boards could be the answer.

A decade ago home security systems were composed mainly of pressure transducers and latching relays. These largely electromechanical systems are being replaced by more sophisticated optical, ultrasonic and microwave burglar-alarm equipment. This market alone is growing at the rate of 15% a year.

Another promising area is video recording-playback systems. Although under development by major electronics firms for a number of years, these relatively expensive instruments are purchased largely for educational, commercial or industrial use. Only one company is selling equipment for the consumer market. Nevertheless, the promise of low-cost, recorded entertainment programming for the home has brought them closer to the consumer product category.

Aerospace technology urged to streamline U.S. kitchens

To copywriters on Madison Avenue, today's American kitchen is a "marvel of scientific wonder." Besides the usual electrical gadgetry, there are microwave ovens, induction ranges and integrated small-appliance centers. Microwave clothes dryers and ultrasonic dish and clothes washers are within grasp. What more could a housewife want?

To Richard L. Martin, a research industrial designer at the Stanford Research Institute, Menlo Park, Calif., the modern American kitchen is a mess.

"We have," he says emphatically, "terribly antiquated kitchens, because we build them only for sale and not for upgrading or remodeling. In fact, there are a whole lot of electronics executives who live in houses that were built by cave men."

Martin can be caustic because he knows what the appliance industry could do to improve the kitchen but so far hasn't. A small dose of aerospace technology is all that is needed, he says.

The modern kitchen, the SRI researcher indicates, should have solid-state, modular designs, so defective parts can be unplugged and replaced on the spot. There could even be computer control of kitchens, to automate everything from menu planning and food preparation to the environment.

Some in the electronics industry agree with this appraisal. AMP, Inc., of Harrisburg, Pa., a maker of connectors and terminals is one.

"Just look inside the average appliance in your home," says Edward Reynolds, supervisor of development engineering in AMP's Terminal Products Div. "The wiring looks like a rat's nest [see photo]. The appliance is so difficult to service that the average service man sometimes forgets to reconnect a wire or two because he loses them in the maze."

Flat, flexible cables the answer

Aerospace wiring and cabling techniques, Reynolds points out, could not only simplify the design of electrical and electronic appliances; it could make them cheaper to build and service. He urges the use of a flat, flexible cable.

AMP has developed a system for wiring appliances with flat, flexible cable, as well as with other types of cable and special connectors. Each system is designed for a different appliance—washing machines, ovens, refrigerators and so on.

"As solid-state controls become more widely used," Reynolds says, "printed-circuit boards will also find their way into appliances."

F. Ryder Amthor, director of consumer product development at Westinghouse Electric in Pittsburgh, supports the call for connectors that can be plugged in and for modular design of the electronics for ease of servicing. "It should be possible," he says, "to unplug a defective part and replace it on the spot. If a part is obviously defective, the consumer should even be able to make the repair himself."

Amthor believes that modular designs will come within the next five years as the appliance industry swings over to solid-state controls. In addition he expects the circuitry in appliances to use lower voltage levels for safer and more reliable designs. Instead of 115 V or 230 V, Amthor anticipates the use of 5 to 10 V.

David N. Kaye
Senior Western Editor

"If your integrated-circuit timer runs off 5 V, why not your pilot lights as well?" he asks, adding: "They'll even last longer."

Solid-state controls coming

Semiconductor companies such as Motorola in Phoenix, Ariz., and Texas Instruments in Dallas have been trying to sell the appliance industry on SCR motor controls for the last few years. The industry is finally coming around. Reynolds of AMP sees solid-state controls in wide use within three years. Others in the industry say three to five years. The controls, however, will be a lot more than just motor units. They will include, appliance timers, computational circuits, a whole array of sensors and perhaps a digital controller.

Integrated-circuit timers have recently been introduced by Signetics of Sunnyvale, Calif., National Semiconductor of Santa Clara, Calif., Motorola and others. They have come down in price to the point where appliance manu-

facturers can begin to design them in. More sophisticated timer and computational circuitry for appliances is being designed at the North American Rockwell Microelectronics Co. in Anaheim, Calif. It is MOS/LSI technology. Others are using bipolar technology as well.

Computer in the kitchen

At present the control function in the kitchen is an appliance-by-appliance approach. And for the next five years, that will likely continue to be true. But centralized kitchen control is envisioned beyond that. A computer or other form of special-purpose digital controller will be used, appliance manufacturers say. Through an array of sensors, both food preparation and the environment in the kitchen will be maintained and controlled.

Food-preparation control will simplify menu planning. With a computer, it will be easy to monitor the diet balance of each mem-

ber of the family and to plan meals that not only have variety but also nutrient balance. Philco-Ford in Philadelphia believes that a voice-activated cassette tape recorder will be used for recipe storage.

With a computer, it is possible theoretically to automate food preparation completely. But Martin of Stanford Research Institute doesn't believe this will ever happen—at least on a large scale. He notes that the kitchen is a creative part of the house for most women and that certain aspects of food preparation are very enjoyable to them. He does believe, however, that parts of the food-preparation process are drudgery and that those should be and will be automated. Areas that he marks for automation include appliance timing, so that different parts of the meal finish cooking at the proper time, the monitoring of food inventory and oven and range temperature control.

For housewives who don't enjoy cooking, the Whirlpool Corp. in Benton Harbor, Mich., has designed and built a completely automated food-preparation center. One industrial consultant, Jay Doblin of Chicago, offers an extremist view: "You ought to be able to live without major appliances. Major food preparation should be done in the factory. With all the prepared meals you can currently buy, we're well on our way."

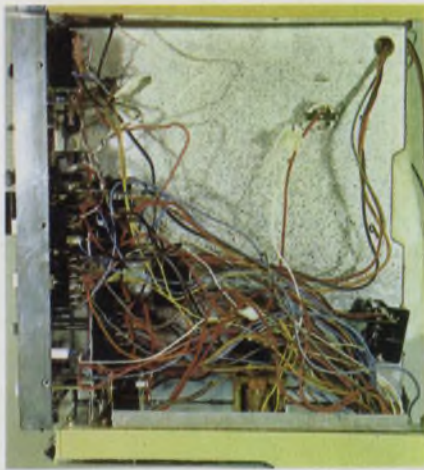
Environmental control in the kitchen most in the appliance industry agree, will be automated because the need is greater here than for any other average room in the home. With inexpensive sensors and a computer, air temperature and purity, range exhaust, water purity and humidity could be controlled.

Separate refrigeration units

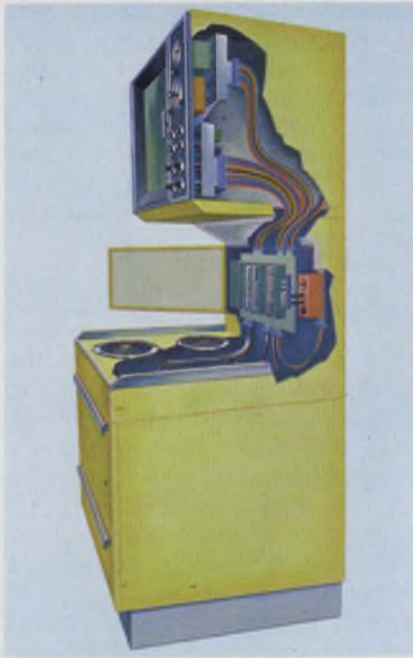
A unique part of environmental control would be refrigeration of food. Different types of food require different storage temperatures, and these temperatures could be monitored by a central control station and regulated independently. Philco-Ford looks to individual refrigeration compartments, controlled independently but possibly operated by a single compressor. Ultimately thermo-electric cooling may be the way to go, says



Prototype of a futuristic kitchen designed by Westinghouse Electric Co. contains a communications command post which incorporates automatic telephone dialing, a tape recorder, AM/FM radio, closed-circuit television and controls for temperature, humidity and a home security system. A cable TV hookup is also under consideration.



Maze of wires inside average home appliance (photo above) is contrasted with concept of next generation cooking range (photo right) which uses organized wiring and printed circuit boards that can be replaced on the spot.



An induction range whose top always stays cool to the touch is being sold by Westinghouse. Coils of wire, under the black ceramic top carry a 25 KHz ac current. When an iron or steel pot is placed over a coil, the pot couples with an oscillating magnetic field created by the coil and the pot heats up.

Philco-Ford, but at present it is far too inefficient.

Meanwhile not all of the bugs have yet been removed from the newer electronics appliances being sold or developed today. Microwave ovens from most manufacturers operate at 2450 MHz, with a magnetron putting out about 600 W. Some Japanese companies and General Electric are working at different frequencies. One of the major problems with microwave ovens centers on costs. But they are dropping. A table-model microwave oven now sells for less than \$300. Replacement magnetrons still cost about \$60 typically, however. The next step in cost reduction, according to industry sources, is to decrease the size of the oven cavity. This will also allow a decrease in the amount of power needed to cook.

Once the power of microwave ovens comes down a bit, manufacturers are prepared to move away from magnetrons and toward an array of solid-state sources. These sources will probably be either Gunn or avalanche diodes or transistor oscillators. Westinghouse reports over 100 W of output from solid-state sources in a test oven in the laboratory. Several sources are being used in the same oven to improve reliability.

Induction ranges—i m b e d d e d coils of wire in a ceramic counter top—were introduced a few months ago for about \$2500 by Westing-

house. At this price, they are too expensive for most consumers, but according to Amthor, the price should decline within five years to less than \$500. When the range is in operation, a 25-kHz ac current is passed through the coils to induce current flow in a cooking pot. Only cast-iron or stainless-steel pots can be placed on the coils, since they provide the proper amount of resistance to current flow and dissipate enough heat for cooking. Other cooking utensils either have too much or too little resistance. When a pot is not present, the range top is cool to the touch. Amthor notes that if 2000 W are put into the coils at least 1600 W are dissipated by the pot. This 80% efficiency compares with about 65% for the standard coiled electric-range burner.

Integrated control on the way

Integrated small-appliance centers were first put on the market by the Nutone Corp. of Cincinnati, Ohio. The company now has a counter-mounted motor and control center that can run a blender, mixer, knife sharpener, meat grinder, ice crusher and shredder/slicer. Coming is a can opener. The control requirements, according to Robert Carringer, product manager at Nutone, are fairly severe. Some appliances require low speed and high torque and other higher speed and torque. Nutone is inves-

tigating full solid-state control and expects to incorporate it within the next few years.

Microwave clothes dryers are not on the market because manufacturers are still investigating the effect of the microwave energy on different fabrics. And ultrasonic dish and clothes washers, in the opinion of many manufacturers, will never be practical—at least, not until some breakthrough occurs. In the case of the dishwasher, breakage is a problem. Different types of glass have different resonant frequencies, and hand-painted china might have its painting removed. So far frequencies in the audio band have been the most effective experimentally, but they are not acceptable from a practical standpoint, the sound would drive a housewife up the wall. Even dogs must be considered in the design of appliances. Although humans might not be disturbed by the noise, the family pet might not be able to stand it. In the case of the clothes washer, it takes a great deal more power to clean clothes than can realistically be produced ultrasonically in the home.

Kitchen communications is an area that is wide open for development. Under consideration in communications are a cable TV hookup; closed circuit TV to the front door, the baby's room, the backyard, the family room or any other site in the home; an intercom system and fire alarms. ■■

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Solid-state designers matching wits with burglars in the home

It's easy to see why electronic security systems, traditionally aimed at commercial markets, are now being sold for use in the home: Every minute of every day four homes are burglarized in the United States, according to the Federal Bureau of Investigation. And this burglary rate is increasing by 6 to 7% a year.

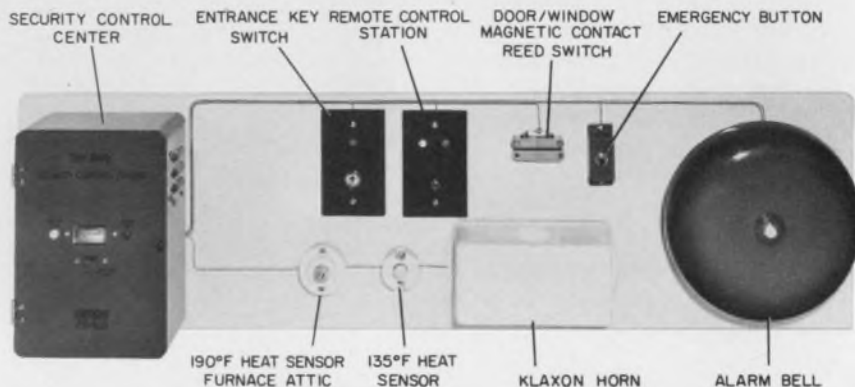
The consumer market for home protection is beginning to take off, manufacturers report, and prospects of a minor boom are not improbable.

Ten years ago home-security systems were limited almost exclusively to simple spot or perimeter alarms. Most consisted of switches, attached to doors or windows, that activated a latching relay. Optical systems were simple and easily overcome by burglars.

But with the new entry of solid-state electronics into the security field, latching relays are being replaced by more reliable thyristors, and the old optical systems are becoming more sophisticated with modulated laser and light-emitting diodes. In addition completely new security systems are making strong inroads in the consumer market. The systems now on the market range from door switches to ultrasonic and microwave devices, and they generally fall into these basic categories:

- Volume alarms, which can detect any movement in a protected area.
- Perimeter alarms, which can detect unauthorized entry into a protected area.
- Spot alarms, which can protect a particular object or entrance.

Of the three types, spot alarms are the simplest. They consist of



Do-it-yourself home-security kits are becoming popular. This one from EICO includes the basics for burglar and fire alarms.



A radio-frequency burglar alarm by Electronic Radio Guard, Inc., features easy installation and operation.

detectors, such as pressure transducers, that are activated when an object is lifted; or of metal foil on a window that triggers an alarm when it is cut; or of magnetic switches. Because they guard only one point, spot alarms may be easily compromised.

If a spot alarm is placed at each potential point of entry, a perimeter alarm can be formed. Other perimeter detectors include light beams, mat switches, capacitance-sensitive devices and pressure switches.

The latest addition to the alarm family is the motion detector, or volume alarm. Most of these work on the Doppler principle and use

either ultrasonics or microwaves to detect motion in an area. However, other motion detectors, such as ultrasensitive microphones and multiple light beams and photodetectors, are also being used.

In the ultrasonic and microwave systems a transmitter emits a signal that sets up a standing wave pattern. As long as this pattern remains unchanged, the alarm is silent. However, any movement in the area protected by such a device will set off the alarm.

These systems have several disadvantages. The ultrasonic alarms protect only a single room, ranging from 300 to 600 square feet. And while the microwave devices can protect several rooms—since the walls that confine ultrasonic signals will pass the 10.5-GHz frequencies that are generally used—there is another problem: The standing wave pattern set up by microwave systems may include some of the area outside the house. If that is the case, false alarms may be triggered by moving branches, animals or the wind.

Both microwave and ultrasonic systems must be carefully chosen. Air-conditioners, draperies blown by breezes and vibrating glass are only a few of the causes of false

Jules H. Gilder
Associate Editor

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Carrier-current alarm by Magnavox uses ac house wiring to connect sensors with an alarm latching circuit.

alarms with these systems. In addition ultrasonic alarms have been known to drive both dogs and television sets crazy.

Ultrasonic alarms are available at prices ranging from \$40 to \$80. The cost of microwave devices ranges from \$250 to \$600.

Modern photoelectric perimeter alarms use modulated infrared light from either laser or light-emitting diodes. This is a big improvement over previous unmodulated systems, where it was often

possible to overcome the alarm with a simple flashlight. As with the earlier systems, light is guided around the area to be protected by inconspicuously placed mirrors. Breaking the light beam triggers the alarm.

Photoelectric systems are also susceptible to false alarms from animals and fluttering draperies.

Most sensors used in burglar alarms consist of some sort of switch, generally of the magnetic or pressure variety. When an in-

truder activates the sensor—by opening or closing the switch, depending on the system used—a signal is sent to either a relay or solid-state latching circuit. This causes an alarm to sound.

A spot-alarm system that is just starting to gain in popularity is the radio-frequency. In this each sensor, or switch, is connected to its own transmitter. When the sensor is activated by unauthorized entry, it switches the transmitter on, and a remotely located receiver turns on the alarm.

Rf systems range in price from \$150 to \$600. They eliminate the need for external wiring and are therefore easier to install.

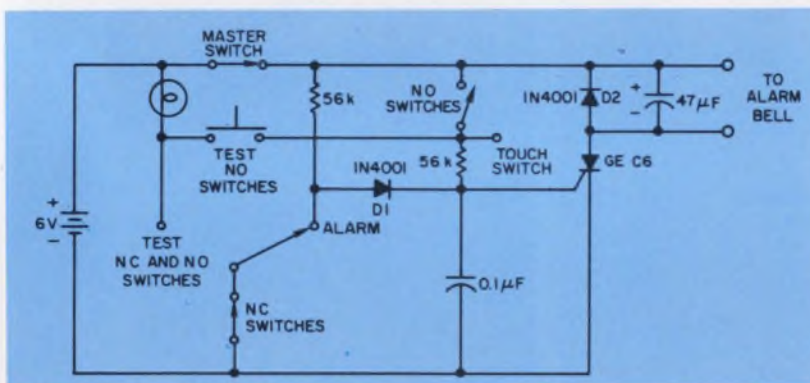
Carrier-current systems offer many of the advantages of the rf systems but at a lower cost. Instead of having an individual transmitter for each sensor, they use standard house wiring as the transmission medium. The alarm receiver may be placed anywhere in the house, as may the sensors. Each sensor is plugged into the ac wall socket, thereby eliminating installation problems.

Another spot-alarm system, the closed-circuit, consists basically of normally closed sensors connected in series and then linked to a latching circuit. All connections are done by external wiring, and that is the major disadvantage of this system. It is, however, fairly inexpensive and very reliable.

Several manufacturers, such as EICO (Electronic Instrument Co.) of Brooklyn, N.Y., and the On-Guard Corp., Carlstadt, N.J., are coming out with do-it-yourself home-security systems that have several sensing switches, latching circuitry and an alarm bell. Systems of this type start at \$75.

An important factor in the design and installation of home-security systems is the need to hold down false alarms. Thomas Wedick, sales supervisor for Holmes Protection, Inc., New York City, says that, on the average, for every 100 alarms that consumer systems transmit to the police, 97 are false. Because of this, he notes, the police in some areas are starting to levy fines for false alarms. In Westchester County, N.Y., for example, the first false alarm brings a fine of \$10, and this increases to \$15 and then \$30 for subsequent infractions. ■■

A \$3 burglar alarm—it works



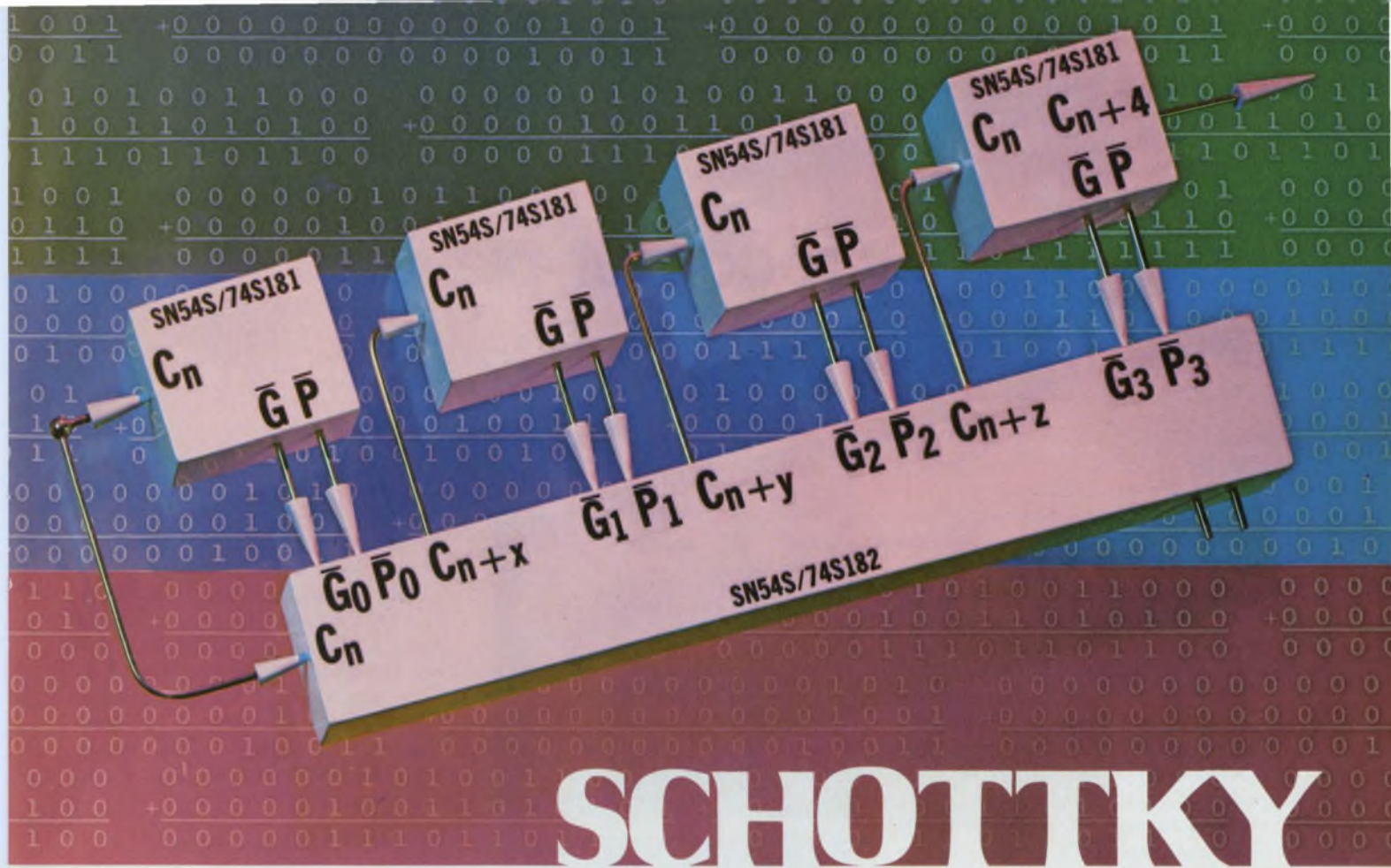
Want a simple alarm system that costs only about \$3 to build? Here's one that Associate Editor Jules H. Gilder came up with while doing research for his article.

The system accepts both normally open (NO) and normally closed (NC) switches and can also be used as a touch switch. For this use, the metal object to be protected is connected to the circuit by a single wire.

When a normally closed sensor is opened by an intruder,

current flows through diode D1, triggering the silicon-controlled rectifier and sounding the alarm. Alternately, if one of the normally open switches closes, current flows through that switch to trigger the alarm.

The system also contains circuitry to test normally closed switches to make sure they are operating properly. In addition, the pushbutton can be used to determine whether or not normally open (NO) switches are in an alarm condition without sounding the alarm.



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COMPARATIVE SPEEDS

Bits	Schottky S181/S182	Standard S181/S182	ALU Units	Look-ahead Units
1-4	11 ns	24 ns	1	0
5-8	18 ns	36 ns	2	0
9-16	19 ns	36 ns	3-4	1
17-64	28 ns	60 ns	5-16	2-5

High performance for new designs

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TEXAS INSTRUMENTS
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Low-cost TV recorder-player systems on the way—finally

After a decade of development effort by major firms such as RCA, CBS and Sony to produce a low-cost video recorder-player for the home television market, only one company—Cartridge Television, Inc., Palo Alto, Calif.—is delivering hardware. However, other video units are close to introduction.

For example, RCA has demonstrated a new magnetic-tape cartridge video unit—the MagTape Selectavision—that it expects to produce and also sell to other manufacturers of entertainment products, including Magnavox, by late 1973. Target price for the MagTape unit is about \$700, according to RCA.

The playback-only color video disc and its player have now appeared on the scene with units using electromechanical playback systems. Thin plastic discs are rotated at speeds as high as 1500 rpm. Piezoelectric cartridges repro-



The precision tape transport is a vital component of RCA's new MagTape cartridge video recorder.

duce hill-and-dale recordings impressed on the discs.

Zenith recently demonstrated such a system in Chicago. Teleddec—an R & D organization owned by Decca in England and AEG-Telefunken in Germany—plans to

demonstrate its own version in the U.S. later this year. Teleddec's system is a refinement of their black-and-white disc and player previously developed.

The Teleddec system uses a 21-cm disc that gives five minutes playing time. A player for a single disc will sell for about \$275, says Leo Hofberg, manager of special projects for London Records, Inc., New York City—Teleddec's U.S. representative. RCA is currently working on a similar system.

Industrial systems available

There are available, or coming into production, a number of industrial video recorder-playback units produced by such manufacturers as Sony, Panasonic, JVC, Concord, Akai, Ampex and Norelco.

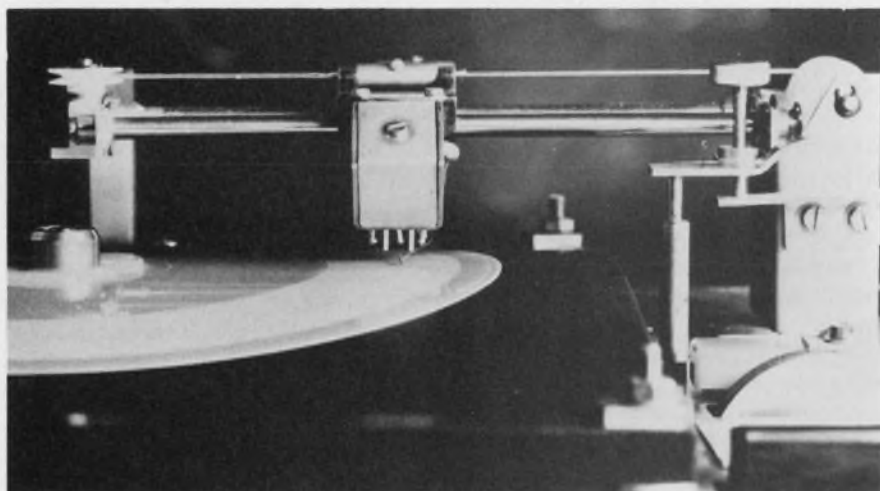
While these firms point out that their units can be used with home television receivers, a survey by ELECTRONIC DESIGN indicates that these systems are sold only to the industrial, commercial and educational markets. The reasons given by the companies are: the relatively high price of the devices and the reluctance of the manufacturers to enter the risky consumer market at this time. These systems typically sell for \$1000 or more.

A 25-inch color TV console incorporating Cartridge Television's 1/2-inch magnetic tape Cartrivision player sells for \$1350 at Sears and Roebuck in Chicago.

The cartridges come in two sizes: 15 to 30 minutes and 30 minutes to 114 minutes. A black and white TV camera for home movies can be added to the system for \$250 extra.

The Cartrivision systems are now being installed in the sets of Admiral, Warwick, Emerson, Teleddyne, Packard Bell, Montgomery Ward and Sears. ■■

Jim McDermott
Eastern Editor



A thin plastic disc coated with foil spins at 1500 rpm in making video hill-and-dale recordings in Teleddec's system. Single-disc players and automatic changers with two hours playing time are under development.

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Bendix

SCIENCE/SCOPE

A "four-for-four" record for the Intelsat IV was achieved recently when the fourth of the giant communications satellites was successfully put in orbit over the Indian Ocean. It joins the Intelsat IVs already stationed over the Atlantic and Pacific to complete the global network. The newest satellite increases by five times the communications capacity among 17 nations in Africa, Asia, Australia, and Europe. It was built by Hughes and an international team of subcontractors for Comsat, manager for the 83-nation Intelsat Consortium.

A small hand-held surgical instrument that uses space-age thermal transfer techniques to bring cryogenic temperatures directly to a surgical area was introduced at the 71st Annual American Proctologic Society Conference in New York recently. Called the KryostikTM, it consists of a 12-inch probe and a ½-liter reservoir that can sustain the probe tip at temperatures lower than -190°C for over 30 minutes. It will be manufactured by Hughes and marketed worldwide by the Ritter Company, division of Sybron Corporation.

The U.S. Air Force's F-15 air superiority fighter, rolled out in St. Louis recently by McDonnell Douglas Corp., will have an attack radar system developed by Hughes which acts as an electronic extension of the pilot's eyes and mind. It automatically scans and acquires targets, makes complex computations, and displays on the cockpit windscreen the instant information he needs for successful air-to-air combat. The new radar makes the F-15 the only USAF fighter that can locate and track low-flying aircraft in the ground "clutter" that blinds conventional radars.

A new high-temperature strain gage for testing aircraft, missiles, and space vehicles in a simulated flight environment has been developed for the U.S. Air Force by Hughes. It can measure structural stresses imposed at temperatures up to 2000°F, producing capacitance instead of resistance changes as a measure of strain. Only ½-inch long, it can be welded or bonded to airframe surfaces. DoD and NASA have bought several hundred of the gages for use in such programs as the space shuttle.

Hughes has immediate openings for engineers in the following categories: field engineers, technical instructors, ground support equipment engineers, test equipment design engineers, technical writers, and configuration engineers. Must have at least a BSEE degree. All openings require U.S. citizenship. Please write: Mr. H. G. Staggs, Hughes Aircraft Company, Field Service & Support Division, P.O. Box 90515, Los Angeles, CA 90009. Hughes is an equal opportunity M/F employer.

Microwave filters for communications satellites and other spacecraft must be made of material with very low thermal expansion. So far, the only successful material has been invar, a very heavy alloy of iron and nickel. On some recent satellites, as much as 120 pounds of invar filters have been used. Now Hughes has developed prototype microwave filters made of graphite epoxy composite materials. They have performed better than their invar counterparts, weigh only 20 to 40 percent as much, are much easier to manufacture, and are expected to cost less.

Creating a new world with electronics



technology abroad

A universal logic element, consisting of two transistors, two diodes and several passive components interconnected on a hybrid substrate, has been devised by engineers at Hafo Maskin in Gutebord, Sweden. By external connections to this hybrid building-block module, circuits such as Schmitt triggers, flip-flops, multivibrators, shift registers, AND gates and OR gates can all be fabricated. The great advantage of this hybrid module over equivalent monolithic circuits is that it does not require a highly stable power supply and is more immune to noise.

CIRCLE NO. 441

A small transmitter/receiver for PCM television, operating in the Q band, has been designed by the British Royal Radar Establishment. Conversion equipment to encode and serialize the TV video information, prior to transmission at 30 GHz, is supplied by Micro-Consultants Ltd. The equipment is both a transmitter and receiver, with de-serializing circuitry for reception functions. The unit includes an a/d converter producing an eight-bit parallel data word at 15-MHz word rate. The parallel data are serialized at 120-Mbits/s and transmitted via microwave. Received signals are first de-serialized, then reconstituted into analog information by a high-speed d/a converter.

CIRCLE NO. 442

A barrier-injection transit time microwave diode capable of a continuous power output of 115 mW at 6.6 GHz has been developed by the Swedish Microelectronics Institute. The Swedes say this is the highest power and the highest power-frequency-squared product obtained to date in this type of diode. The device offers a signal-to-noise ratio of 10.5 dB at 7 GHz,

and an oscillator FM noise measure of 15 dB with 1 MHz of carrier.

CIRCLE NO. 443

A 4096-bit MOS memory on a single chip to be available later this year, has been announced by Britain's Mullard. The new design is based on an earlier 1024-bit RAM, measuring 3 by 4 mm, with an access time of 220 ns. The 4096-bit RAM will be produced on a silicon chip that is only 40% larger than that of the 1024-bit device. British market experts are predicting that semiconductor memories will, in the next two years, take over half the market now held by ferrite memories.

CIRCLE NO. 444

An exposure-control circuit from Philips of the Netherlands makes possible reliable photographic exposures when ambient light levels are as low as 0.01 lux (a clear moonlight night is about 0.25 lux). The high sensitivity is achieved by measuring the short-circuit current of a 3-mm² silicon photodiode mounted on the camera's hinged mirror. When the camera mirror is flipped out of the focal plane for an exposure, the light-level reading is stored temporarily in a memory circuit for reference. The photocurrent is applied directly to a converter that is series-connected with a dc amplifier. The converter maintains the photodiode voltage at zero regardless of the photocurrent delivered. The amplifier gain is adjusted to a value that is appropriate to film speed and aperture setting. When the short-circuit current reaches a preset reference value, a capacitor coupled to a trigger circuit discharges and closes the open shutter. The supply voltage is 4 to 6 V, and current drawn is 10 mA.

CIRCLE NO. 445

Hughes is in industrial electronics, too: components, equipment and systems.



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HUGHES

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Examine HP's new low-cost multimeter 3490A. It's a full 5-digit instrument that's priced \$300 less than two other major manufacturer's units—yet its low price includes Self Test.

Self Test is the built-in bonus you get because the circuits within the 3490A perform double-duty. Design scrutiny coupled with unique signal routing let us include Self Test without adding more circuits, and without raising the price.

Always Ready—Need to use your DMM? Simply flip the switch and Self Test tells you that 3490A is ready to perform. With a 3490A, you'll never be in doubt concerning your DMM's readiness.

Programmable—For systems work, 3490A's Self Test is remotely programmable, which lets your computer determine its operational capability *before* you start to measure data. You'll have assurance that your DMM is ready to tackle its assigned tasks.

Cuts Equipment Costs—Because calibration is aided by Self Test, the time needed to calibrate your 3490A is trimmed significantly, while the need for costly calibration equipment is reduced. And, if problems ever should occur in your 3490A, Self Test will assist your technician in isolating the fault.

Price for the 3490A is just \$1650 which includes AC, DC, Ohms, and Self Test functions. (Systems features—isolated BCD output and isolated remote control are low-cost options.) For further information on the 3490A, contact your local HP field engineer, or write Hewlett-Packard, Palo Alto, California 94304. In Europe: 1217 Meyrin-Geneva, Switzerland.

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AO92/3

DIGITAL MULTIMETERS



washington report



Michael H. Blake, Jr.
Washington Bureau

McGovern is firm on defense cut plan

Many who paid little or no attention to Sen. George McGovern's (D-S.D.) "alternative national defense budget" last January when he was a very dark horse candidate for president of the United States are now studying it carefully.

Despite a strong attack on the plan by Defense Secretary Melvin Laird a week before the nomination and the mollifying effect that actually winning a nomination sometimes has, McGovern has stuck to his guns. On the day following the nomination, a legislative advisor to McGovern, Ann Purcell, told *ELECTRONIC DESIGN* that the Senator's position on slashing the defense budget by \$30-billion over the next two years remained unchanged.

Such action, Secretary of Defense Melvin Laird told Sen. William Proxmire's (D-Wis.) Appropriations Subcommittee on Foreign Operations, would amount to a "white flag surrender budget." Among other things, Laird charged, the McGovern plan would: (1) damage, possibly beyond repair, the nation's industrial and technological capacity by eliminating or drastically reducing basic research and exploratory development work; (2) destroy thousands of scientific and technical jobs in the U.S. with a guaranteed loss of the technological superiority which the U.S. currently possesses; (3) practically eliminate the needed modernization of our forces and result in the padlocking for half a decade or more of many U.S. shipyards engaged in naval construction programs; and (4) create employment turmoil by rapid and massive reductions and redistributions of both civilian and military manpower.

Eximbank spurs \$75-million in electronics exports

The U.S. Export-Import Bank (Eximbank) is helping a number of countries, Asian and European, including Yugoslavia, buy industrial electronic equipment and jet aircraft from the United States. The total sales at this time amount to approximately \$75-million.

An electronics firm in Yugoslavia, named Cajavec, has received a direct loan of \$4.5-million from the Export-Import Bank plus another \$4.5-million loan, arranged by Eximbank, from the United California Bank. Cajavec will buy measuring instruments and systems for developing and testing TV sets. Cajavec will also buy electronic equipment needed to set up production lines for manufacturing car radios and printed circuits. The company also plans to build an entire hybrid circuit facility with the money.

Eximbank also made \$18-million available to Comco International, Inc., in Brussels, Belgium, to aid European firms buy up to \$40-million in U.S.

computers and related equipment. Comco is a wholly-owned subsidiary of Commercial Credit Co., which in turn is wholly owned by Control Data Corp. CDC expects to sell computers to Australia, Canada, Thailand, Mexico and all the major countries of Europe.

Eximbank authorized a credit of more than \$6-million and agreed to provide guarantees of loans totaling more than \$11-million, if requested, to Union de Transports Aeriens, S.A. of France for the purchase of a DC-10 jet liner, related spare engines, parts, equipment and services. The total buy may reach \$26.2-million. Part of the financing will be handled by McDonnell Douglas and General Electric.

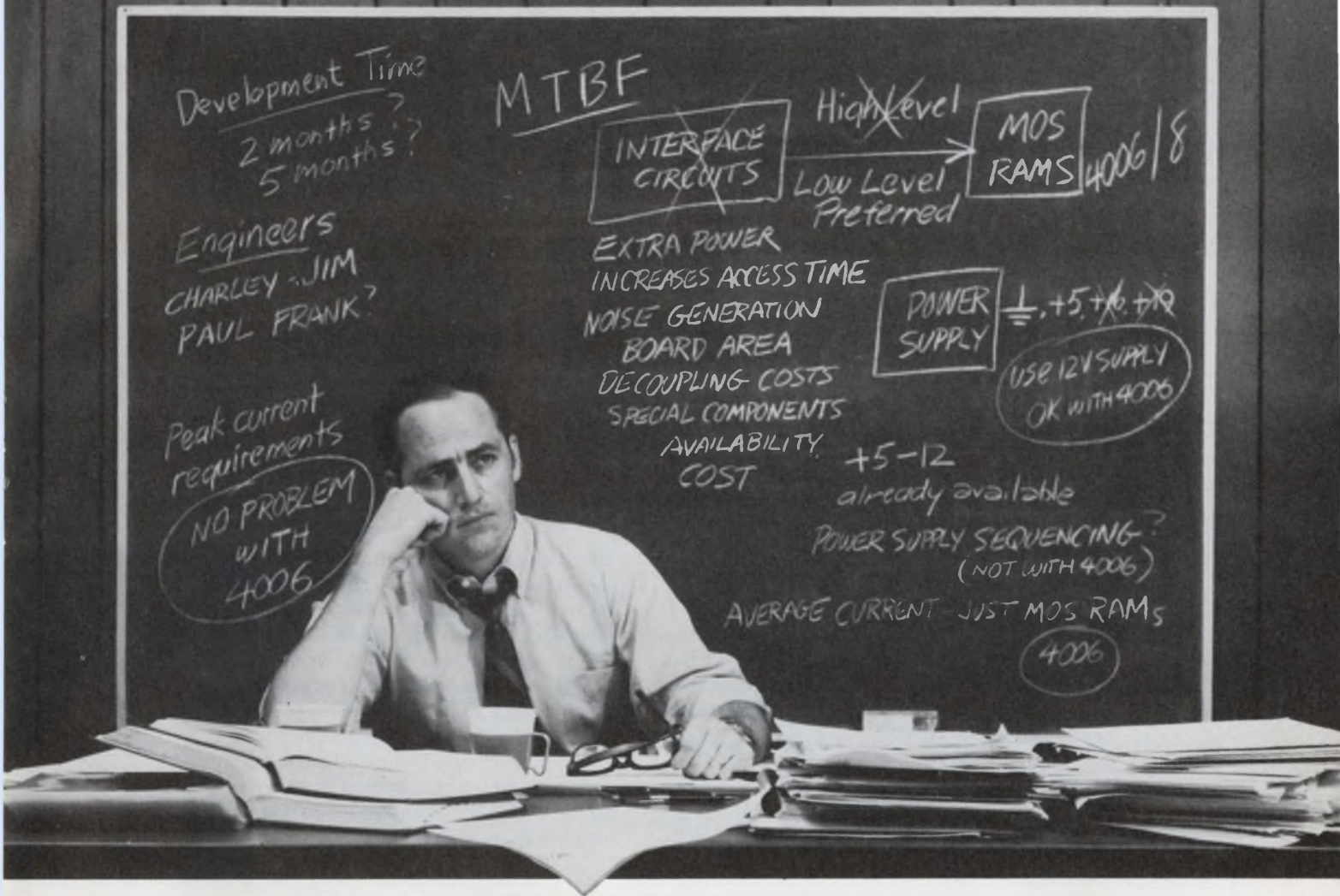
Lockheed lands Arts-II airport systems pact

A computerized air traffic control system for low-density airports is being built by Lockheed Electronics, Plainfield, N.J., for the Federal Aviation Administration. The \$1,561,935 contract covers manufacture and delivery of a prototype of the system known as the programmable Arts-II (Air Route Traffic Control) system. After testing and evaluation of the system, FAA plans to buy 208 systems valued at approximately \$35.5-million for installation at 207 low density airports around the country. The Lockheed system consists of a Mac-16 minicomputer, data acquisition subsystem and data entry and display subsystem.

Japanese TV yoke anti-dumping probe dropped

The Treasury Dept. has "tentatively" discontinued investigation of the case involving the dumping of color TV deflection yokes into this country by Japan. Assistant Treasury Secretary Eugene T. Rossides said the investigation revealed some instances where the yokes were being sold in the U.S. cheaper than the going Japanese prices, but that these sales were "minimal in terms of the volume of sales involved." He added that formal assurance was received from the sole manufacturer involved that no future sales for export to the U.S. will be made at less than fair value.

Capital Capsules: The last contract has been awarded in the U.S. supersonic transport (SST) program that was killed last year. **The FAA awarded \$3-million to General Electric, Evendale, Ohio, to complete research on jet engine noise reduction.** Transportation Secretary John A. Volpe said that the results will be made available to Government and industry for other advanced aircraft engine systems . . . **The Federal Communications approved a request by the Communications Satellite Corp. (Comsat) for permission to continue supplying satellite communications service to NASA in support of the Apollo space project until December 31 of this year, the scheduled completion date of the project.** Opposing the request were ITT World Communications, RCA Global Communications, and Western Union, who claimed they were also able and willing to provide the service. . . . **The National Academy of Sciences is seeking new information on low-exhaust emission engines.** Submissions should be sent no later than Aug. 7 to the Executive Director, Committee on Motor Vehicle Emissions, National Research Council, 2101 Constitution Ave., N.W., Washington, D.C. 20418.



Looking for semiconductor memory components that fit your system?

Our 1024-bit MOS RAM checks out. Try it in for size.

If you're designing memory systems for such applications as computers, peripherals, office machines or terminals you're concerned about a number of critical items. Look at that cluttered blackboard for a starter! So which RAM to choose? We've got some ideas that will help you make up your mind. Read on . . . and see how our 1024-bit MOS RAM, the MK 4006 P, checks out against your system requirements.

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marketplace more quickly. This means a lot — not only to your marketing people but to your customers as well.

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End of checklist? Not really. We invite you to check around. Find out who's buying 1024-bit MOS RAMs and who's shipping them in quantity. (You might be surprised at where the action is.) Then call your nearest MOSTEK sales office, representative or distributor. *We'll help you make up your mind — while we take a load off it.*



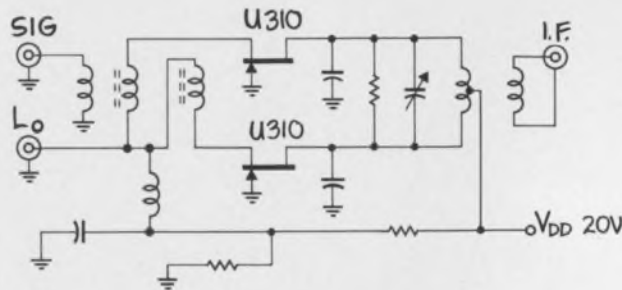
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Try our U310 junction FET in this balanced mixer and make your own performance comparison. Our results are below. The inherent square-law transfer characteristic of the FET ensures high intermodulation intercept and signal desensitization. The grounded-gate connection is most stable, while source injection of both the signal and local oscillator make easy impedance matching into the FETs. Also, the balanced configuration reduces l.o. radiation from the signal port and suppresses the generation of even harmonics (which helps reduce intermodulation).

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50-250 MHz Mixer Performance Comparison

Characteristic	JFET	Schottky	Bipolar
Intermodulation Intercept Point	+ 32 dBm	+ 28 dBm	+ 12 dBm [†]
Dynamic Range	100 dB	100 dB	80 dB [†]
Desensitization Level (the level for an unwanted signal when the desired signal first experiences compression)	+ 8.5 dBm	+ 3 dBm	+ 1 dBm [†]
Conversion Gain	+ 3 dB*	- 6 dB	+ 18 dB
Single-sideband Noise Figure	6.5 dB	6.5 dB	6.0 dB

[†] Estimated * Conservative minimum

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and get the complete story on VHF/UHF mixing and the Siliconix U310.

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We ain't so smart; We need your help

Every month about a thousand of you use our Information Retrieval Cards to let us know what you like in *ELECTRONIC DESIGN*, what you don't like and what you would like. If we were as smart as we'd like to be, we wouldn't need this feedback. We'd always know the subjects that would be most useful to you at any particular time. We'd know which authors to get for you. And we'd know which products to examine in *FOCUS* reports. We're not that smart.

But we've been lucky. In most cases we've been able to anticipate your suggestions. For example, we were preparing reports on function generators, CMOS ICs, fast-logic ICs, industrial electronics, consumer electronics, calculators and cassette and cartridge recorders before we started receiving your recommendations for covering these subjects. We can't depend on luck, however.

There are subjects we're planning now that we might have missed without your guidance. There are others we planned without your help; we won't know if these were good choices till they're published. And that's not the best way to put out the best magazine.

Of course, we must use our own judgment. We obviously can't follow the advice of both R.W. Raible of the University of Arkansas in Little Rock and J.S. Killarney of Control Service Associates in Sausalito, Calif. Raible wrote: "Don't start articles on economics, markets, etc. Stick to engineering." And Killarney wrote: "Get some market research ideas, techniques. Please." At times it's difficult for us to gauge your feelings, though it's useful for us to know that they are varied.

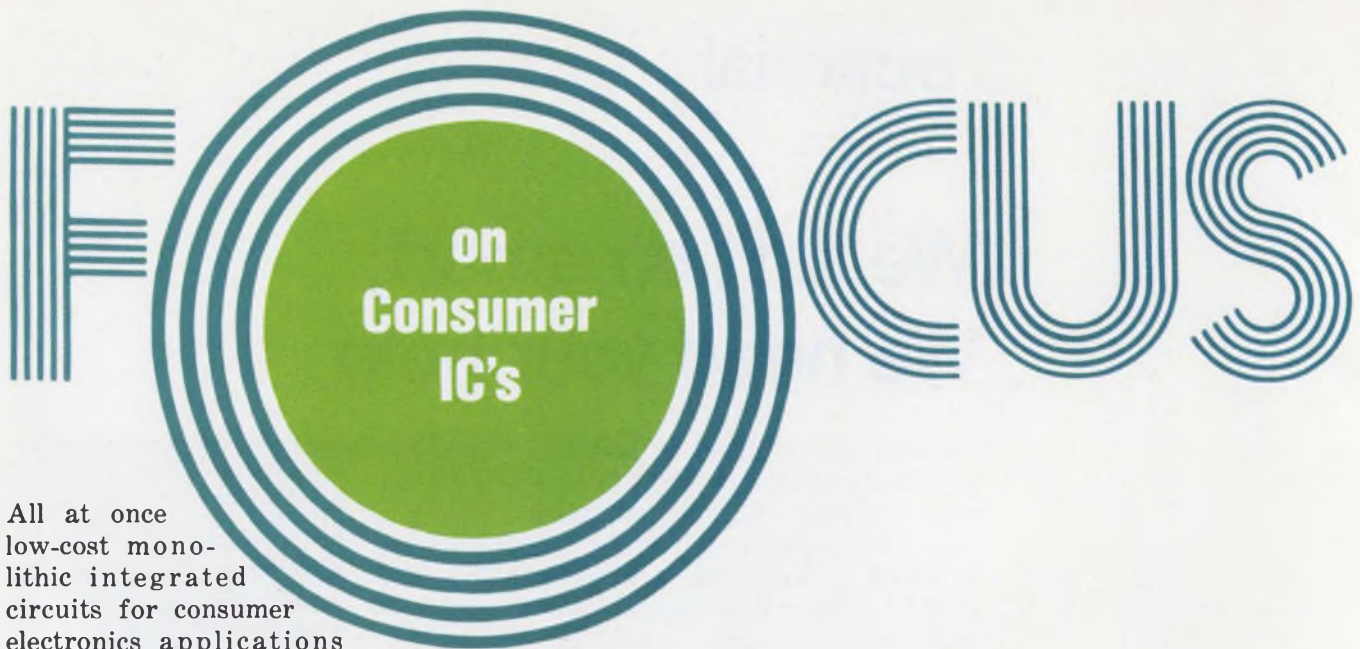
A recent editorial, for example, drew responses like these: "I liked very much the editorial 'The Curse of Courtesy.' Keep doing it this way." . . . "I liked the editorial. However, I don't agree." . . . "Avoid obscenity and profanity. A breakdown of moral standards is contagious and dangerous. We've gone too far." . . . "Loved your editorial. It really hit the nail. Let's have more like it." . . . "Very much liked your editorial posture. Don't always agree, but your ideas start us thinking."

And there's the key. We may not always agree but *your* suggestions can start us thinking of newer and better ways to help you. Please keep them coming.



A handwritten signature in dark ink, which appears to read "George Rostky". The signature is fluid and cursive.

GEORGE ROSTKY
Editor



Focus on Consumer IC's

All at once low-cost monolithic integrated circuits for consumer electronics applications are all the rage. Linear ICs are turning up as functional building-block circuits in color television, FM receivers, phonographs, automobile tape players and multichannel sound systems. Digital ICs are finding their way into such products as electronic organs and rhythm instruments, hand calculators and quartz-crystal-timed wristwatches and clocks.

The linears look like a simple answer to a designer's problem. And IC manufacturers tend to promote them on that basis by contending that they can be connected into an over-all design with little difficulty, thus saving design effort that normally would go into constructing a circuit board full of discrete components.

But it just isn't so.

"Designing with consumer ICs is fully as time-consuming as with discrete circuits," says Lee Hoke, supervisor of solid-state color TV design for Philco-Ford, Philadelphia. "Most of the time it's even more so. Applying consumer IC building blocks is no longer a straightforward circuit substitution problem. It's a different ball game—it's subsystem integration."

ICs are complete subsystems

The linear IC building blocks contain complete subsystems—circuits like a video i-f channel or a TV sound i-f system—on a single chip. The subsystems typically come in 8, 14 or 16-pin, dual-inline plastic packages. And therein lies a potential pitfall. If the IC circuit doesn't work properly when integrated into the finished product, you can't get inside it. You can't tweak one or two of the components, as with a discrete com-

ponent layout, to get the circuit working properly. You have to reject it.

As one designer interviewed by *ELECTRONIC DESIGN* put it, "As yet, it's a high-risk game."

Robert B. Hansen, manager of consumer product engineering for Motorola's Entertainment Products Div. in Chicago, sums up the design situation this way: "The use of linear ICs in consumer products is still an emerging art. From both the manufacturer and user's viewpoints, we are going through the same learning process the industry did with transistors."

Complicating the problem, Hansen says, is this fact: Manufacturers are offering many essentially untried IC types to encourage their use. But just having an IC that performs a function isn't of too much use, he notes. The devices must be carefully integrated into circuits, and they may not work with any of the basic electronics the designer has on hand.

There is, however, one way that large electronics manufacturers—those whose requirements are in the millions of units—can go, and that is to select new circuits of potential use and then spend several thousand dollars per circuit with an IC manufacturer to develop that circuit.

But the smaller manufacturers, whose requirements are only in the thousands, have a handicap. They can, for cost reasons, only incorporate what's already available, depending upon the skill of their designers and the assistance of application engineers supplied by the IC manufacturer.

The available specifications and application data for consumer ICs range from sketchy sheets to detailed pages of helpful material. Some of the latter—such as data put out by RCA and Motorola—contain full-sized layouts of PC

Jim McDermott
Eastern Editor

boards, complete with provisions for both discrete and IC components and ready for photographing by the user.

In addition small users can profit from the experience of designers who are successfully incorporating these IC subsystems in their products, of which color TV represents one of the toughest design problems.

With all the apparent limitations of consumer ICs, a natural question is: Why use them at all? There must be something good to be said for them, because all the large manufacturers are using them, ranging from four ICs in Zenith's 1973 top-of-the-line color television to 10 in Philco's comparable model.

When to use a consumer IC

Motorola's Hansen sums up the consensus among leading manufacturers. A consumer IC should be used, he says, when it can do the following:

- Reduce costs over discrete counterpart circuitry.
- Improve performance and provide extended performance at peak performance levels.
- Provide higher reliability—although this is one area where risks must be taken at present.
- Provide some circuit function that wasn't available before.

Cost is repeatedly emphasized as the leading factor in choosing ICs, but RCA balances this against performance.

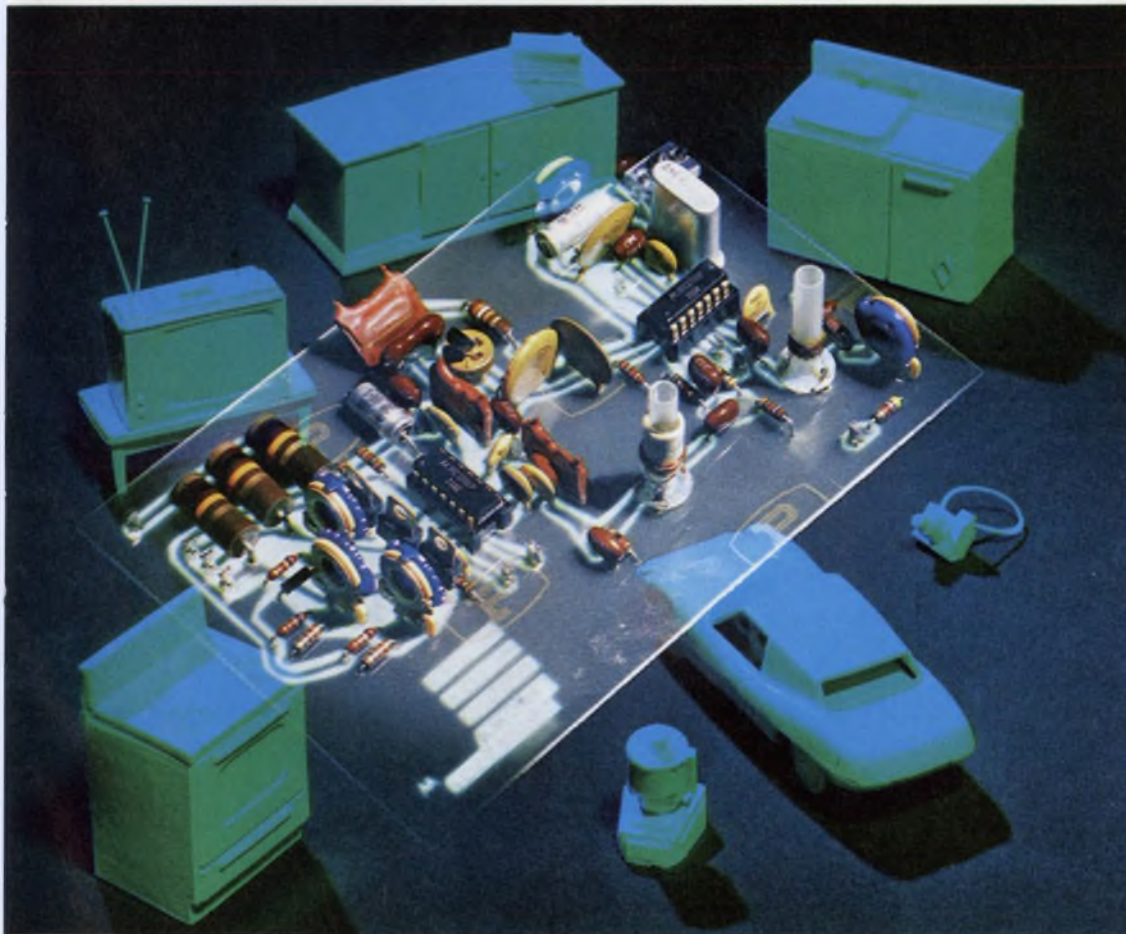
"If a circuit is clearly superior to that of its discrete counterpart," says John Konkle, manager of electrical engineering for color TV at RCA in Indianapolis, "we'll use it, even though it costs a bit more."

Looking at the problem from the viewpoint of automotive applications, Fred Bauer, electrical systems engineer in the Ford Motor Co.'s Product Development Group, Dearborn, Mich., says that in addition to lowered costs, Ford requires that an IC meet these criteria:

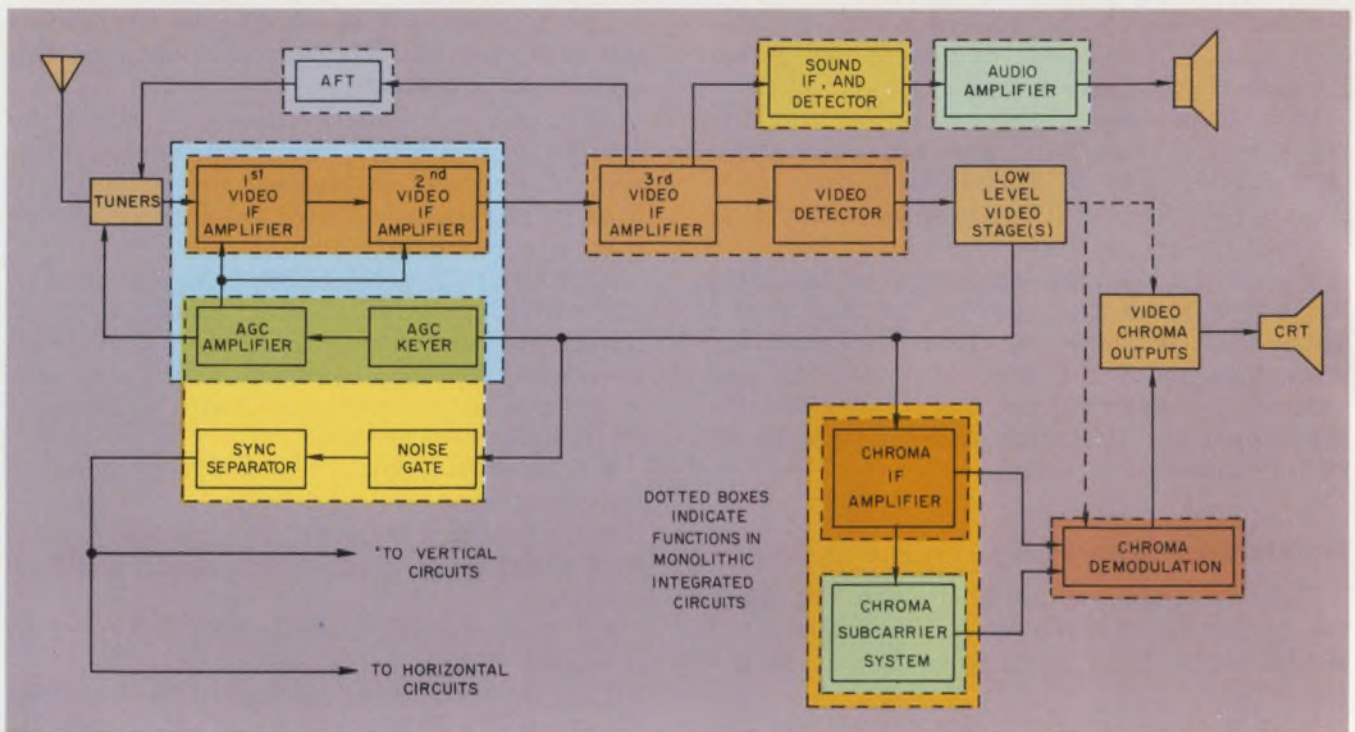
- It must be a device that can be produced in high quantity.
- It must be a "mature" IC—that is, it must have a history of proved performance and high reliability.
- It must decrease the size of the unit in which it is used.

These factors, Bauer points out, have dictated the use of ICs in Ford's AM/FM stereo receiver for 1972 and 1973 autos. This radio has two ICs in the FM i-f system, and it also has a stereo multiplex decoder IC.

In 1973, Bauer notes, Ford will incorporate additional ICs, because the AM/FM stereo receiver will have added to it an eight-track tape system. In this case the tape-driving mechanism



Integrated circuits are being applied in consumer products in substantially increasing numbers. A wide variety of linear IC packages, like those on the chroma board for a color TV, are available.



ICs are being used in color television receivers to perform several subsystem functions. The ICs, indicated by dotted boxes, can provide complex circuits and better

performance than normally attainable from discrete circuits. Lower assembly costs and improved reliability are advantages. Better performance may be another plus.

takes so much space, he says, that the rest of the radio has to be smaller.

Production volume has a considerable impact on whether or not ICs are used, Bauer notes. He points to an antitheft system that Ford will market next year for the first time. It monitors the hood, the trunk lid and the doors of a car. It is armed as you leave the vehicle. If the car is disturbed, the horn honks for several minutes. Ford is using discrete components in this, Bauer says, because the demand for the system is not yet up in the hundreds of thousands.

If the IC is still new—in its first year of use, say—Ford is inclined to wait before trying it. The use of discrete components permits continuous changes in production. If a computer line runs into problems with some digital circuits, it can be shut down, Bauer notes, but you can't shut down an auto production line without disastrously high economic losses.

The new ICs are not without their flaws. The transistor, Motorola's Hansen notes, was a simple, three-terminal device that could be readily interchanged with another transistor. A change in its external circuitry could easily compensate for undesirable operating characteristics. But as more and more circuitry is packed inside the consumer IC, the manufacturer is limited in his ability to compensate for faults in processing. These faults include leakage, channeling and poor topography, among other things.

For these reasons, Hansen warns, the designer must protect himself against poor batches with

a reasonably long lead time.

One problem with present consumer ICs, says Philco's Hoke, is that IC manufacturers have had only limited experience in producing these linear circuits with highly competitive processes; they're still learning.

But even when the designer has protected himself with sufficient lead time and his QC department has passed devices that appear to be good, he still can have plenty of problems with the plastic encapsulation used on the majority of consumer IC packages.

Plastic ICs, Hoke says, are generally subject to the same failures that plastic-encapsulated transistors are—lead corrosion and lead-bond separation or fracture. And because hermetically sealed TO cans and ceramic hermetic packages cost more, the plastic package is something the consumer electronics designer must live with.

Plastic-encapsulated devices, Hoke says, are lot-sensitive when it comes to corrosion. As a result, it is possible to have a bad lot show up after it's out in the field. The electronics manufacturer then can either recall all the known defective units or sit by uncomfortably while failures progress for weeks or months.

To avoid this, Hoke says, Philco samples incoming ICs and puts them through the standard pressure cooker test.

The smaller electronics manufacturer can protect himself against potential failures by following a procedure adopted by Zenith. In the early days of Zenith's use of ICs in color television, the

company designed standby modules with discrete circuitry, ready to substitute for any defective IC modules. Recent experience, says George Shupp, vice president and chief engineer at the Zenith Radio Corp., Chicago, has given the company enough confidence to consider shelving this approach.

The design engineer, says Motorola's Hansen, must program his activity to make sure he has more than one source for his ICs. He has to look at these ICs as if they had a 2N manufacturing number.

The IC manufacturer, in an attempt to develop an IC for a customer, will ordinarily make a limited run of a few thousand. If the designer samples and likes them and then wants a few hundred thousand or so, he can have problems in getting his supply, Hansen reports. One large order can wipe out an inventory.

The designer has to ask the supplier: How many ICs can I have and when? How many today? How many six months from now? What is the turn-around time for getting a corrected lot of ICs in case trouble appears?

In addition the designer has to ask himself: What are the detailed specifications on the device? This includes his own as well as the IC manufacturer's specs.

Specifications for new ICs, Hansen says, are invariably understated. As an example, he notes, only two or three pages are written by the IC manufacturer to describe the new device. After about five years' production, when the manufacturer understands a device, it may take 25 pages for the same description.

Cross-reference lists need checking

IC manufacturers, Hansen notes, provide lists that cross-reference their own products as equivalents of those of other manufacturers. But there can be enough differences to make direct substitution impractical. As a result, he cautions, don't take these cross-reference lists as gospel. Compare the specifications and look for the differences rather than the similarities.

In characterizing consumer IC specs at Philco, Hoke says they tend to be function-oriented.

"We deliberately try to specify those parameters at the terminals that will influence functional performance," he explains. "Then we try to set limits on the IC as to what it can tolerate, both signal and dc-wise."

At this point, Hoke notes, "we go back to the IC manufacturer and tell him, 'This is what we think the center of your distribution should be.'"

For a single manufacturer, this works fairly well, Hoke says. But for second-sourcing or third-sourcing, where the parameters don't track too closely, "we've run into trouble," he acknowl-

edges.

The alternative then is for the designer to modify the circuitry around the IC until all manufacturers' devices work in it. However, Hoke cautions, this is not apt to be easy, and designers generally resist this approach.

The testing of consumer ICs has a considerable bearing on their cost. As an example, Hansen at Motorola says: "If you look at the rock-bottom cost of a 14-pin, dual-inline IC and at the highest-priced device of a similar line, the cost difference is about 4:1, and most of this cost relates to testing."

Linear IC testing is the big hangup

Testing is the most important step in using consumer ICs, if production and field troubles are to be held down. It's vastly different from checking digital circuits, where the gates, along with a couple of leakage-current tests, can be readily checked.

Also, Hansen says, computer test programs aren't anywhere near sophisticated enough for linear ICs. Linear IC tests are jig types, he notes, and they depend on the capability and judgment of the people handling them.

Because the cost of the device depends so much on testing, IC manufacturers tend to do a minimum of it. The user, of course, should demand as much testing as he can. Somewhere between these two outlooks there is a compromise on costs.

"The manufacturer would like to specify all of the test parameters as dc measurements," says RCA's Konkle. "But then you have a serious correlation problem relating dc functions to your ac signal characteristics."

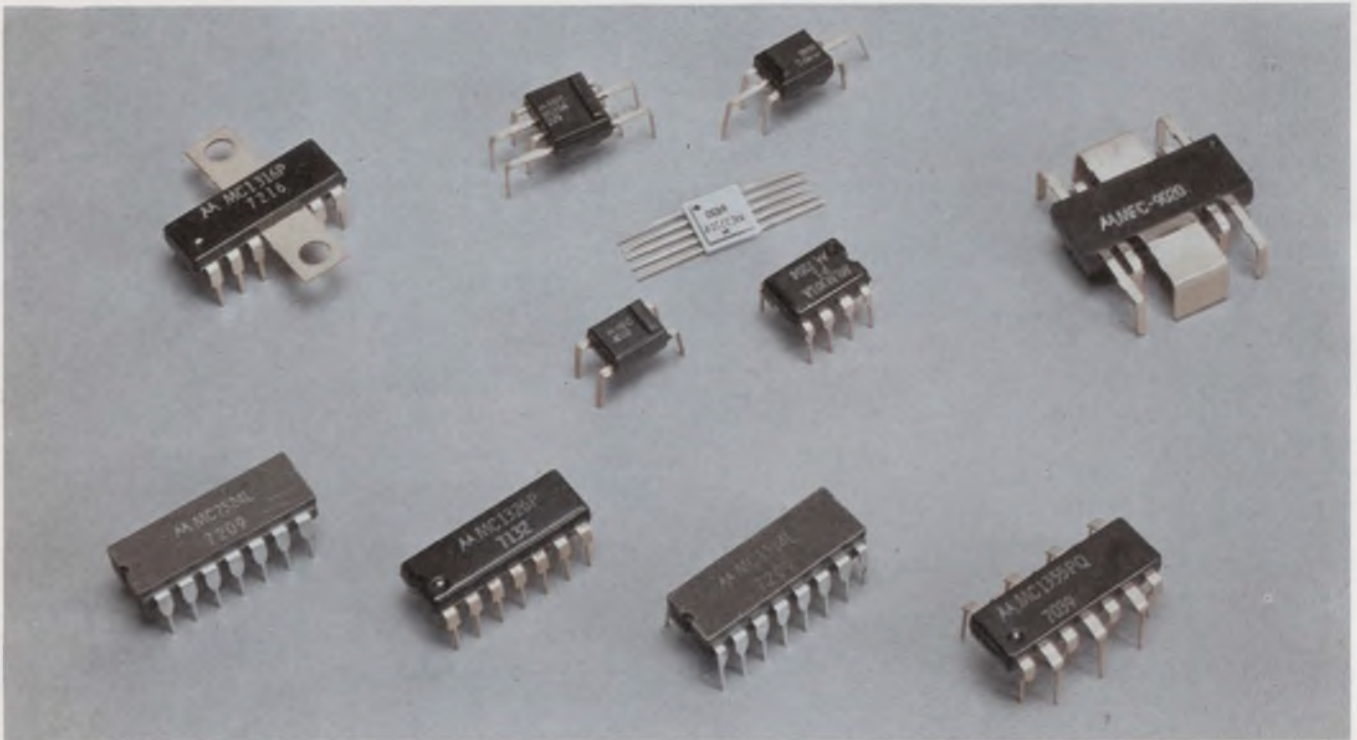
The type of testing and the extent of it depends, naturally, upon the environment in which the product will be used. An example is the worst-case environment of the automobile.

"In the electrical environment of the auto," says Ford's Bauer, "there are some 100 to 150 electrical components, many of which are sources of transients. To these spike voltages, all ICs are potentially fallible."

Influences entirely outside the automobile's environment may also affect the reliability or operation of circuits in the car. For example, car electronics are susceptible to strong radio broadcast fields. A car owner with an electronic door control may drive by a 50-kW transmitter and suddenly find the doors swinging open.

Because of the complex of systems in the car, each system must have very high reliability to make the over-all reliability acceptable, Bauer points out.

For example, he explains, Ford's "heat and beat" radio environmental specs exceed those of



Consumer ICs are produced in many encapsulated packages, like these from Motorola. The devices include those for power-amplifier applications, which require the broad

center strap for heat transfer. Sprague has a power unit with straps on the end to permit use of all of the center pins on the device.

the military and even NASA in some respects.

"We subject car AM/FM radios to 30-g shocks at the rate of one per second, while operating the set at 50% overvoltage—21 V," Bauer says.

In addition the radio is alternately cycled between a hot chamber at 185 F and a cold chamber at -40 F. The set is mounted on a tray with plug-in connections, so it can be rapidly lifted from the hot to the cold chamber. In the cold chamber, the set gets wringing wet.

Donald F. McGuiness, manager of integrated circuit and transistor operations at the Sprague Electric Co. Semiconductor Div., Worcester, Mass., agrees that the auto environment can be worse than the military's.

"For circuits designed particularly for cars, at present we add temperature compensation to a maximum of 125 C," he says. "But 135 C might be better."

In general, McGuiness says, the electrical and electronic circuits in the car must be overdesigned if they're to meet the reliability requirement of a 1% return on warranties.

Aside from the ICs for entertainment units, most of the electronics planned for the auto, McGuiness says, are control devices, safety devices and systems that perform routine functions that can't be done well mechanically. And many of these devices, he predicts, will be bipolar chips, with some low-power transistors that drive power transistors for energizing solenoids or other high-current devices.

Many consumer ICs are being incorporated in

plug-in modules or boards. The company's servicing philosophy and the price of the set determine whether sockets are used or the ICs are soldered into the circuit boards.

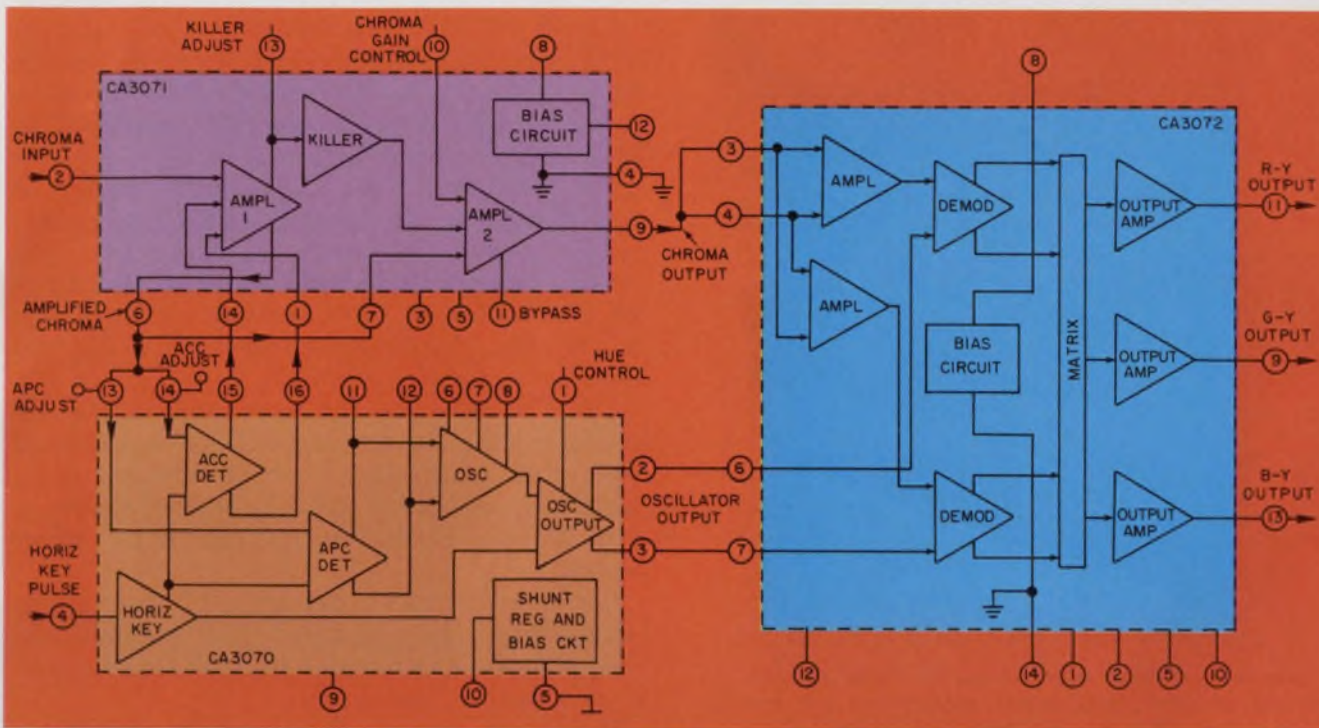
Zenith has all of the ICs in its color TV Duramodules set up as plug-ins, thereby giving the serviceman the option of replacing an entire module or just the IC itself. Many of the lower-cost TV receivers on the market have the ICs soldered in.

A manufacturer like Heath of Benton Harbor, Mich., uses ICs of several kinds—both linear and digital—in its kits. "Where we once soldered them in," says Raymond Freridge, manager of design engineering, "we now use IC sockets for ease of assembly and, we believe, greater reliability."

A definite trend in consumer entertainment ICs has been to incorporate more and more circuits in one package. Most consumer ICs developed so far have been low-level, small-signal linear circuits. But recently, at the IEEE Spring Conference on Broadcast and Television Receivers in Chicago, several manufacturers included not only low-level amplifiers but audio driver stages and power amplifiers, ranging from 1 to 5 W output, in the same IC package.

A logical question is: How much can you put on one chip?

"There is a practical chip size that you don't want to go above," says Motorola's Hansen. "So long as you can design your chip function within this size, it's economical."



A complete chroma system for high-quality television receivers, by RCA, comprises three IC packages. The IC at bottom left is a complete subcarrier regeneration sys

tem. A chroma amplifier, upper left, and a color demodulator, at right, round out the system. For lower-cost receivers, a two-package system is available.

RCA's Konkle agrees. "One of the major objectives," he says, "is to partition your functional circuits so as to minimize chip cost."

But Hansen points out that with ion implantation, the industry may in the future be able to get more on the same sized chip.

Using digital ICs in consumer products is easier than using linears, because the processing of digital circuits has been well developed over the last few years. Also, digital devices are much easier and less costly to test on automatic computer-controlled test equipment. Consequently the digital consumer designer has fewer quality-control problems.

Digital ICs simplify organ design

Many digital circuits are being used in musical instruments, such as electronic organs. Several suppliers provide low-cost digital frequency-dividers for this purpose.

"Digital ICs are used in our frequency-dividing and counting circuits," says Lee Childers, director of engineering for Thomas Organ, Chicago. "And we incorporate a programmed ROM to store the data that provide the various kinds of rhythm patterns that go with the separate rhythm accompaniment."

For wave-shaping and sound-effects circuits, Childer says, the company uses discrete components rather than ICs.

However, Childers points out, this is not a real penalty, since there is plenty of room inside these

instruments for discrete PC boards. And with the discrete circuitry, he says, Thomas is able to give the customer good quality and reliability at a competitive cost.

Digital circuits are available for other consumer applications, too. Timing-circuit ICs that can substitute for mechanical and electromechanical timers in appliances and household devices are being produced by Texas Instruments, Motorola, Fairchild and General Instrument. Two new arrivals on the timing scene have been announced by Exar Integrated Systems, Inc., and Signetics, both in Sunnyvale, Calif.

IC manufacturers producing digital circuits for wristwatches and clocks, as well as those making ICs for calculators, are in a unique position. Few design problems exist for these circuits; the problems involve assembly and packaging of these ICs into the end product.

Wristwatch and clock ICs are being supplied by U.S. manufacturers to watchmakers in this country and abroad. Recently wristwatch kits that can be put together by qualified assemblers were announced by Microma Universal, Motorola, and Optel, Inc. Some of these kits include the display.

Single-chip calculator ICs are being produced by TI, Mostek, General Instrument and Cal-Tex.

Of long-term significance is a trend in which digital circuitry is taking over functions formerly reserved for linear or analog circuits. One example is a digital FM stereo tuner produced by the Heath Co. The digital keyboard, pre-programmed cards or an automatic sweep system, to-



The take over of linear applications by digital circuits is beginning to take place. Initial applications are in TV and FM tuners, like this one from the Heath Co.

gether with associated circuitry, program a digital divider circuit. The divider circuit divides the tuner's voltage-controlled oscillator frequency and compares it with a reference frequency. The result of this comparison is the tuning voltage. Changing the divide ratio of the divider circuit changes the dc voltage applied to the tuner, and a new station is tuned in. A digital display of the station frequency appears on the readout.

Linear ICs for entertainment electronics are being produced by a number of suppliers. Generic types of these ICs—particularly those for television and FM receivers—are being marketed by more than one manufacturer.

For television, these IC building blocks, or subsystems, include chroma signal processors; multi-stage video i-f amplifiers; a video i-f amplifier and detector; a 4.5-MHz sound i-f and detector; jungle circuits (sync and timing functions); an automatic fine-tuning control and audio pre-amplifier and driver sections.

For FM receivers, the most popular ICs are multiplexer circuits that use coils, or phase-locked loops, and multiplexer circuits without coils; multistage 10.7-MHz limiting i-f amplifiers; a dual stereo preamplifier, and an audio driver section.

Combinations and refinements of the various circuits have been produced. For example, the chroma processing function is available as a two-IC or a three-IC subsystem.

In another case one TV sound detector has a conventional volume control, while a comparable IC has electronic attenuation of the sound signal.

Because of the wide variety of ICs available, and also because of possible differences between the same generic devices supplied by different manufacturers, the IC specifications have not been compared in this article.

In applying these ICs, users recommend a cross-comparison of specifications of interest and close liaison with the application engineering departments of the manufacturers. ■■

Need more information?

Readers who would like information on the specific consumer ICs may wish to consult the manufacturers. ELECTRONIC DESIGN is grateful to the following for their help in furnishing information for this report.

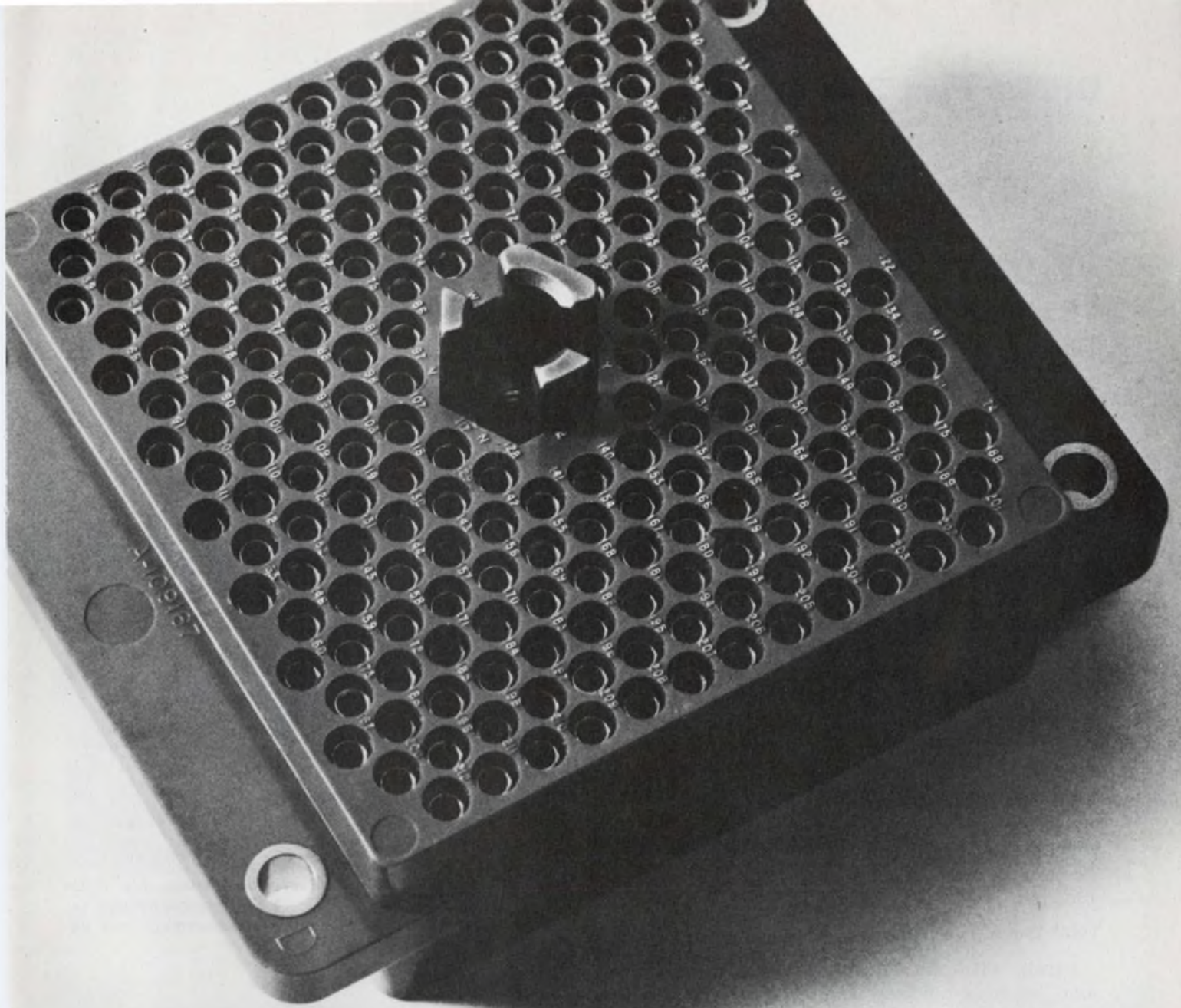
Entertainment ICs:

- Amperex Electronic Corp., 99 Bear Hill Rd., Cranston, R. I. 02920. (401) 737-3200. **Circle No. 400**
- Fairchild Semiconductor, 313 Fairchild Drive, Mountain View, Calif. 94040. (415) 962-5011. **Circle No. 401**
- Intersil Inc., 10900 N. Tantau Ave., Cupertino, Calif. 95014. (408) 257-5450. **Circle No. 402**
- ITT Semiconductors, 3301 Electronics Way, West Palm Beach, Fla. 33407. (305) 842-2411. **Circle No. 403**
- Motorola Semiconductor Products, Inc., 5005 E. McDowell, Phoenix, Ariz. 85036. (602) 273-3465. **Circle No. 404**
- National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. **Circle No. 405**
- RCA Solid State Div., Route 202, Somerville, N. J. 08876. (201) 485-3900. **Circle No. 406**
- Signetics Corp., 811 E. Arques Ave., Sunnyvale, Calif. 94086. (408) 739-7700. **Circle No. 407**
- Silicon General Inc., 7382 Bolsa Ave., Westminster, Calif. 92683. (714) 892-5531. **Circle No. 408**
- Solitron Devices, Inc., 8808 Balboa Ave., San Diego, Calif. 92123. (714) 278-8780. **Circle No. 409**
- Sprague Electric Co., 347 Marshall St., North Adams, Mass. 01247. (413) 664-4411. **Circle No. 410**

- Texas Instruments Inc., 13500 North Central Expy., Dallas, Tex. 75222. (214) 238-3741. **Circle No. 411**
- Transitron Electronic Corp., 168 Albion St., Wakefield, Mass. 01880. (617) 245-4500. **Circle No. 412**

Digital ICs:

- American Micro-systems, Inc., 3800 Homestead Rd., Santa Clara, Calif. 95051. (408) 245-0330. **Circle No. 413**
- Cal-tex Semiconductor, 3090 Alfred St., Santa Clara, Calif. 95050. (408) 247-7660. **Circle No. 414**
- Exar Integrated Systems Inc., 733 North Pastoria Ave., Sunnyvale, Calif. 94086. (408) 732-7970. **Circle No. 415**
- General Instrument Corp., Andrews Rd., Hicksville, N.Y. 11802. (516) 681-4300. **Circle No. 416**
- Hughes Microelectronics Products Div., 500 Superior Ave., Newport Beach, Calif. 92663. (714) 548-0671. **Circle No. 417**
- Inselek, University Park Plaza, 743 Alexander Rd., Princeton, N.J. 08540. (609) 452-2222. **Circle No. 418**
- Intersil, Inc., 10900 N. Tantau Ave., Cupertino, Calif. 95014. (408) 257-5450. **Circle No. 419**
- Micro Power Systems, Inc., 3100 Alfred St., Santa Clara, Calif. 95050. (408) 247-5350. **Circle No. 420**
- Mostek Corp., 1400 Upfield Dr., Carrollton, Tex. 75006. (214) 242-1494. **Circle No. 421**
- Motorola Semiconductor Products Div., 5005 E. McDowell Rd., P.O. Box 2953, Phoenix, Ariz. 85036. (602) 273-6900. **Circle No. 422**
- National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. **Circle No. 423**
- Optel Corp., P.O. Box 2215, Princeton, N.J. 08540. (609) 452-9250. **Circle No. 424**
- RCA Solid State Div., Route 202, Somerville, N.J. 08876. (201) 722-3200. **Circle No. 425**
- Solitron Devices, Inc., 8808 Balboa Ave., San Diego, Calif. 92123. (714) 278-8780. **Circle No. 426**
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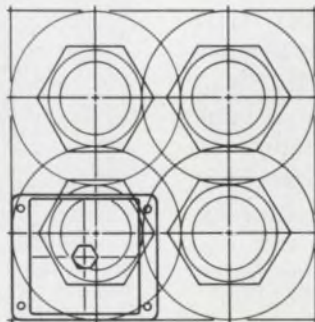
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DPMs--Part 3 of a series

Which DPM, five-volt or line powered?

The choice is not as simple as it seems but depends on the particular application.

The choice between the DPM powered from a 5-V logic supply and the more common DPM powered from the ac line involves many considerations.

There are, of course, some obvious differences in the two meters; 5-V DPMs cost less per unit, are smaller and require less power. However, a closer look at the two types reveals some subtle differences. The total system power consumption and dissipation may actually be greater for the 5-V unit. Also, with some 5-V units, additional ground-loop problems may occur.

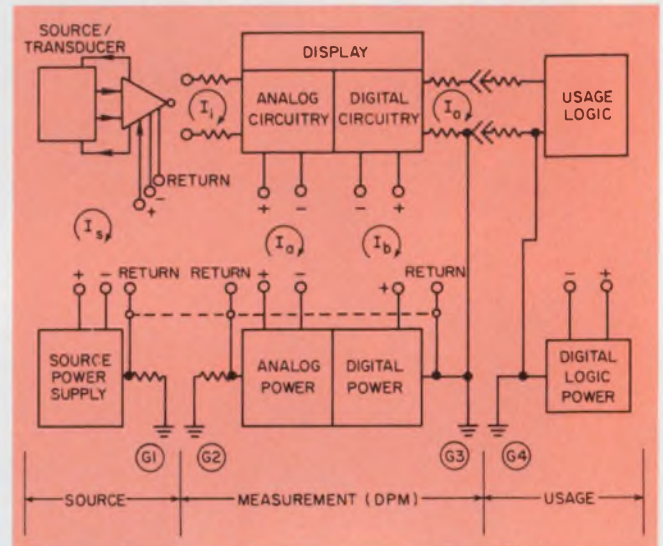
Thus a potential DPM user can be misled into making a choice based only on apparent cost, size and power consumption, when he should let his particular application determine which type to use. Let's look at the two DPM types in more detail.

Total power is what really counts

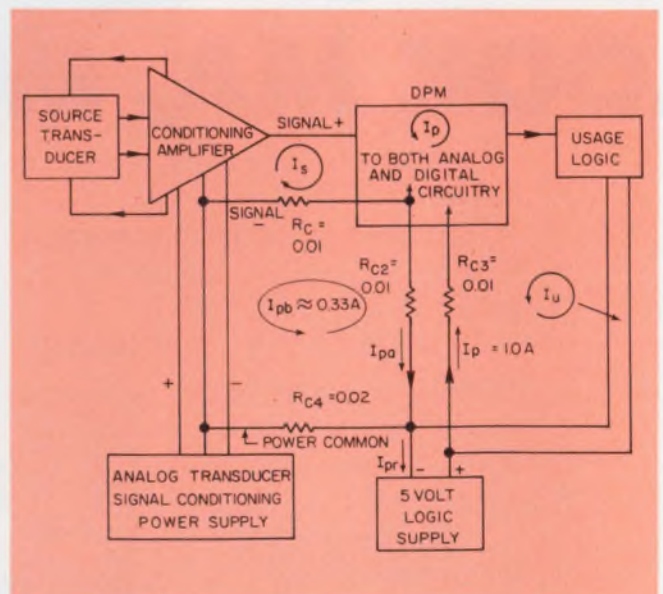
First, with respect to power dissipation, it soon becomes obvious that the power consumption of the panel meter itself does not tell the whole story. For example, one available line-powered meter requires 3.5 W. This is the entire power consumed within a system to energize the panel meter. In the case of a 5-V-powered panel meter, however, unless it's operated from batteries, power must be derived from a dc line somewhere in the instrument or system. Since 5-V power supplies have efficiencies of 35 to 60%, it is clear that a total power between one and one-half and three times the nominal amount of power is required.

Thus a 5-V supply with 35% efficiency (not uncommon for a modular power supply) must draw 15 W to deliver 5 W to a 5-V DPM. Since in an enclosed instrument there will be a temperature rise proportional to the amount of power dissipated, dissipation in the system may be an important and limiting factor in choosing a DPM.

Albert L. Grant and Fred Molinari, Analogic Corp., Wakefield, Mass.



1. Generalized DPM system can be divided into three distinct subdivisions to illustrate the interconnection relationships. They are the source, measurement and usage subsystems.



2. Ground loop problems occur in five-volt powered DPMs where all subsystem returns are common. The ground loop causes voltage drops in the input circuit, resulting in a possible 3% reading error.

Next, let's see how some 5-V meters are connected to the external source. Connections for a DPM are more complex than those of an analog meter, which is a passive device. The user of an analog meter, therefore, need concern himself only with the proper method of connecting the two terminals to the external circuit. The only currents that flow in and out of the analog meter are those of the signal source.

Things are not quite so simple with DPMs. In addition to the analog signal currents, DPMs have power and digital signal currents flowing in and out. Further, the increased accuracies and higher speeds that make DPMs more prone to spurious signals and other interference require more careful connections.

Since DPMs obtain both their analog and digital circuit power directly from the 5-V source, without conversion or isolation of any kind, the analog signal ground return is connected directly to the digital power return. For most practical applications this direct connection can cause measurement difficulties.

Multiple grounds create problems

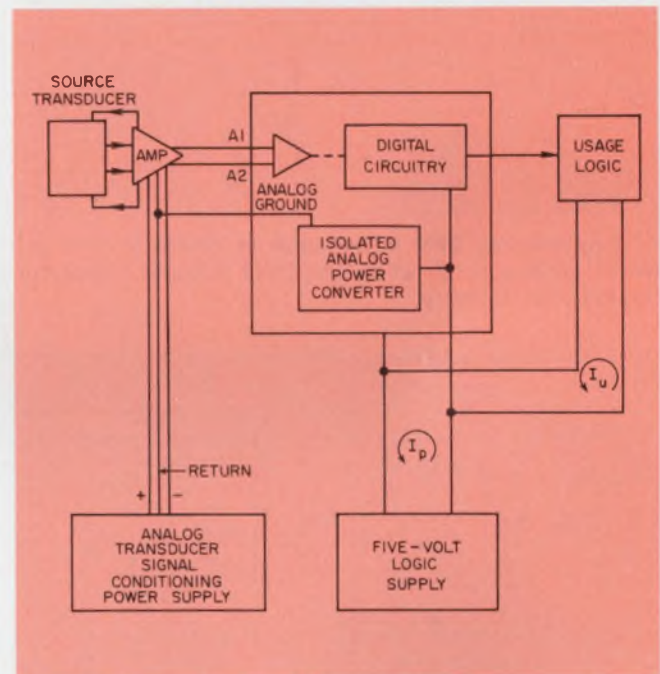
Figure 1 shows the general interrelationships within such a source/measurement/usage system. The system consists of an analog signal source with its conditioner and conditioner power supply; a panel meter containing analog and digital circuitry; display devices; the meter's power source; and an external-usage logic circuit with its power source. Note that this system has four major ground systems: G_1 , associated with the source and signal-conditioning power supply; G_2 , associated with the panel-meter analog circuitry; G_3 , associated with the panel-meter digital circuitry; and G_4 , associated with the external-logic circuitry.

It should be clear that power currents flow in and out of the source and signal-conditioning circuitry; signal currents flow in and out of the measurement analog circuitry; power currents also flow in and out of the panel-meter analog and digital circuitry; and currents flow in and out of the usage-logic circuitry. It should also be clear that all signal leads have some finite resistance and that the paths which the currents take will be determined by the relative resistance of all available paths.

Figure 2 depicts a ground-loop problem that occurs in this type of 5-V-powered meter. The meter's analog and digital grounds are directly returned to its supply, which also powers external logic. An independent power supply is used for the source and its signal-conditioning circuitry.

The meter current, I_p , flows from the 5-V-logic supply into the panel meter and returns to the

supply. Since the meter's analog circuitry is also powered directly from the 5-V source, its return point is common with the power-supply return and digital returns. Also, since typical connector resistance ranges from approximately 10 to several tens of milliohms, we may assume that the various connection resistances (R_{cs}) are as shown in the diagram. Thus, I_p , having several return paths, divides up so that it flows back through not only the desired path of resistance, R_{c2} , but through the additional path formed by



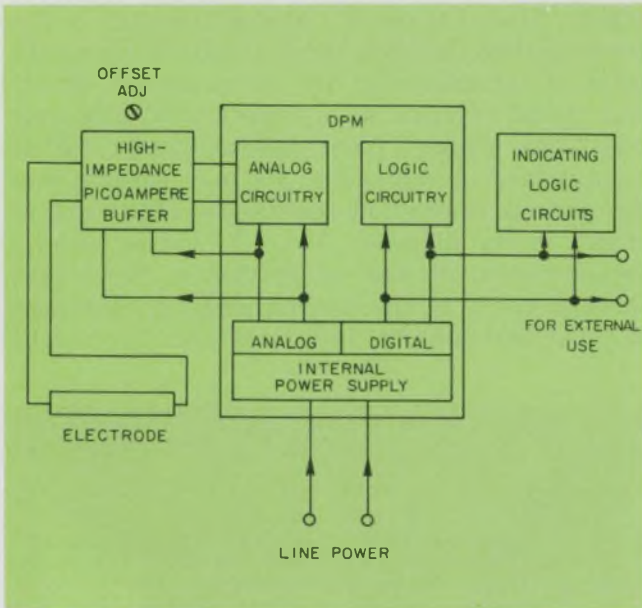
3. Differential inputs plus a power converter eliminate the multiple paths and the erroneous readings.

R_{c1} , and R_{c1} . R_{c1} , however, is in the signal path and, consequently, an unwanted voltage is developed in this path.

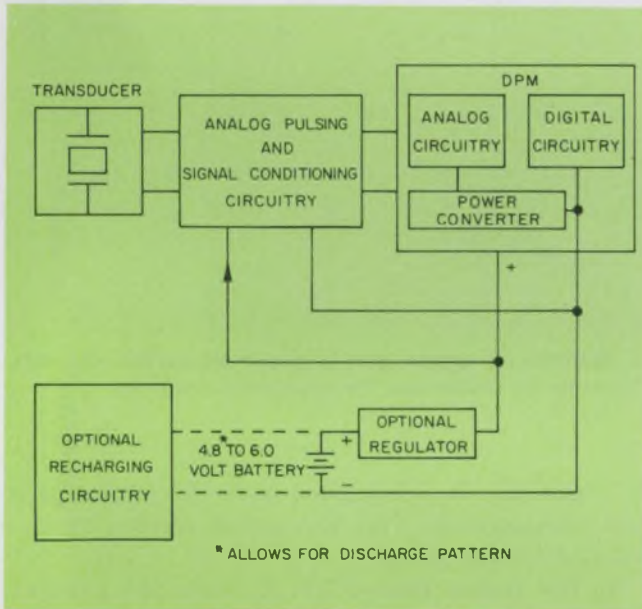
If the meter draws 1.0 A, then the current will divide up so that 1/3 A flows into R_{c1} and 2/3 A flows through R_{c1} . The unwanted voltage drop across R_{c1} caused by the ground loop is 3 mV, an error of 3% in DPMs which have a full scale reading of 100 mV.

There is no way to hook up this combination of power signal source, measurement circuitry, and usage circuitry without encountering some offset voltage in the signal path. The problem is further complicated by the fact that the copper connections have temperature coefficients of approximately 4000 ppm. Even if one attempts to balance the offset in some manner it would vary considerably with temperature (of course, if a 5-V powered panel meter has internal automatic zero such offsetting could not be done).

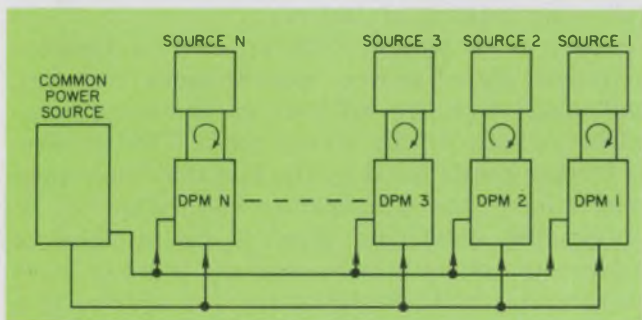
The ground-loop problem can be avoided by using the type panel meter shown in Fig. 3.



4. Line-powered DPM is the superior choice for this pH meter application in which the DPM supplies power for the external circuitry.



5. A portable, battery-operated instrument, such as this ultrasonic thickness gauge, is a natural application for a five-volt-powered DPM.



6. Five-volt units are called for in this application, where multiple displays are fed by independent signal sources. Considerable saving results from the use of a common power supply.

Power for this meter is also derived from a 5-V power supply which may also drive external-usage logic. However, in this case, the 5-V supply is changed by a dc-to-dc converter into a floating, galvanically-isolated power supply. And, because the converted power source is bipolar, a true differential input is possible. As a result, for the same source, measurement and usage system there are no multiple-return paths for the powering currents. The analog transducer and its signal-conditioning power supply may, if desired, be connected to the panel-meter ground and the output of the transducer may be connected to the differential inputs of the meter. The combination of differential-input circuitry and ground separations provides greater measurement flexibility.

The application dictates the choice

In the short time that 5-V meters have been available, it has become apparent that while there are many more applications than originally thought, the number of applications for line-powered meters still exceeds that for 5-V units. The table lists fourteen usage conditions and shows the meter type likely to be most effective for each condition. Of course, every application is unique so the table merely provides a basis for initial assessment.

Let us now consider an example where a line-powered panel meter appears to be a superior choice—a pH meter in which the major portion of the circuitry is in the panel meter itself. A pH meter can consist of a panel meter plus a high-input-impedance, pico-amp, buffer amplifier to which the pH electrode is attached. In addition, there may be some minor conditioning logic.

Since a line-powered panel meter can provide external power for the buffer amplifier and the external logic (in reasonable amounts), the total system will consume less power and, as a result, cost less. This is, in part, true because the incremental cost of a line-powered panel meter is generally less than the cost of an independent power supply. Further, the over-all efficiency of the power system will be considerably higher with a line-powered unit than with one that must first develop five volts for the panel meter.

As another example, consider a panel meter used with a portable, ultrasonic thickness gauge. The gauge (Fig. 5) is powered by a 6-volt battery, with optional recharging circuitry. Since the unit operates directly from the battery source, it is most economical, and most power conserving, to use a 5-V-powered unit. Note that, in this application, it's essential to have a differential input (with isolated analog and digital circuitry) to avoid ground loops.

In another application (Fig. 6), where a number of displays are simultaneously powered and

Table. Match the DPM to the job

Cost/usage effective comparison choice*			
	Condition	Line powered	Logic powered
A	One or few of a type line-powered test equipment	X	
B	To be designed into instrument with only minor analog or digital circuitry (such as pH meter)	X	
C	Built in 50/60 ~ period integration required	X	
D	Inadequate logic power available without additional supply	X	
E	High-voltage display preferred	X	
F	Standard for use in many diverse equipments desired	X	
G	Total power of system to be minimized	X	
H	Battery operated instrument with pre-inverter	X	
J	Battery operated instrument without pre-inverter (i.e., direct battery operation)	X	
K	Many units used together from single available power source		X
L	Extra logic power available		X
M	Magnetic field of local power transformer cannot be tolerated		X
N	No high voltages tolerable for safety or UAL purposes		X
O	Limited volume directly behind front panel		X
P	To be designed into instrument having considerable analog and digital circuitry		X
Q	Universality of primary power source desired (for foreign or domestic usage)		X

*Assumes comparable range, accuracy, stability, quality, type of input circuit.

where the various signal sources have different ground-return points, the choice would be 5-V meters. First, if there are enough DPMs, a substantial cost saving results from eliminating the individual power supplies of each meter. Second, there are many multidisplay applications where the higher voltages required for ac line powering can be hazardous. Finally, when a number of meters are powered from a common source, it becomes practically impossible to hook up the various sources and meters without ground loops. ■■

This is the final article of the series. The first article covered DPM selection and appeared in the July 6 issue. The second discussed the interfacing of a DPM and appeared in the July 20 issue.

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Frequency multipliers using solid-state, voltage-variable capacitors—more commonly, varactor diodes—are generally designed to get ever higher power ratings and efficiencies. The most common method is to stack the varactor diodes in series or parallel (Fig. 1). But you can probably do better with a stacked multi-chip varactor design.

The approach of Fig. 1 calls for a relatively complex electrical and mechanical design. Several packages are normally required for the higher-power jobs, and you must provide correct phasing of the diode arrays. Moreover heat dissipation from all the diode packages becomes a multiple headache.

These problems can be eliminated with a multi-chip design. Here the complete varactor diode consists of several stacked-diode chips connected in series and mounted on a common stud. A deceptively simple modification, this arrangement is actually electrically superior to the single-chip device.

Electrical advantages result

The series connection of N chips produces \sqrt{N} times the power-handling capability, and the total junction capacitance is $1/N$ times the capacitance of a single chip. The breakdown voltage increases by a factor of N , while the cutoff frequency remains constant. The constancy results from a cancellation of opposing effects: While the diode spreading resistance (R_s) increases by a factor of N , the junction capacitance decreases inversely for an essentially constant cutoff.

As an example of the design of a multi-chip varactor multiplier, let's assume that a times-two frequency multiplier, or doubler, is required and that it should be able to do the following:

- Handle 80 W of cw power.
- Operate over the temperature range of -54 to $+71$ C.
- Exhibit a 40-MHz bandwidth between 1-dB

points on the output-power curve.

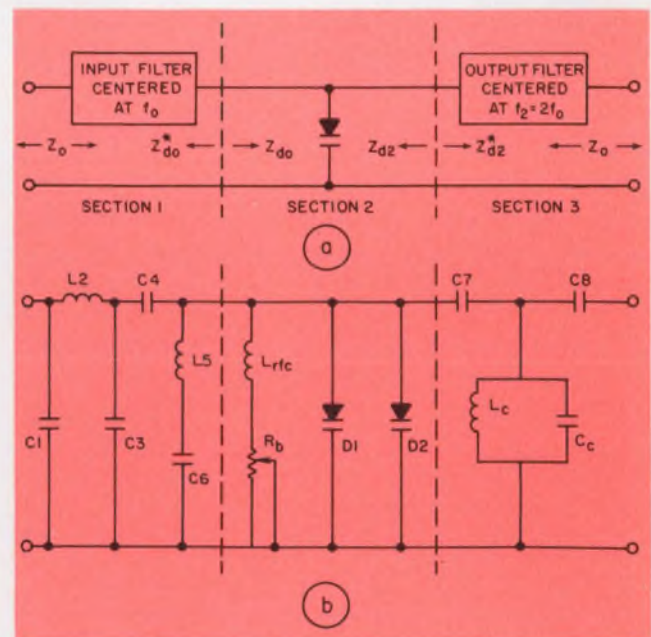
- Operate with at least 50% efficiency.
- Function with a center, input frequency $f_o = 415$ MHz.

A single commercially available multi-chip diode can dissipate only about 30 W. Since the complete diode must dissipate around 40 W (assuming 50% efficiency), two such diodes in parallel are required to do the job.

Calculate varactor-diode parameters

Many of the parameters to specify the two multi-chip diodes can be calculated from the original multiplier specs. One parameter not normally determined is thermal resistance, θ_{jc} . However, a low value is implicit in the specs of this high power multiplier to avoid overheating. Typically, a thermal resistance of $5^\circ\text{C}/\text{W}$ is adequate.

The calculated parameters—cutoff frequency,



1. Varactor-diode power handling can be increased by series stacking (a) or parallel stacking (b) of single chip varactor diodes. The ratings are increased even further when several such diode chips are mounted on a common stud—as in multi-chip designs.

Walter C. Zaremba, Consultant Engineer, WM Associates, 910 Denston Dr., Ambler, Pa. 19002.

breakdown voltage and diode capacitance—are found from formulas.¹ The calculated values of diode capacitance and cutoff frequency are taken to be those values measured at -6 V. Experimentation has shown that this approach leads to a closer correlation between calculations and measurements.

For cutoff frequency, the relation is

$$f_{c-6} = \frac{10.35 f_2}{1-N},$$

where f_c = cutoff frequency (the additional -6 in the subscript denotes the -6 V reference), f_2 = output frequency = 830 MHz, and N = diode efficiency = 0.70 (to compensate for input and output circuit losses). Inserting these values in the formula, we get $f_{c-6} = 28.6$ GHz.

The breakdown voltage is found from the formula

$$V_b = \frac{P_a f_{c-6}}{0.3 f_o R_s},$$

where P_a = power available to each diode (assume 40 W as a conservative estimate), $R_s = 1.5 \Omega$ (for the diode chosen) and f_o = input frequency = 415 MHz. The calculation results in $V_b = 120$ V (min).

Finally, diode capacitance is calculated as

$$C_{j-6} = \frac{1}{2\pi f_{c-6} R_s}.$$

From values already given, $C_{j-6} = 3.72$ pF.

Generally a simple times-two multiplier can be

represented by a three-section circuit (Fig. 2a). Section 1 consists of a section that matches the diode impedance and also of a filter network that blocks the transmission of all frequencies except the fundamental, or input, frequency. Section 2 corresponds to the diode and bias circuitry. And Section 3, an output filter, restricts the current flow to that of the second harmonic and matches the diode impedance to the load. More specifically the multiplier circuit can be shown in terms of discrete components (Fig. 2b).

To calculate the various components of the multiplier, two identical multi-chip diodes must first be selected. A readily available diode that has the required specs is Philco-Ford's L8505—a three-chip device. It has a rating of $V_b = 175$ V (min), $C_{j-6} = 3.0$ to 6.0 pF, $f_{c-6} = 30$ GHz, $P = 30$ W dissipation at 25 C and $\theta_{j-c} = 5$ °C/W.

Measure the input impedance

Now the diode input impedance can be measured. Of course, it could be calculated from the manufacturer's data sheets. But a measurement at the operating frequency and bias voltage offers a faster and possibly more accurate alternative.

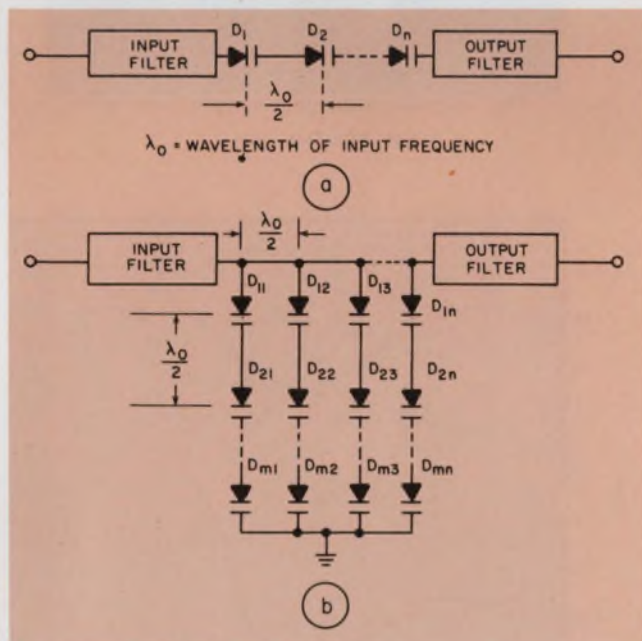
A Smith-chart plot of diode impedance as a function of bias voltage reveals little capacitance change as a function of applied reverse voltage above 20 V. But below this voltage a rapid capacitance change develops known as punch-through. This characteristic occurs between -6 and -14 V.

The simplest and easiest method of matching the diode is by means of an L network. It consists of a series capacitance, C_4 , and a shunt inductance, L_5 . In addition a series capacitor, C_6 , prevents the inductor L_5 from shorting the bias current, and provides a fine tuning control for the inductor.

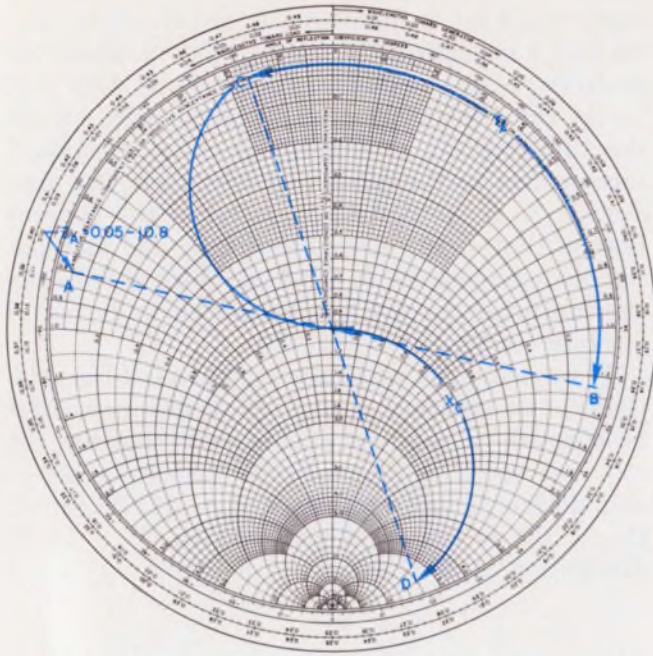
Matching the diode impedance to a standard 50- Ω line proceeds as follows: With a bias voltage of $(1/3) V_b$, the diodes are screened for matching impedances at the input frequency and operating point. Next the impedance of a single diode is halved, and the result, Z_A , is plotted on a Smith chart (point A of Fig. 3).

Point B, diametrically opposite point A and located on the same VSWR circle, gives the diode admittance, Y_A . This point is rotated along a constant VSWR circle (toward the generator) to the unit G circle—point C. The difference in susceptance between points B and C is the admittance of the shunt inductor, jY_1 , normalized. Its value is $jY_1 = j/\omega LY_o = 1.38$. And for a 50- Ω input line and $f = 415$ MHz, $L = 1.38$ nH.

Capacitor C_4 can now be found from the same Smith-chart plot. A line from point C through the



2. Any multiplier design reduces to a simple diode-filter combination (a). For the 80-W multiplier, the equivalent circuit is represented with discrete components (b). Capacitors C_4 and C_6 and inductor L_5 provide diode-input matching. At the output is a cavity filter.



3. The calculation of the input matching elements, C_1 and L_2 , is performed graphically with a Smith chart. All that's needed to start the calculation is Z_A , one-half of the input impedance of a diode.

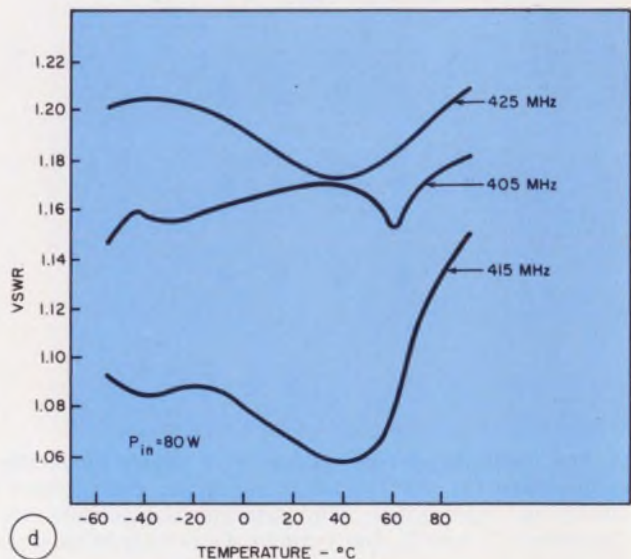
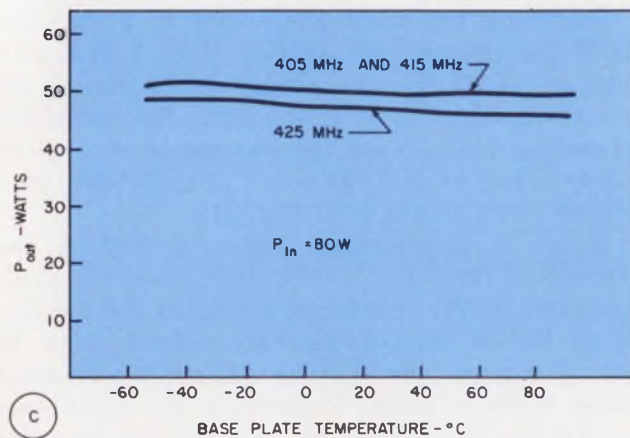
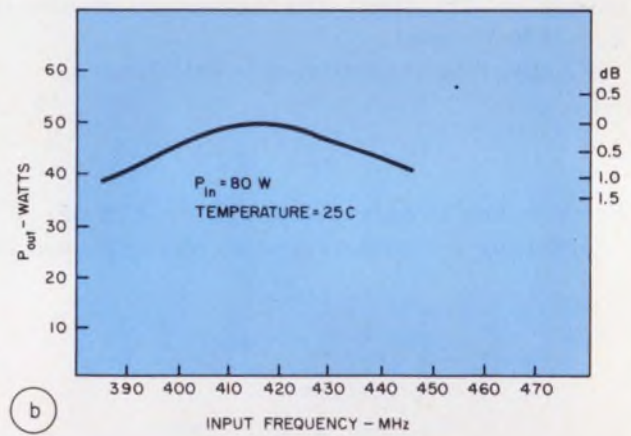
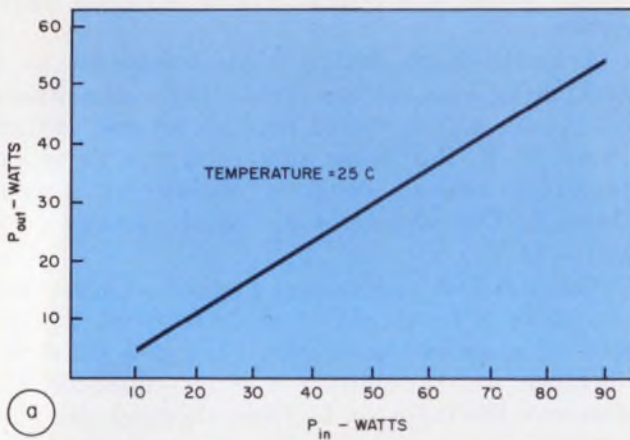
center of the chart and intersecting the constant-R circle yields point D—the impedance to be matched by C_1 . Point D is rotated along the constant-R circle to the center of the chart. The distance from point D to the chart center around the constant-R circle equals the capacitive reactance required. A short calculation gives $C_1 = 1.02$ pF.

Now the diode impedance can be matched to a 50- Ω line. The only remaining elements in the design are the low-pass input filter and the output filter.

Standard filters can be used

A three-section, lumped-circuit filter with input and output impedances equal to 50- Ω is the simplest input filter that can do the job. Element values can be found in standard tables of filter design.² From such tables the filter elements, assuming a low-pass cutoff at 600 MHz, are $C_1 = 5.4$ pF, $L_2 = 16.5$ nH and $C_3 = 5.4$ pF.

For the output filter, a cavity type becomes necessary because of the higher frequency and the need to maintain low loss.



4. Measured results of the multiplier design reveal a linear input/output power variation (a) and a 1-dB bandwidth of 14% (b). Operation up to a base-plate temperature of 80 C is possible (c), while VSWR over the -60 to 90 C range is held below 1.22:1.

A cavity filter that's easy to build consists of a shortened quarter-wave coaxial resonator with capacitive coupling on the input and output. With a cavity characteristic impedance of 72Ω and a transmission line-length of $\lambda_2/9$ ($\lambda_2 =$ wavelength of second harmonic), the coupling capacitors C_7 and C_8 are empirically determined to be 0.05 pF and 0.25 pF , respectively.

Test the assembled design

The assembled 415-MHz doubler has the two diodes soldered into a 1/4-by-28 copper screw to improve the thermal path of the heat sink. Boron-nitride sleeves are also placed on both sides of the diode receptacle to provide a low thermal path and reduce the coax line impedance. The impedance is approximately 20Ω .

Measured curves of multiplier performance are shown in Fig. 4. All curves are typical and represent a sampling of 10 pairs of diodes.

The output power as a function of input power (Fig. 4a) shows a linear relationship. With the saturation mode avoided, even with maximum rated power, over 90 W can be applied if external or forced-air cooling is used. Typically the temperature rise of the multiplier is 45 C above ambient when bolted to a nine-inch-square aluminum plate 1/4-inch thick. The maximum junction temperature of these devices is 175 C, and multiplier efficiency is 62.5% (including input, output, diode and coupling losses).

The frequency response of the multiplier (Fig. 4b) reveals a 14% bandwidth to the 1-dB points. And base-plate temperature vs output power (Fig. 4c) shows a fairly flat behavior up to 80 C. This corresponds to a junction temperature of about 140 C. Beyond this value the multiplier cannot generally be reliably operated.

Finally, the input impedance as a function of temperature is presented as input VSWR vs temperature at three frequency points (Fig 4d). Not surprisingly, the best match occurs at the center of the frequency band. The VSWR response for the band edges is not a consequence of tuning at the center frequency, but rather an iterative, compromise tuning process between the band center and the band edges.

Tuning at room temperature only is possible. Retuning at the temperature extremes is unnecessary, provided that the VSWR at all points in the band does not exceed 1.2:1. Values exceeding this VSWR result in a variety of multiplier failures. ■■

References

1. Zaremba, Walter, "Frequency Multiplication Using the Abrupt-Junction Varactor," *Master's Thesis*, The Pennsylvania State University, September, 1967.
2. *Microwave Engineers' Handbook and Buyers' Guide*, Horizon House - Microwave, Inc., February, 1968.

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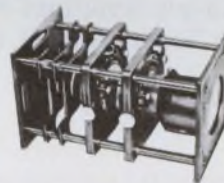
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INFORMATION RETRIEVAL NUMBER 27

Reconstruct NRZ-L and clocks from biphase-level PCM signal

Biphase-level (Bi- ϕ -L) pulse-code modulation can be generated by an EXCLUSIVE-OR gate with nonreturn-to-zero-level (NRZ-L) PCM and a clock as inputs.

A circuit which does the opposite and reconstructs the NRZ-L and clocks from Bi- ϕ -L is shown in Fig. 1. With a line receiver to shape the Bi- ϕ -L signal and provide TTL logic levels, the circuit becomes an inexpensive bit synchronizer. A typical application is the recording and later playback of digital data from a modem.

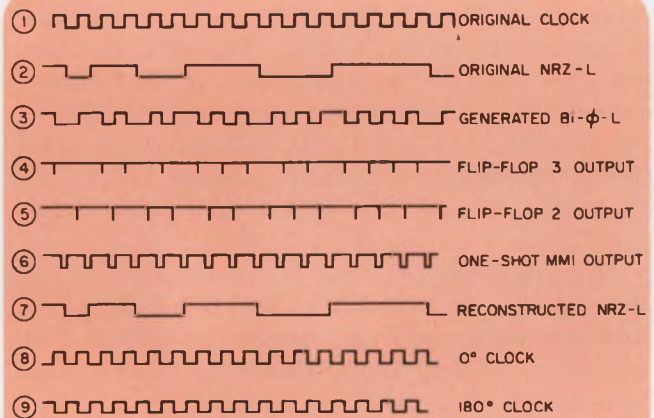
Bi- ϕ -L PCM offers the advantage of recording directly on magnetic tape without the need for a separate clock track and without the use of FM electronics. It has a transition every bit period and requires a minimum bandwidth in hertz from 0.2 to 1.5 times the bit rate.

In the circuit (Fig. 1), a negative Bi- ϕ -L transition sets flip-flop FF₂ if it is not held in reset. Similarly a positive Bi- ϕ -L transition, after inversion by NAND gate G₁, sets flip-flop FF₁ if it is not held in reset. Monostable multi-vibrator MM₁ is triggered for a three-quarter bit period if FF₁ or FF₂ set. MM₁ then holds both FF₁ and FF₂ in reset until it times out. MM₁ shifts the inverted Bi- ϕ -L logic level into FF₃ at the end of the time period. The output of FF₃ is the NRZ-L signal (Fig. 2).

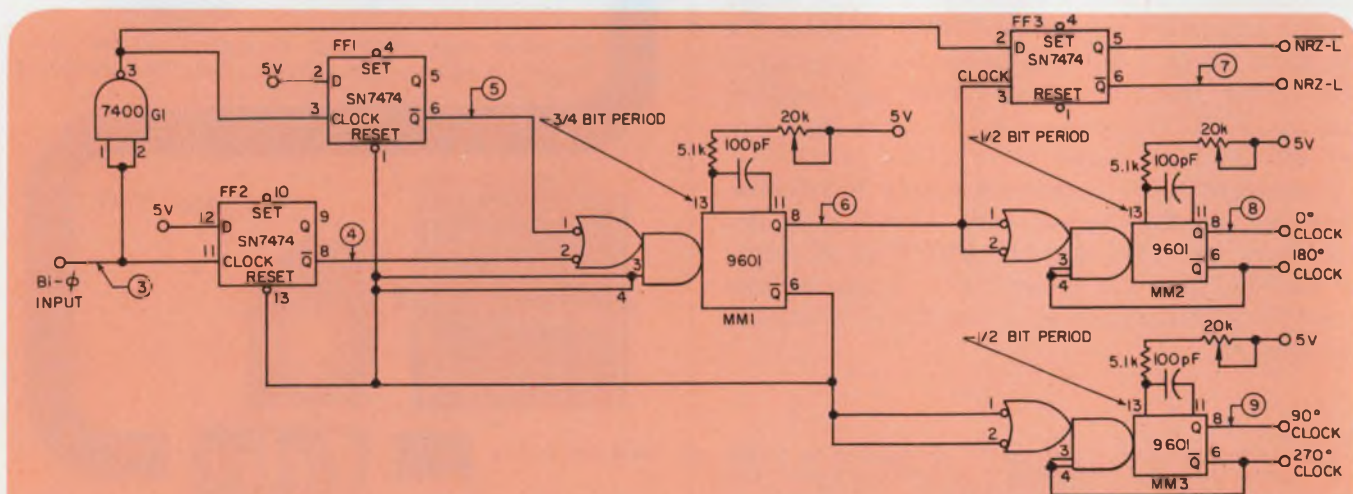
One-shot MM₂ provides a clock in phase with the NRZ-L signal, and it is triggered at the time that FF₃ clocks in the Bi- ϕ level. The third one-shot MM₃, provides a clock 90° out-of-phase with the NRZ-L signal, and it is triggered at the same time that MM₁ is triggered.

Walter E. Bentley, 143 1/2 S. Main, Highlands, Tex. 77562.

CIRCLE No. 311

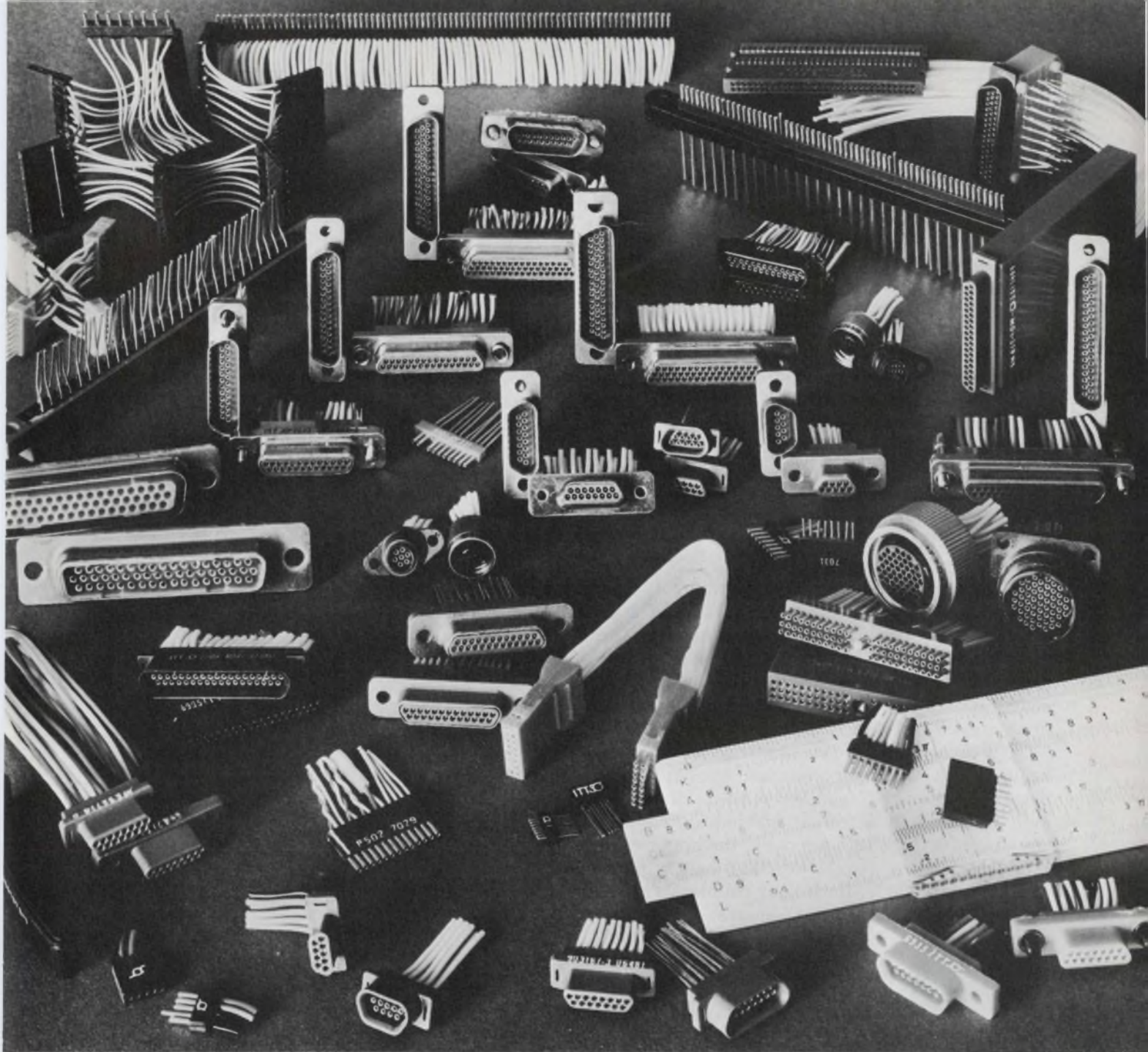


2. Original clock and NRZ-L together with reconstructed waveforms, illustrate the components of biphase-level PCM.



1. Flip-flop FF₁ provides an NRZ-L output, and MM₁ yields a clock in phase with the NRZ-L signal

to produce the reconstructed components of biphase-level PCM. A bit synchronizer results.



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Build a quartz-crystal-controlled digital clock with only six ICs

A quartz-crystal-controlled 12-hour digital clock requires only six CMOS MSI circuits for timing and counting. During power-line interruptions the clock continues to run on a single small dry-cell battery.

To conserve power during stand-by battery operation, voltage is automatically removed from the output display. The oscillator, timing and counting circuits, however, continue to operate from the battery without interruption, consuming only about 50 mW of power. When line power is restored, the correct time is automatically re-displayed without need to reset the clock.

The oscillator uses a CR-18/U crystal unit, which operates at a frequency of 2.236962 MHz. The oscillator frequency is divided by two cascaded 14-stage binary counters (IC₅ and IC₆ in the figure) to produce one pulse a minute. These pulses are totaled in four additional cascaded decade counters (IC₁ through IC₄) with 10 decoded outputs, producing the discrete minute and hour signals for the display.

To provide the proper counting and decoding sequence in the hour decades, the unit hours decade counter IC₂, together with its display circuit, is wired in an offset fashion, as shown in the diagram. In a 12-hour clock, the hour decades must go from a display of "12" hours to "01" (rather than "00"). Both hour counters are reset to zero (displayed as "01" hours) after a dis-

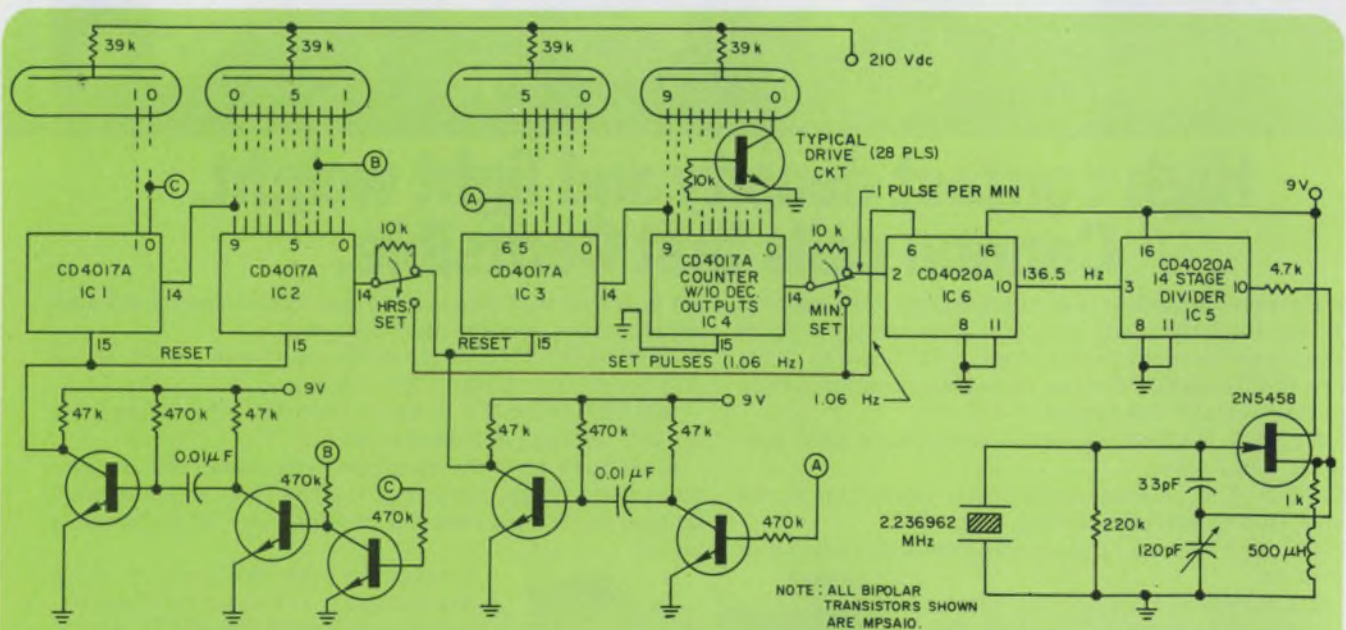
played hours count of "13" is reached. This occurs within a few microseconds after the undesired display of "13" is reached, so that the displayed hours count appears to move directly from "12" to "01" hours.

This hours counting and display scheme also requires that the carry to the tens of hours decade must come from the digit nine in the units hours decade rather than the usual carry output terminal. In a similar fashion, the tens of minutes decade is reset to "0" after a count of "6" is reached. The connection sequence is summarized in the accompanying table.

R. J. Battes, P.O. Box 11604, Palo Alto, Calif. 94306.

CIRCLE No. 312

UNIT HOURS DECODING										
UNIT HOURS COUNTER DECODED OUTPUT	0	1	2	3	4	5	6	7	8	9
CONNECT TO DISPLAY NUMERAL	1	2	3	4	5	6	7	8	9	0



Four digital displays exhibit hour and minute outputs from four CMOS cascaded decade counters

IC₁ through IC₄. The table shows the connection sequence to the displays.

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DANA

Dana Laboratories, Inc. 2401 Campus Drive, Irvine, California 92664

INFORMATION RETRIEVAL NUMBER 32

Pulse width and rep rate are controlled by gating

In this gating circuit (Fig. 1), one logic input controls the width of the output pulses, while a second input determines their repetition rate. The circuit consists of just two ICs—a Schottky dual D flip-flop and a quad high-speed gate. The only restrictions on the circuit are that the frequency of input B must be greater than that of input A, and input B's pulse width must exceed 20 ns and its frequency must be less than 25 MHz.

When input A goes HIGH, the transition toggles edge-triggered flip-flop FF₁, making its output Q₁ HIGH. This in turn causes the D input of FF₂ to go HIGH. When the B input goes HIGH, a ONE is transferred to the Q output of FF₂. A pulse at input A thus appears as a delayed ONE at output Q₂.

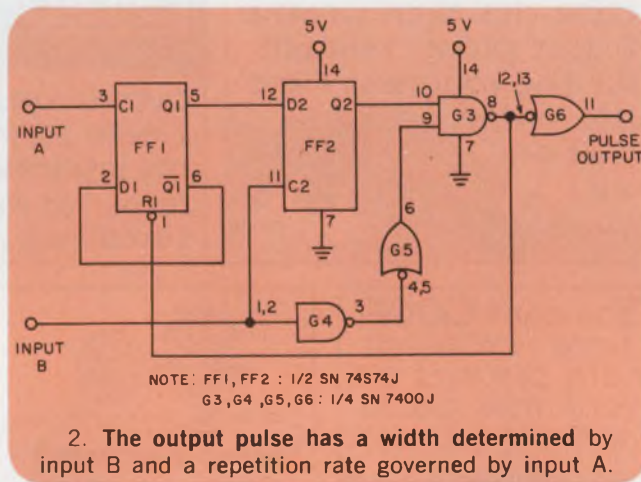
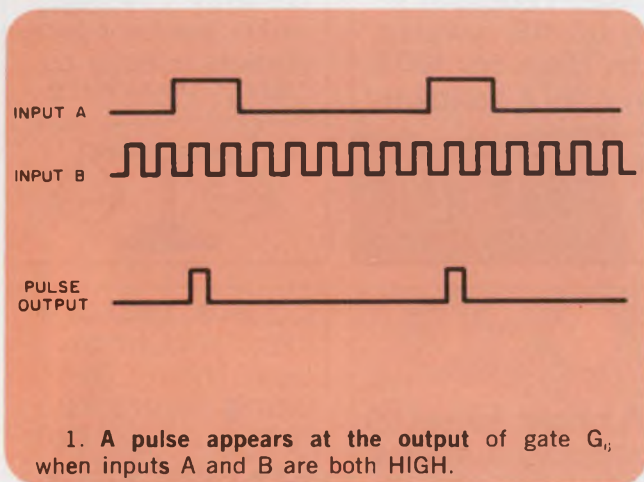
A pulse appearing at input B is delayed by two gate delays, approximately 12 ns, through

gates G₄ and G₅. The input-B pulse appears at the output of NAND gate G₃ only if it coincides with the ONE at output Q₂. When the output of gate G₃ thus goes LOW, it resets flip-flop FF₁, setting output Q₁ and input D₂ to ZERO. When input B goes HIGH again, a ZERO is transferred to output Q₂. Gate G₃ remains HIGH. The output of gate G₃ is inverted by G₆ and transferred as a pulse output (Fig. 2).

If the repetition rates of inputs A and B are harmonically related, the pulse output will be synchronized to input B. If there is no correlation between the two inputs, the period of the output pulse will vary from pulse to pulse, such as in frequency modulation.

Joe Morrone, Grumman Aerospace, Product Support Div., Bethpage, N.Y. 11714.

CIRCLE NO. 313



IFD Winner of April 1, 1972

Hank Olson, Stanford Research Institute, Menlo Park, Calif. 94205. His idea, "Use diodes for amplitude control in 0.001-Hz Wien Bridge oscillator," has been voted the Most Valuable of Issue award.

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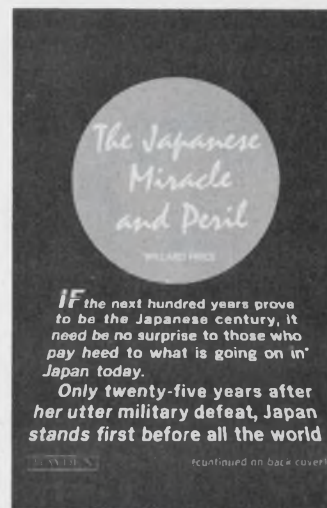
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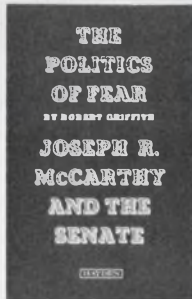
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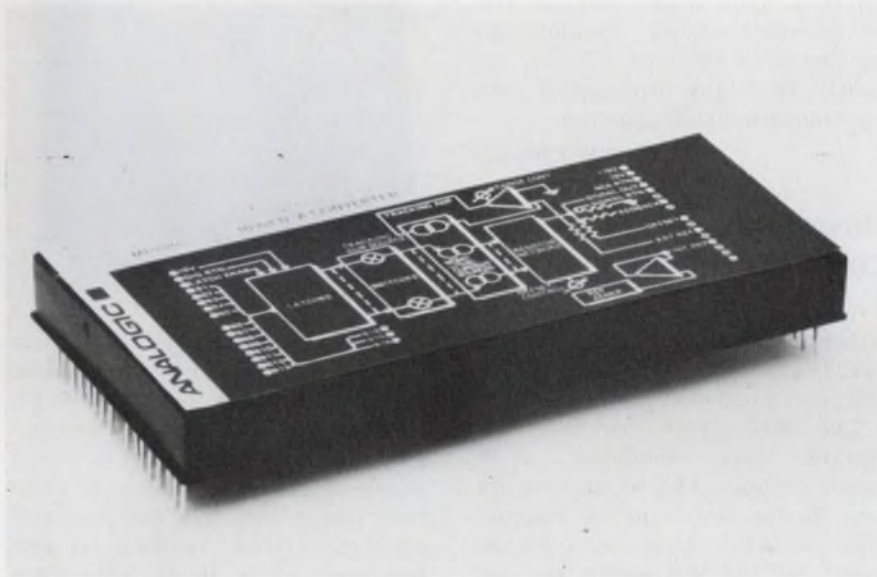
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INFORMATION RETRIEVAL NUMBER 37

ELECTRONIC DESIGN 16, August 3, 1972

new products

Almost 16-bit d/a converter is industry's fastest, most stable, least expensive



Analogic, Audubon Rd., Wakefield, Mass. 01880. (617) 246-0300. See text: stock to 4 wks.

A couple of years ago Bernard M. Gordon, chairman of Analogic, said that the laws of physics made it impossible to build a true 16-bit d/a converter—one that would be stable enough with time to maintain a resolution of 1/2 LSB.

In keeping with the spirit of this statement, Analogic has introduced the MP1916A, a 16-bit d/a converter guaranteed to be stable to one bit—not 1/2 LSB—for at least three months. This is the recalibration interval recommended by Gordon in an interview with *ELECTRONIC DESIGN* (the information, however, does not appear on the data sheet).

The specified drift of one bit actually places the MP1916A's resolution somewhere between 15 and 16 bits. Of course, a given unit might hold 16-bit resolution, but, as Gordon says, "It's not something a guy should defend his honor or his life with."

The unit appears to be Analogic's response to a rival 16-bit d/a, the DAC-16QM, from Analog Devices. The competing units claim the

same linearity error— $\pm 0.0015\%$ —and both are packaged in a $2 \times 4 \times 0.4$ -inch module. But the similarity ends here.

The MP1916A is faster (in voltage mode), more stable (temperature-wise), and costs less than the DAC-16QM. And the MP1916A's \$595 price includes built-in storage registers, which are optional (and externally mounted) with the \$745 DAC-16QM.

Both units can be used in either a current-output mode or, by appropriately connecting an internal amplifier, in a voltage-output mode. However, both operate considerably slower in the voltage mode. In current mode, Analogic's MP1916A specifies a maximum settling time (to 1 LSB) of $3.5 \mu\text{s}$ for a full-scale step, while Analog Devices gives settling curves. From these curves the *typical* current-mode settling time appears to be $3.0 \mu\text{s}$. In voltage mode Analogic's settling time stretches to $20 \mu\text{s}$, maximum, while the 16QM slows to a sluggish $220 \mu\text{s}$ (typical).

Temperature drift, the omnipresent bane of conversion devices—and the spec hardest to get the

drift of—is "fully" specified for the MP1916A. Thus a designer is given $4 \text{ ppm}/^\circ\text{C}$, maximum, as the tempo of gain; $2 \text{ ppm}/^\circ\text{C}$ *typical*, as the tempo of linearity; $5 \text{ ppm}/^\circ\text{C}$ max. as the tempo of the reference voltage; $3 \text{ ppm}/^\circ\text{C}$ max. for offset drift in bipolar current-mode operation ($1 \text{ ppm}/^\circ\text{C}$ max. for unipolar); and, finally, $4 \text{ ppm}/^\circ\text{C}$ max. for offset drift in bipolar voltage-mode operation. What do you do with these? If you're a pessimist, you sum them; if you're an optimist you root-sum-square them; but if you really know your application you use just those drifts that affect you most.

The DAC-16QM, on the other hand, specs only the reference-voltage tempo and the voltage-mode drifts for gain and for unipolar and bipolar offsets. These are $\pm 6 \text{ ppm}/^\circ\text{C}$, $\pm 15 \text{ ppm}/^\circ\text{C}$, $\pm 9 \text{ ppm}/^\circ\text{C}$ and $\pm 15 \text{ ppm}/^\circ\text{C}$, respectively. These tempcos are typical; and the gain and bipolar-offset tempcos are over three times greater than those of the MP1916A.

For more information:

From Analogic **CIRCLE NO. 250**

From Analog Devices

CIRCLE NO. 251

1% analog divider gives 60-dB dynamic range

Optical Electronics Inc., P.O. Box 11140, Tucson, Ariz. 85706. (602) 624-8358. \$122 (10-29); stock.

The Model 5895 analog divider has a dynamic range (of both numerator and denominator) of 1000 to 1, with a maximum error of less than 1%. Packed in a $2.5 \times 1.5 \times 0.5$ -inch module, the 5895 features a dc to 30-kHz BW, 10 V FS input, $100 \mu\text{A}$ FS-current input, and 450 mW total power supply dissipation.

CIRCLE NO. 252

Active filters are lowest cost

Burr-Brown Research Corp., International Airport Industrial Park, Tucson, Ariz. 85706. (602) 294-1431. See text.

Burr-Brown's new line of active filters, the ATF76 series, are about half the price of the company's older 5700 series, and are less expensive than competing units. And, unlike some competing units, no external resistors are required. Low-pass, bandpass and band-reject types are offered. The low-pass units are available with Butterworth (maximally-flat amplitude), Bessel (linear phase) or Chebyshev (sharp-cutoff) response, and with 2, 4, 6, or 8 poles. Center frequencies range from 1 Hz to 20 kHz and are accurate to $\pm 2\%$. Stability of the center frequency is $0.05\%/^{\circ}\text{C}$. The bandpass units (2 or 4 poles) have center frequencies from 1 Hz to 20 kHz and Q_s from 2 to 10. The center frequencies of the two-pole (single-tuned) bandpass and the band-reject units are externally adjustable. Both the bandpass and band-reject filters have 1% center-frequency accuracy and $0.03\%/^{\circ}\text{C}$ center-frequency drift. +15 V is required for all units. Operating temperature range is -25 to $+85$ C. The units are a small 0.4 inches high and range from 1.5×1.5 to 2.1×3 inches, depending on the number of poles. Prices range from \$21.00 (100-249) for the two-pole low-pass (10 Hz to 20 kHz), to \$109 (100-249) for the eight-pole Chebyshev low-pass (1 Hz to 10 Hz).

CIRCLE NO. 253

Galvanometer pen motor weighs only 6 oz.

General Scanning Inc., 80 Coolidge Hill Rd., Watertown, Mass. 02172. (617) 924-6620.

The Series G-200 pen motor is intended for recording systems. The 6-oz. unit is only 3/4-inch wide and draws 2.5 W. Rated torque is 350 gm-cm and max. torque is 800 gm-cm. Rotor inertia is 1 gm-cm². The G-200 can be frequency-compensated beyond the natural frequency of 175 Hz (no load). It's tangent-corrected and electromagnetically damped.

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Power supplies come in two series

Triad Distributor Div., 305 N. Briant St., Huntington, Ind. 46750. (219) 356-6500. WR, \$49; NCB, \$88.50; (50-99).

The WR series are four, adjustable and regulated, 40-W power supplies. The NCB series are five, B-size slot supplies ranging from 5 V-5.1 A to 28 V-1.5 A. Specs for the WR series are: input: 115 V $\pm 10\%$, 47-440 Hz; regulation: line: $\pm 0.1\%$, load: $\pm 0.2\%$ (50% load change); ripple: 2 mV rms, 6 mV pk to pk; temperature range (operating): 0 to $+40$ C ($+65$ C derated); TC: $0.03\%/^{\circ}\text{C}$ (typical). Specs for the NCB are: input: 115 V $\pm 10\%$, 47-440 Hz; regulation: line: 0.04% +2 mV, load: 0.04% +2 mV from zero to full rated load; ripple and noise: 1.5 mV rms; 5 mV pk to pk max; temperature range (operating): -20 to $+71$ C; TC: $0.02\%/^{\circ}\text{C}$ max., $0.01\%/^{\circ}\text{C}$ typical.

CIRCLE NO. 255

Step-motor accelerator handles 20,000 pps



Dahmen Burnett Electronics, Grenier Industrial Village, Londonderry, N.H. 03053. (603) 668-2777.

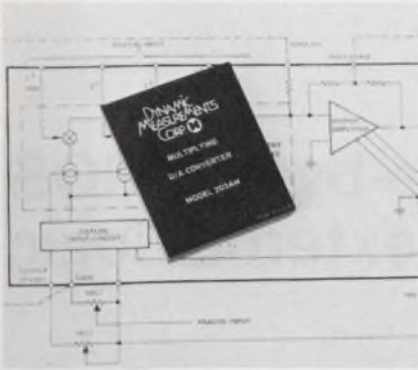
The A6 is a high-speed accelerator designed to handle a broad range of steppers, loads and stepping frequencies. The new unit will accelerate drive systems to any frequency of an input pulse train between 200 and 20,000 pulses per second. Designed for use where step loss between input and output is critical, the unit begins acceleration with the first pulse and continues until the required stepping rate is obtained. The unit will phase lock to the input frequency. Operator control is not necessary beyond application of the pulse-train input. When input pulses are stopped, the unit decelerates smoothly to a halt, without loss of steps. A three-bit binary input permits selection of eight separate response factors.

CIRCLE NO. 256



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 INTECH'S A-701 AND A-702 FAST FOUR-QUADRANT MULTIPLIER CAN DOUBLE FREQUENCIES DIVIDE, SQUARE SQUARE-ROOT AND DO OTHER MATHEMATICAL COMPUTATIONS. THE A-701'S ACCURACY IS BETTER THAN 0.5% @ 10V INPUT DIFFERENTIAL AND NEARLY 0.1% AT 5V DIFFERENTIAL. THE 702 IS TRIMMABLE WITH A POT.
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Multiplying DACs settle in 500 ns



Dynamic Measurements Corp., 6 Lowell Ave., Winchester, Mass. 01890. (617) 729-7870. \$125 (8 bits); stock to 3 wks.

The 200AM series of 8, 10 and 12-bit multiplying DACs settle to \pm LSB in less than 500 ns for FS digital input, and in less than 1 μ s for FS analog input. No external driver amplifiers or current boosters are required. All the converters have \pm 10 V @ 40 mA output. Output ranges of 0 to +10 V, \pm 5 V and \pm 10 V are available simply by strapping pins. Provisions are made for externally adjusting zero and full scale. All units are TTL and DTL compatible and are housed in encapsulated modules, 2.5 x 3.0 x 0.5 inches.

CIRCLE NO. 257

Isolation transformer offers 0.5 or 2 kVA

KGS Electronics, Inc., 2029 Lincoln Ave., Pasadena, Calif. 91103. (213) 798-0787. \$90; stock to 4 wks.

This shielded isolation transformer, the IT-1500, reduces electrical leakage from ac source to ground, and minimizes ground loop hazards when used with industrial commercial, medical and other electronic and electrical apparatus. The portable unit has a built-in selector switch to accommodate input voltages of 115 or 230 V ac (50-60 Hz) for 115 V ac output. Also available are units for 115 V ac input and 230 V ac output. Four sizes are available from 5 x 6 x 7 inches for a 500-VA unit (wt. approx. 19 lbs.) to 6-3/4 x 8 x 9 inches for the 2000-VA model (wt. approx. 55 lbs.).

CIRCLE NO. 258



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INFORMATION RETRIEVAL NUMBER 39

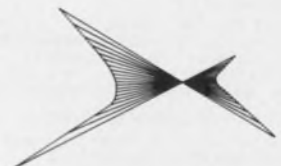
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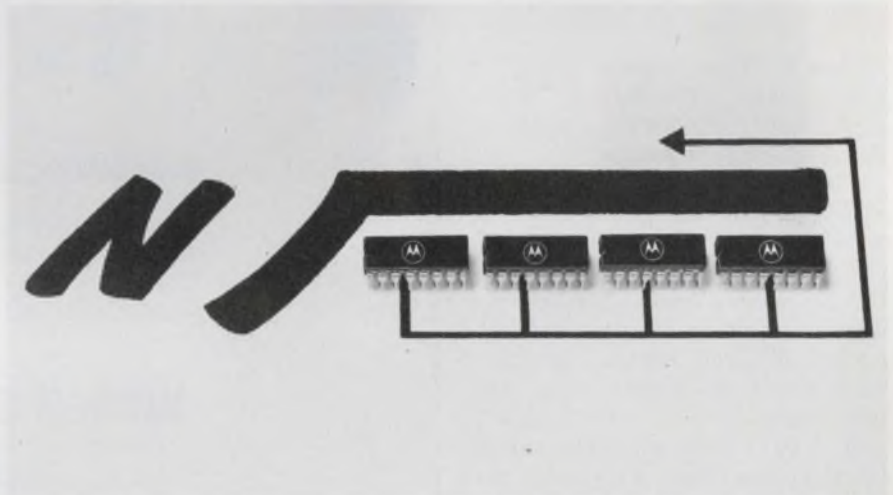
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INFORMATION RETRIEVAL NUMBER 41

ICs & SEMICONDUCTORS

Cascaded divide-by-N CMOS counters avoid external logic



Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, Ariz. 85036. (602) 273-3465. MC-14522AL and MC14526AL: \$11.85; MC14522CL and MC14526CL: \$6.60 (100 up); stock.

Both the MC14522 divide-by-N decade counter and the MC14526 divide-by-N binary counter—each a CMOS IC—can be programmed with a set of input signals to perform cascaded divide-by-N functions. Previously available CMOS divide-by-N counters have required external logic circuitry to perform these functions.

The new Motorola CMOS (MCMOS) devices feature a cascade feedback input and decoded ZERO outputs. These permit the construction of divide-by-N functions without additional circuitry.

The MCMOS synchronous counters list an output ON resistance of typically 500 Ω at 10-V supply, typical noise immunity of 45% of supply voltage and guaranteed operating frequency of 3 MHz. Supply voltage can range from 3 to 18 V.

Operating temperatures cover the -55 to 125 C range (AL suffix) and -40 to 85 C range (CL suffix). Both modulo-N counters

use toggle, master-slave flip-flops that are positive-edge triggered.

A frequency divider can be built to divide by any number N as follows: $N = M^n - 1$; where $M = 10$ (MC14522) or $M = 16$ (MC14526), and $n =$ number of stages. In a three-stage programmable frequency divider, for example, N may equal 1-to-999 using the MC14522. If the MC14526 is used, the range of N can be 1-to-4095.

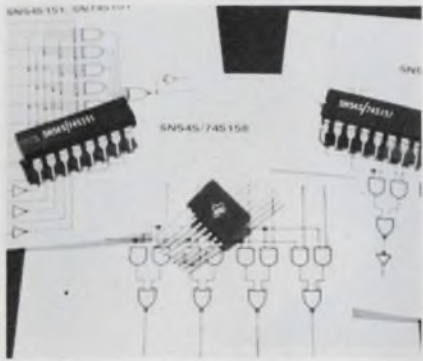
The decoded ZERO output of the least significant digits is connected to all preset enable inputs, and the decoded ZERO outputs of the more significant digits are fed back to cascade feedback inputs of preceding digits.

The output pulse that occurs after N input pulses equals that of the clock. These units provide a clock inhibit input that allows the pulse counting function to be disabled. Also, a master-reset input is available for synchronously initiating the divide-by-N cycles.

These counters can be used in frequency synthesizers, phase-locked loops and other applications where programmable frequency division is needed.

CIRCLE NO. 259

Multiplexers extend Schottky-TTL devices



Texas Instruments Inc., Components Group, P.O. Box 5012; M/S 308, Dallas, Tex. 75222. (214) 238-3741. SN74S151N: \$7.20; SN74S157N: \$4.50; SN74S158N: \$4.50; stock.

Three multiplexers—the SN-54S/74S151, 157 and 158—are recent additions to the company's Schottky-TTL line. The 151, an 8-line-to-1-line multiplexer, features a strobe-enable control input. The 157, a quad 2-line-to-1-line multiplexer with noninverting data lines, is designed specifically for data-source doubling of input or data lines. Finally, the SN54S/74S158 IC routes data from 1 of 2 data sources for a 4-bit word and features a delay time of 4 ns.

CIRCLE NO. 260

Shift registers come in commercial, MIL grades

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086. (408) 732-2400. Am1402A: \$12; Am1403A: \$9.60; Am1404A: \$9.60 (100 up).

A six-part MOS shift register group, featuring three devices with 10 MHz guaranteed frequency operation, are pin-for-pin replacements for similar Intel and other circuits. But unlike most shift registers these are available in both the commercial and military temperature grades. Power dissipation is 0.1 mW per bit at 1 MHz. The silicon-gate devices are quad 256-bit (Am1402A and Am2802), dual 512-bit (Am1403A and Am2803) and single 1024-bit (Am1404A and Am2804). For each set, the first unit operates from 400 Hz to 5 MHz; the second, from 400 Hz to 10 MHz.

CIRCLE NO. 261

Computer Graphics Displays Medical Displays Process Control Displays Document Retrieval Displays Educational Displays Business Data Displays C. C. T. V. / C. A. T. V. Displays Scientific / Test Equipment Displays Command and Control Displays That about covers the uses for the Hughes Scan Conversion Memory Unit. So far.

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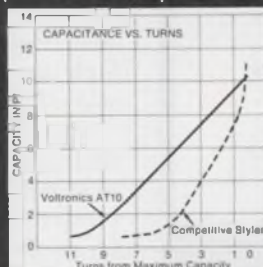
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tion first turn to last with positive stops. It all adds up to the most reliable design. Electrical Q is 4000-plus at 100 MHz with no self resonance above 2 GHz. Call or write for catalog and copy of an independently made comparison study. Voltronics Corp., West St., E. Hanover, N. J. 07936 (201) 887-1517.



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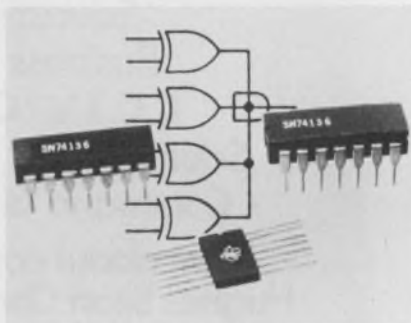
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ICs & SEMICONDUCTORS

EX-OR TTL gate has open-collector output



Texas Instruments Inc., P.O. Box 5012, M/S 308, Dallas, Tex. 75222. (214) 238-3741. SN74136N: \$0.90; SN54136N: \$1.35; 100-up; stock.

The SN54/74136, a TTL quad exclusive-OR gate, includes an open-collector output. Four of the circuits can be connected to perform a single comparison of two 8-bit complementary binary words since the open-collector outputs can be wire-AND connected. By using one input of each exclusive-OR gate as a control line, the IC can also be wire-AND connected to detect all ONEs and all ZEROs.

CIRCLE NO. 262

Thyristor lists 85-C rating of 1.6 kV, 70 A

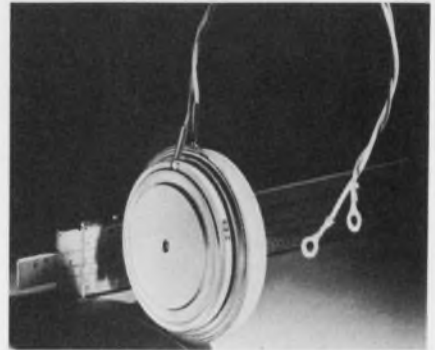


Amperex Electronic Corp., Solid State and Active Devices Div., Providence Pke., Slatersville, R.I. 02876. (401) 762-9000.

A series of silicon thyristors includes the BTW23 which handles currents as high as 70 A at 85 C and repetitive peak potentials as high as 1600 V. The new series also offers plastic triacs rated at 6 and 10 A at 400 V and stud-mounted types rated at 25 and 50 A at potentials up to 1600 V. Fast turn-off thyristors can be operated up to 25 kHz.

CIRCLE NO. 263

SCR has surge current rating of 20 kA

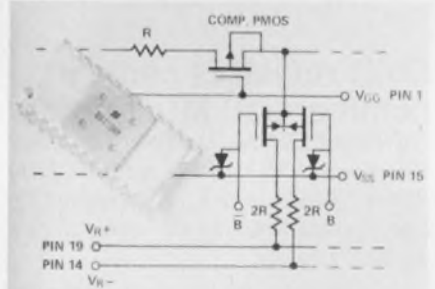


International Rectifier Corp., Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245. (213) 678-6281. 1000PA120: \$281 (10-99); stock.

A 1600 A (rms), 1200 V SCR lists a maximum peak one cycle, nonrepetitive surge current of 20,000 A—believed the highest rating for a device of this size. Termed the 1000PA, the new device is available in versions with maximum repetitive peak reverse voltage ratings from 500-to-1200 V. Maximum average on-state current at 180 degree conduction is 1000 amps.

CIRCLE NO. 264

Monolithic DAC boasts $8 \pm 1/4$ bit accuracy



Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, Calif. 95054. (408) 246-8000. \$31.50 for DA112 to \$15 for DA110; stock.

The DA110 series of monolithic d/a converters have $8 \pm 1/4$ bit accuracy over the -55 to $+125$ C temperature range. Least-significant-bit (LSB) accuracy of the DA110 is rated at ± 1 bit, with accuracy of the DA111 at $\pm 1/2$ bit and the DA112 at $\pm 1/4$ bit. All devices have settling times to LSB of $4 \mu\text{s}$ at zero to full-scale output voltage, and $3 \mu\text{s}$ zero to most-significant-bit. Output offset voltage is less than 0.25 mV.

CIRCLE NO. 265

Monolithic FET-switch drivers offered

Teledyne Crystalonics, 147 Sherman St., Cambridge, Mass. 02140. (617) 491-1670. \$7.40 to \$21.20 (100-249); stock.

The CDR125 series of monolithic six-channel FET-switch drivers perform the amplification and dc level shifting required between low level logic and MOS or junction FET switches. Four types are available: CDR125AL, CDR125AP, CDR125BL and CD125BK. The AL and AP models are MIL types. The BL and BK models have an operating temperature range of -20 to +85 C.

CIRCLE NO. 266

IC set forms processor system

National Semiconductor Corp., 2900 Semiconductor Dr., Santa Clara, Calif. 95051. (408) 732-5000. Less than \$100 (100 up).

An IC set provides many of the performance features of a mini computer controller at a fraction of the cost. Called MAPS for Micro-programmable Arithmetic Processor System, it is unlike a mini computer based controller because once programmed MAPS is dedicated to a particular application. MAPS includes an arithmetic unit, register unit, timing and control circuit, control ROMs, keyboard interface and static data monitors.

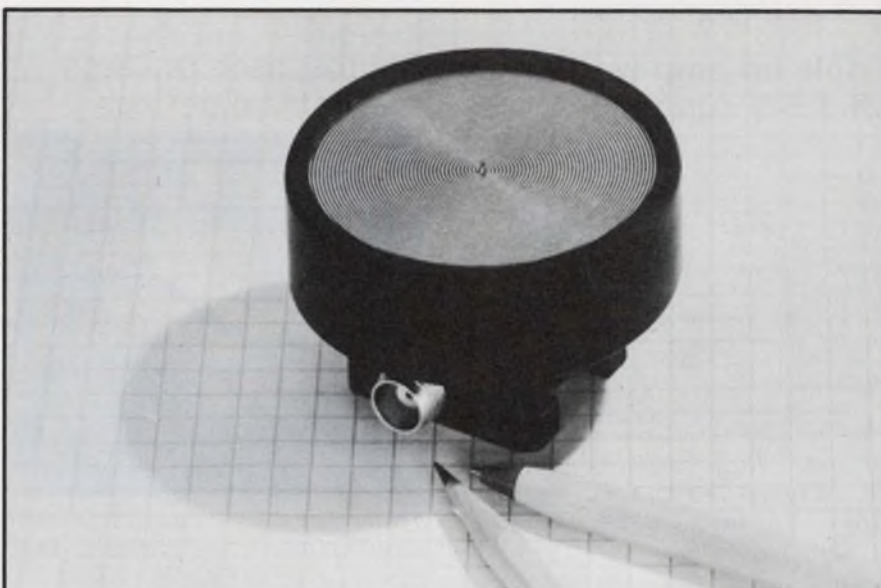
CIRCLE NO. 267

Fastest comparator weighs in at 7-1/2 ns

Advanced Micro Devices Inc., 901 Thompson Pl., Sunnyvale, Calif. 94086. (408) 732-2400. Am68534U: \$8.95 (100-up).

With a maximum guaranteed propagation delay of 7-1/2 ns, the Am685 is believed to be the fastest available comparator. The new IC has 500 μ V input resolution and complementary ECL outputs capable of driving 50- Ω lines. The circuit can be operated in a sample/hold mode at rates up to 100 MHz by means of a built-in latch. The enable time of the latch allows input signals to be acquired in less than 2 ns.

CIRCLE NO. 268



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Transco Products, Inc., 4241 Glencoe Ave., Venice, Calif. 90291

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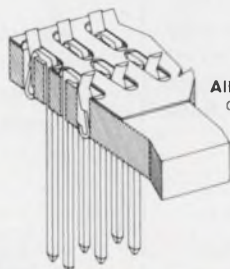
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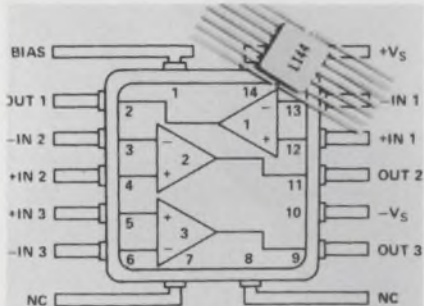
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INFORMATION RETRIEVAL NUMBER 46

Triple op amp works off 1.5-V supply

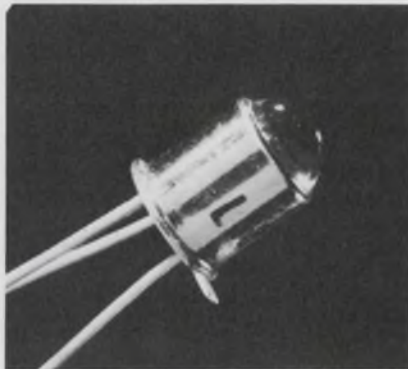


Siliconix Inc., 2201 Laurelwood Rd, Santa Clara, Calif. 95054. (408) 246-8000. L144C: \$11.75 (1-29).

An array of three low-power op amps on a single chip can be powered by a 1.5-V supply. Termed the L144 op amp, the new IC is unity-gain stable, with 80-dB gain under a 20-kΩ load. The device can drive capacitive loads of more than 1000 pF, and has ±30 V differential input voltage range. Output voltage swing is ±14 V typical. Internal compensation and continuous short-circuit protection are included.

CIRCLE NO. 269

Photosensor replaces mechanical devices



Texas Instruments Inc., P.O. Box 5012, Dallas, Tex. 75222. (214) 238-3741. \$1.75 (100-up); stock.

An npn phototransistor can replace mechanical functions in applications such as tape readers, velocity indicators, and encoders. Termed the TIL81, its typical light current is 22 mA for a collector-emitter voltage of 5 V. Dark current is 20 mA when collector-emitter voltage is 10 V. As a photodiode for fast switching, rise time is typically 350 ns.

CIRCLE NO. 270

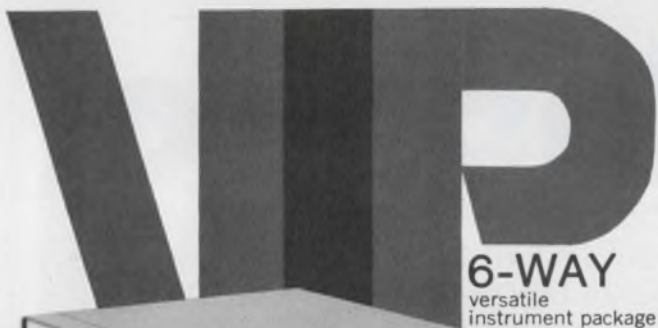
710-A SCR features 10-μs turn-off time



International Rectifier Corp., Semiconductor Div., 233 Kansas St., El Segundo, Calif. 90245. (213) 678-6281. 450PF60: \$117; 451PF60: \$105.30 (10-99); stock.

A 710-A (rms) inverter SCR with 10-μs turn-off time has the fastest turn-off time for this current rating, according to the company. The units are available in the 450PF series (ceramic) and 451PF series (plastic), with forward and reverse voltage ratings from 50-to-600 V.

CIRCLE NO. 271



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INFORMATION RETRIEVAL NUMBER 47



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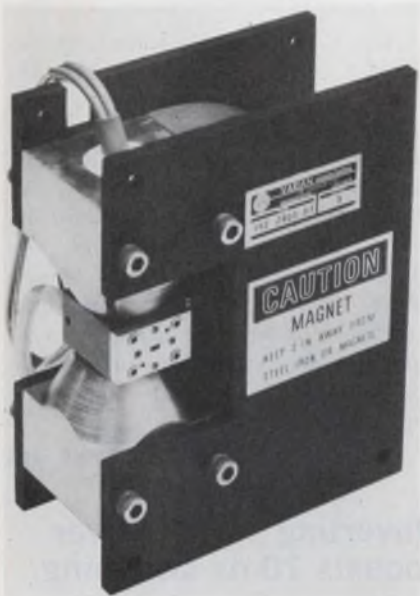
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INFORMATION RETRIEVAL NUMBER 48

ELECTRONIC DESIGN 16, August 3, 1972

Millimeter oscillators deliver 35 W typical



Varian Associates of Canada, 45 River Dr., Georgetown, Ontario, Canada. (416) 877-6901.

The VKE-2401A series of extended interaction oscillators delivers a typical output of 35 W (into a matched load) in the frequency range 50-to-80 GHz. Outputs as high as 50 W are attainable in the 50 to 60 GHz range. Typical operating conditions include an electronic tuning range of 150 MHz, a beam voltage of 6.8 kV dc and a beam current of 112 mA dc.

CIRCLE NO. 272

Digital system can handle 20-Mbit rates

Culbertson Industries, 1053 E. Meadow Circle, Palo Alto, Calif. 94303. (415) 327-6800.

The Model 10A, an 11-GHz digital microwave system, is capable of handling 1152 voice channels of communication or data rates up to 20 megabits. One system can transmit twelve "T" lines to provide 288 VF channels. And 576 VF channels (24 "T" systems) can be made available from one 11-GHz channel allocation by means of cross-polarization, using two Model 10A systems on one antenna. This capacity can be increased to 1152 VF channels (48 "T" systems) in one 11-GHz common allocation.

CIRCLE NO. 273

50-to-1250 MHz amps deliver up to 150 W

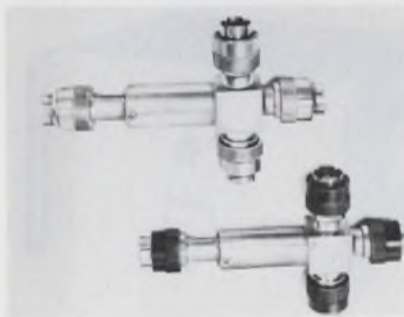


Acrodyne Industries, Inc., 21 Commerce Dr., Montgomeryville, Pa. 18936. (215) 368-2600. \$2500 to \$5000 (small quantities); 60-75 days.

Two solid-state amplifiers, termed Models A-2039 and A-2040, cover the combined frequency range of 50 MHz to 1250 MHz. These amplifiers can be obtained with output powers up to 150 W cw. At lower power levels, full instantaneous octave-band frequency coverage is offered. These features, combined with power gains to 30 dB and above, make these Class C amps well suited for airborne radar, jammer and communications applications.

CIRCLE NO. 274

Rf bridge line good to 500 MHz



General Radio, 300 Baker Ave., Concord, Mass. 01742. (617) 369-4400. \$250.

The GR874-BR rf bridge line features a frequency range of 400 kHz to 500 MHz. Directivity is greater than 45 dB over most of the range, while insertion loss is held to 6 dB. Both the standard ports and the unknown ports are accessible and can be terminated or connected in a variety of configurations. The bridges are available with 50 Ω or 75 Ω lines.

CIRCLE NO. 275

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- ± 0.2% ± ½ LSB accuracy
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1-to-2 W amp covers 0.5-to-1.0 GHz range



Hughes Electron Dynamics Div., 3100 W. Lomita Blvd., Torrance, Calif. 90509. (213) 534-2121. \$1495; stock.

The Model 1401H, a solid-state linear amplifier, operates in the 0.5 to 1.0 GHz frequency range. It provides 1 W minimum power output at 1 dB gain compression, a small signal gain of 30 dB minimum over the entire frequency range and more than 2 W of saturated power over most of the range. The new model weighs about 10 pounds and measures 10.2 × 14.6 × 4 inches.

CIRCLE NO. 300

'Button' filters for emi/rfi

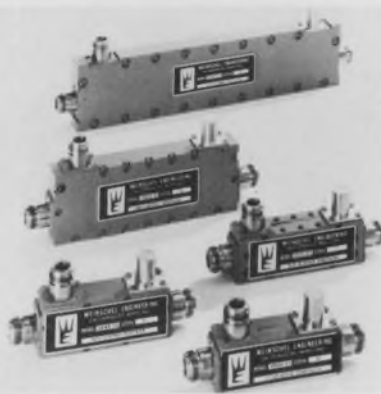


U.S. Capacitor Corp., Centralab Electronics Div., 2151 N. Lincoln St., Burbank, Calif. 91504. (213) 843-4222. \$3-\$4 (production quantities); stock to 4 wks.

A line of "button" type emi/rfi filters for the reduction of rf interference is now available from the company. Designated the 1020-000 (hermetically sealed) and 1021-000 (epoxy sealed), these units are rated for 50 V dc, 15 A and feature a tin plated brass, 1/4-28 threaded case.

CIRCLE NO. 301

Octave couplers have ±0.2-dB response



Weinschel Engineering Co., P.O. Box 577, Gaithersburg, Md. 20760. (301) 948-3434. 1540 through 1543: \$200; 1544: \$250; 60 days.

A series of five octave-band directional couplers covering the 0.5-to-12.4 GHz range and available with both 10 and 20-dB nominal coupling are now offered by the company. All five models have a frequency response of ±0.2-dB deviation from the average coupling. Three have extended octave ranges: 0.95 to 2.2 GHz (Model 1541), 1.7 to 4.2 GHz (Model 1542), and 3.7 to 8.3 GHz (Model 1543).

CIRCLE NO. 302

Traveling-wave amp covers 2-to-12 GHz



Cober Electronics, Inc., 7 Gleason Ave., Stamford, Conn. 06902. (203) 327-0003. See text.

The Model 1704 traveling-wave tube amplifier covers the S, C and X bands—a range of 2.0 to 12.4 GHz in a single package. The output is 1.5 W with a gain of 25 dB. In addition the unit has the capability to be serrodyne-modulated over the full frequency range. The 1704 is priced under \$10,000 and can be delivered within 60 days.

CIRCLE NO. 303

Impatt diodes for K-band oscillators

Varian, Solid State Div., 8 Salem Rd., Beverly, Mass. 01915. (617) 922-6000.

The VAO-53 series Impatt diodes consist of five models in the 18-to-26 GHz frequency range, with minimum rf power outputs from 100 to 300 mW. The operating voltages are between 53 and 57 V. Designed primarily for use in K-band fundamental oscillators, the diodes generate microwave power when operated in a reverse-bias condition. A locally-established avalanche zone followed by a suitable drift space in the diode makes the operation possible.

CIRCLE NO. 304

Inverting switch driver boasts 10-ns switching

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

A switch driver, the SD 1009, is an inverting TTL-compatible device intended to complement the company's non-inverting SD 1000 series. The SD 1009 drives shunt, series and series/shunt microwave p-i-n diode switches at less than 10 ns total switching time. The 1009 provides current from either the positive or the negative supply voltage, depending on the input from a TTL gate. And for high speed diode switching, current spikes are provided.

CIRCLE NO. 305

Backward diodes don't require forward bias

Philips, Electronic Components and Materials Div., Eindhoven - the Netherlands.

Two subminiature, germanium-bonded backward diodes that do not require a bias in the forward direction are the AEY31 and AEY31A. They also feature a 1-to-18 GHz bandwidth. The diodes have X-band zero-bias tangential sensitivities of typically -53 dBm for the AEY31 and -50 dBm for the AEY31A. VSWR is less than 5:1 over the whole frequency range. As mixers, the diodes, with a 3-kHz i-f, exhibit an over-all noise figure of typically 18 dB.

CIRCLE NO. 306

Hybrid amps come in 4-pin DIPs



Fairchild Camera & Instrument Corp., Microwave & Optoelectronics Div., 464 Ellis St., Mountain View, Calif. 94040. (415) 962-3816. FMA 105: \$63; FMA 111: \$59; FMA 115: \$69 (100 up).

Three hybrid amplifier circuits are packaged in modified four-pin DIP packages for simplified rf grounding and more efficient heat transfer. The FMA 105 provides optimum performance from 375 to 500 MHz. The FMA 111, a two-stage amp, lists similar specs. The third device, the FMA 115, has a range of more than 10 octaves.

CIRCLE NO. 307

Planar spiral antenna has 2-to-18 GHz range



Watkins-Johnson, 3333 Hillview Ave., Stanford Industrial Park, Palo Alto, Calif. 94304. (415) 326-8830.

A wideband planar spiral antenna, the WJ-8596, performs over the entire 2 to 18 GHz range and can be flush-mounted on the skin of high-speed aircraft. Squint angle for the WJ-8596 is maintained within 5 degrees, and the 3-dB beamwidth remains less than ± 10 degrees regardless of polarization or antenna orientation. The antenna meets the environmental requirements of MIL-E-5400, Class 2.

CIRCLE NO. 308



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Why \$49.00? Two reasons.

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Printact Relay Division, Executone, Inc., Box 1430ED, Long Island City, N.Y. 11101

INFORMATION RETRIEVAL NUMBER 51

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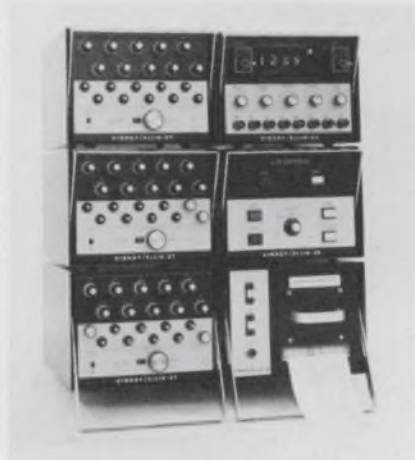
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(303) 442-3837 TWX 910-940-3246

INFORMATION RETRIEVAL NUMBER 52

DATA PROCESSING

Modular design offered for strain-gauge scanner



Vishay Instruments, Inc., 63 Lincoln Highway, Malvern, Pa. 19355. (215) 647-5115.

Reading and recording up to 100 channels of strain-gauge inputs, the V/E-20 series is a complete modular data-acquisition system. Starting with the V/E-20, digital-strain indicator, and adding a V/E-21 switch and balance module for each 10 channels, plus a V/E-25 scan controller, the system is completed with the V/E-22 printer. The scanning is manual or automatic at 1 chan/sec.

CIRCLE NO. 320

Crossbar switch works as data-acquisition scanner



Lear Siegler, Inc., Cimron Instruments, 714 N. Brookhurst, Anaheim, Calif. 92803. (714) 774-1010. \$2495.

Model 8400 crossbar scanner transfers information sequentially from several signal sources to measuring and recording equipment. The scan is automatic or manual within adjustable upper and lower scan limits. Input channels can be addressed by presenting a BCD code and a 5 V strobe pulse.

CIRCLE NO. 321

Nonimpact teleprinter cuts noise, speeds data

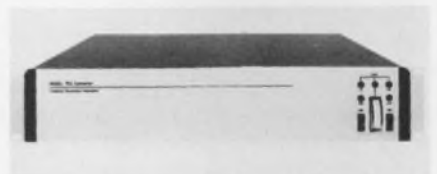


Computer Devices, Inc., 9 Ray Ave., Burlington, Mass. 01803. (617) 273-1550. \$2700.

Designed to replace older, slower and more noisy teleprinters, the Model 930 Teletherm has no moving parts except for the paper advance and print-head positioning mechanism. Interfacing is convenient because both serial and parallel signals are available at the rear-connector panel. Its solid-state, nonimpact printer is three times faster than Teletype equipment, and almost silent—even when printing at 30 chars/s.

CIRCLE NO. 322

Format changer couples dissimilar data systems



Frederick Electronics, Hayward Rd., P.O. Box 502, Frederick, Md. 21701. (301) 662-5901.

The Model 702 universal format converter interfaces devices having dissimilar code formats, timing, and input/output levels. It can accept any 5, 6, 7 or 8-level start-stop code and generate an output in any other start-stop (Baudot, ASCII, Typesetter) code. The converter handles I/O speeds from 37.5 to 4800 baud.

CIRCLE NO. 323

INSTRUMENTATION

Serial-bit monitor displays four characters



Time Share Peripherals, Miry Brook Rd., Danbury, Conn. 06810 (203) 743-7624. \$1600.

A portable troubleshooting and testing instrument for serial data transmission devices—multiplexers, terminals, data sets, etc., and for software—has been developed by Time Share Peripherals Corp. The monitor loads and displays the bit structure of up to four consecutive characters of transmitted or received data. The monitor may be set to display the first or last four characters of a transmission or to display a preselected character whenever it appears, plus the three following characters. The instrument will display the structure of characters of from 9 to 11 bits and at specified rates from 10 to 60 Hz.

CIRCLE NO. 324

Ten-inch chart recorder costs only \$395

Houston Instrument, 4950 Terminal Ave., Bellaire, Tex. 77401. (713) 667-7403. \$395.

A ten-inch strip chart recorder, designated the OmniScribe, has been introduced by the company. The unit features a multispeed chart drive, independent of line frequency. Four pushbutton speeds range from 1 to 10 inches per minute. A sprocketless, positive-feed paper drive is self aligning. Paper is standard 11 inches \times 100 feet. Another feature is the noncontact rebalance element that eliminates cleaning and trace glitches from the recording. The basic unit is 10 mV FS; and FS response is 1/2 second. The unit is available with single or dual pen, manual or electric pen lift and optional event marker.

CIRCLE NO. 325

Scope calibrator reads amplitude % error



Ballantine Laboratories, P.O. Box 97, Boonton, N.J. 07005. (201) 335-0900. \$1875; 2 to 4 wks.

The Model 6125A scope calibrator is a universal, self-contained instrument with a front panel deviation meter. The unit performs amplitude, time and rise time calibration of oscilloscopes. The front panel deviation meter reads the error in a scope's time or amplitude calibration directly in terms of percentage error. No calculations are necessary. The Model 6125A is designed for use with scopes up to the 250 MHz range and can also be used to calibrate counters and voltmeters. Amplitude accuracy is better than $\pm 0.25\%$; timing accuracy is $\pm 0.01\%$ of setting (crystal controlled); and the rise time calibrator presents a square-wave output having a rise time of less than 1 nsec positive into a 50 ohm load.

CIRCLE NO. 326

Digital lock-in amp offers 1 Hz to 100 kHz



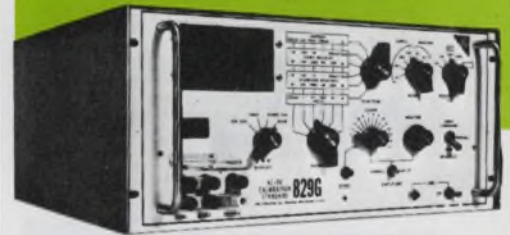
Evans Associates, P.O. Box 5055, Berkeley, Calif. 94705. (415) 653-2616.

A new digital lock-in amplifier, the Model 4101, features a 1 Hz to 100 kHz frequency range, digital readout, and separate differential voltage/current inputs. Pushbutton controls set meter multiplier, filters, time constant, internal oscillator range, phase quadrant, second harmonic operation, locking frequency source and power. The unit automatically tracks either its own internal oscillator or an external source. Acquisition time is four cycles plus 5 ms over the entire frequency range, without tuning.

CIRCLE NO. 327

INFORMATION RETRIEVAL NUMBER 53 ►

Now the famous 829 has a "G" for good measure!



Calibrate or Measure with the

RFL Model 829G

RFL's famous 829, for 15 years the industry calibration standard, now gives way to the new 829G — still the industry calibration standard, but now it's twice as useful. The 829G provides a precision source of AC and DC volts, amps and ohms — plus precision measurements of these parameters from external sources. It offers four-terminal sensing in both source and measurement modes, and high accuracy, resolution and regulation, with 5-digit readout. 5 ranges of AC or DC, 0.1 to 1000V. 6 ranges of current, 100 μ A to 10A. 50, 60, 400, 1000 Hz AC plus EXT. And many other features — all for just \$3,600. □ Write for complete data today. RFL Industries, Inc., Instrumentation Div., Boonton, New Jersey 07005. Tel: (201) 334-3100 / TWX: 710-987-8352 / CABLE RADAIRCO, N. J.



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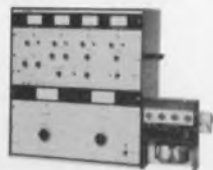
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INFORMATION RETRIEVAL NUMBER 54

evaluation samples

Insulators

A 43-page Component Mounting Insulator catalog lists over 100 insulators designed for capacitors, diodes, resistors, DIPs, relays and transistors. This illustrated book includes an actual sample of each insulator, technical data, drawing, photographs and detailed specifications. Robinson Electronics, Inc.

CIRCLE NO. 328

Conductive boards

Conductive foams provide the equipotential that eliminates static build-up for MOS devices, sensitive electronic components and electroexplosive assemblies. Conductive film poly bags and conductive boards enable MOS products to be shipped without static charge build-up. Wescorp.

CIRCLE NO. 329

Solderless terminals

Several new configurations of solderless terminals include 22-16 ring tongues with both long and short barrel; 22-16 and 16-14 spade and flanged spade terminals for barrier blocks; and 22-16 and 16-14 rectangular tongue with long and short barrel. All feature bright tin plating, giving improved corrosion protection, shelf life and appearance. These Zierick terminals are pre-packaged in 100-piece lots, or are available in bulk. Zierick Manufacturing Co.

CIRCLE NO. 330

Mounting clips

A new approach to simplify the fastening of plastic wiring duct to electrical circuit boards and control panels uses a system of nonconductive mounting clips. Plastic mounting clips are simply attached to appropriate panels by means of screws, nylon rivets or a pressure-sensitive adhesive provided on the underside of the clip. Any standard wiring-duct segment can then be snapped securely in place. Taylor Industries Inc.

CIRCLE NO. 331

application notes

Minicomputers

In an exciting 22-page booklet entitled "If Minicomputers are the Answer, What was the Question?", a detailed discussion of minicomputer solutions to data processing problems is presented. GRI's Direct Function Processing technique is described in the context of reducing system complexity while increasing flexibility. GRI Computer Corp., Newton, Mass.

CIRCLE NO. 332

Phase jitter

A seven-page application note No. 109 describes a step-by-step procedure for measuring phase jitter. The procedure determines that Models AT-443 and AT-463 level meters constitute a negligible phase jitter themselves. W & G Instruments, Inc., Hanover, N.J.

CIRCLE NO. 333

Frequency measurements

Frequency measurements using a 7000-series oscilloscope, the 7D14 plug-in digital counter, and current probes are described in a new application note. The advantage of using current probes for minimizing accidental grounds, loading effects, and monitoring signal currents at ground points are given. Tektronix, Inc., Beaverton, Ore.

CIRCLE NO. 334

Magnetic cores

"Broad Band-Rated Ferramic Components," a 24-page design guide, describes a new family of magnetic cores specifically manufactured and tested for broadband applications from 0.3 kHz to 250 MHz. Design examples, applications and specifications are provided in terms of electrical characteristics. Typical curves are included to illustrate variation of shunt impedance properties with frequency and variation of inductance with flux density, temperature, and direct current bias. Indiana General, Valparaiso, Ind.

CIRCLE NO. 335

Three Output Power Supply



For Op Amps & Companion Logic

Outputs are ± 15 VDC (tracking) @ 50 ma and 5 VDC @ 250 ma. All outputs have regulation of $\pm 0.1\%$, ripple of 1.0 mv, and are short circuit protected. Only 3.5"x2.3"x1.0". Mounts directly on a PC board. Order Model 5E25D-D15E05. Price: \$88.00 (For ± 12 and 5 VDC, Model 5E25D-D12E05. Same price. Other voltage and current ratings also available.) Shipment: Three days.



Acopian Corp., Easton, Pa. 18042
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INFORMATION RETRIEVAL NUMBER 55

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100 ma, 5 or 15 amp, alternate or momentary action switches mount on centers as close as $\frac{1}{32}$ " (15 amp, $\frac{3}{32}$ "). Minimum life, 100,000 cycles.

Independent, isolated incandescent, neon or LED lamp for indicator. Switch contact rating: 100 ma @ 28 VDC; 5 or 15 amps at 115 VAC, 60 Hz or 28 VDC resistive. Priced as low as \$3.60 in quantities of 100-499.

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INFORMATION RETRIEVAL NUMBER 57

new literature



Slide switches

Two bulletins give descriptions, applications and specifications for design slide switches; Models SSR/rocker adapter (Bulletin 2805) and Models SSR/flush mount (Bulletin 2806). Airpax Electronics/Pacific Div., S. El Monte, Calif.

CIRCLE NO. 336

Wire wrap tools

A 20-page booklet provides information and specifications on wire wrap tools designed to provide fast, reliable electrical connections for commercial and military applications. Gardner-Denver, Quincy, Ill.

CIRCLE NO. 337

Plugs and sockets

A 20-page catalog lists the complete line of Jones plugs and sockets. Electrical and physical specifications and information on the proper method of handling and wiring these Jones connectors are included. Units stocked by distributors, and available for off-the-shelf delivery are designated in the catalog. Cinch Connectors, an Operation of TRW Electronic Components, Elk Grove Village, Ill.

CIRCLE NO. 338

Optical inspection

A catalog describes instruments that are being used for inspecting and measuring patterns in photo masks, memory frames, leads on ceramic circuits, gaps on magnetic tape heads, holes in PC boards, reed switches, diodes and hybrids. Opto-Metric Tools, Inc., Rockleigh, N.J.

CIRCLE NO. 339

Terminal blocks

A compact, six-page brochure makes use of convenient tables and charts to present information on terminal blocks, relay socket assemblies and standard control assemblies. Terminal blocks are presented in order of capacity, from the high-current blocks for power circuits to control blocks and low-capacity blocks. All pertinent dimensions and other data required for the selection of a component for a specific application are included. Curtis Development and Manufacturing Co., Inc., Milwaukee, Wis.

CIRCLE NO. 340

Servo controller

A servo controller for driving a hydrodynamic actuator in load or position closed-loop servo control is described in a bulletin. Koehring, Pegasus Div., Troy, Mich.

CIRCLE NO. 341

Communication systems

Capabilities in computer-controlled data communications systems are described in an eight-page brochure. The brochure describes the "turn-key" approach to systems design, highlights the benefits and features of Sigma Communications Systems, and summarizes the hardware, software and support available to communications customers. Xerox Corp., El Segundo, Calif.

CIRCLE NO. 342

Paper tape system

A four-page bulletin describes a high-speed fan-fold paper tape system which comes in a single, rack-mount package and is available for use with the Micro 800 and Micro 1600 computers. The bulletin lists features, specifications and instructions. It also contains a general description along with individual descriptions of the controller and reader/punch assembly. Microdata Corp., Santa Ana, Calif.

CIRCLE NO. 343

DIP socket cards

Socket cards that provide for up to 1050 ICs in a single 7 × 7-1/4 × 19-inch horizontal file are featured in a four-page bulletin. Electronics Engineering Co. of California, Electronic Products Div., Santa Ana, Calif.

CIRCLE NO. 344

Modular sinewave source

Precision modular sinewave oscillators are described in a four-page report which includes methods of optimizing usage and several applications. Frequency Devices, Inc., Haverhill, Mass.

CIRCLE NO. 345

Traveling-wave tubes

Traveling-wave tubes are described in a four-page catalog. ITT Electron Tube Div., Easton, Pa.

CIRCLE NO. 346

Modems

The Model 2011, a Bell 201A compatible modem capable of synchronous operation at 2000 bits per second over dial-up telephone lines, is described in a six-page brochure. Included in the brochure are descriptions of important features, detailed theory of operation, complete technical specifications, and drawings. Intertel, Burlington, Mass.

CIRCLE NO. 347

Power modules

"Take a Good Look Inside," a four-page brochure, features encapsulated PC card mounted power modules. Computer Products, Inc., Fort Lauderdale, Fla.

CIRCLE NO. 348

Switches and relays

Engineering Catalog, G-308, contains 104 pages of drawings, pictures, dimensions, materials, ratings, operating features, delivery and prices for the company's line of rotary switches, push-button switches, termination hardware, wire ties and solid-state relays. Everything needed to select, specify and order can be found on the pages of this data book. Grayhill, Inc., La Grange, Ill.

CIRCLE NO. 349

2 for 1



5 1/2 DMM

BASIC ACCURACY IS $\pm 0.001\%$ f.s. $\pm 0.007\%$ rdg. ± 1 DIGIT GUARANTEED FOR 6 MONTHS.

"Two for the price of one." This is the way many of our customers have reacted to our Tri-Phasic 5 1/2 DMM. At a cost of 50% less, they purchase two of ours for the same price or less than one of the closest comparable DMM's.

It's The Best Buy in the DMM field.

This precision 5 1/2 digit Model 2540 gives you DC Volts, AC Volts, Resistance, Voltage Ratio, Auto-Ranging, Auto-Polarity, Isolated BCD Outputs, Remote Triggering and Remote Ranging. Documented by full test data and Certificate of Conformance. **All for \$1195.**

Choose from eight 4 1/2 digit and 5 1/2 digit models from \$580. Call or write Bob Scheinfein (617) 246-1600, Data Precision Corp., Audubon Rd., Wakefield, Ma 01880.



INFORMATION RETRIEVAL NUMBER 59

THE GREATEST
ACHIEVEMENT
YET IN
**ELAPSED
TIME
INDICATORS!**



CompaC T12

Yes, ENM has put it *all* together in a small package and gift wrapped it for you. Everything you've ever wanted in an elapsed time indicator that records to 100,000 hours.

Epicyclic gearing conserves space and delivers an easy-to-read 6 digit indicator only 1.72" wide. And it even counts tenths of hours.

The versatile CompaC T12 is interchangeable with competitive devices and may be base mounted or back panel mounted for multiple stacking in minimum space. Or add a bezel for front panel mounting.

And we didn't forget price, either. How does \$5.68 in 100 lots grab you? That's the gift wrapping.

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INFORMATION RETRIEVAL NUMBER 60

ELECTRONIC DESIGN 16, August 3, 1972

COMPRESSED VIDEO

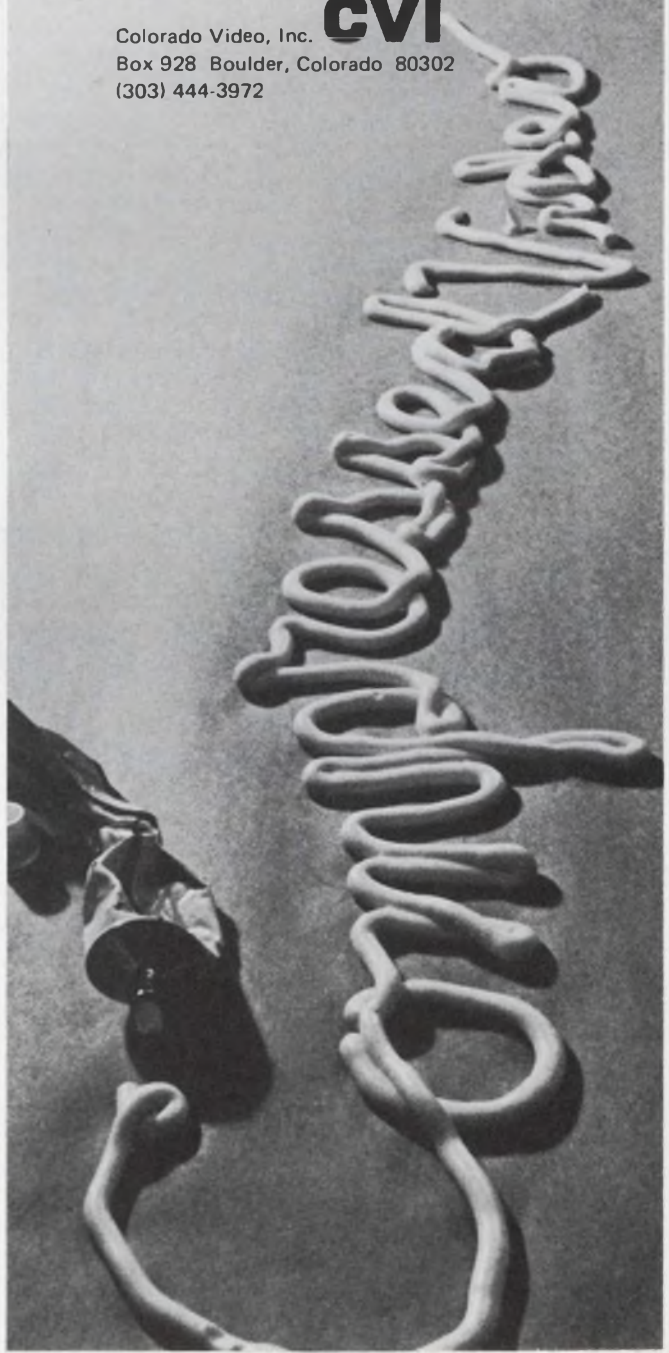
- Starts with a standard CCTV camera
- Ends on the screen of a standard CCTV monitor
- Uses "dial up" voice grade telephone circuits in the middle
- Is a highly flexible alternative to facsimile or the Picture Phone

The CVI 200 series Video Converters provide for single frame TV picture transmission over audio bandwidth circuits. Options include multiple image storage, hard copy, computer I/O, and color.

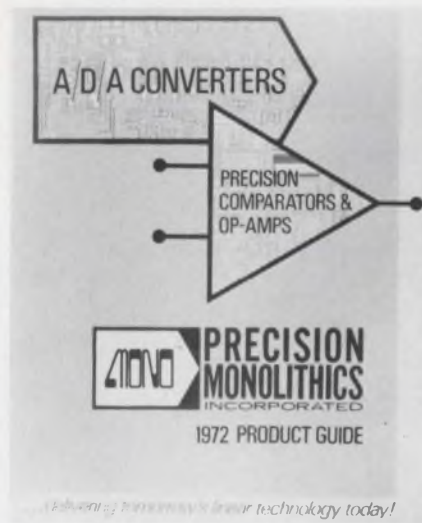
Video instruments for data acquisition, processing, transmission, and display.

cvi

Colorado Video, Inc.
Box 928 Boulder, Colorado 80302
(303) 444-3972



INFORMATION RETRIEVAL NUMBER 61



A/d, d/a converters

A 12-page short form catalog describes a line of high-performance linear ICs including integrated d/a converters, precision comparators, precision op amps, improved performance second source op amps and monolithic chips. Also described are high-performance modular a/d and d/a converters. Prices, local representatives and stocking distributors are indicated in the price list. Precision Monolithics, Inc., Santa Clara, Calif.

CIRCLE NO. 350

RFI filters

RFI power line filters are described in a 6-page catalog. This brochure describes five series of filters with a wide variety of case styles and termination arrangements. Also included are complete electrical and mechanical specifications. A feature of this catalog is an application/specification selection chart which allows the user to select the proper filter for specific applications. Corcom, Inc., Chicago, Ill.

CIRCLE NO. 351

Printer interface

New supporting literature is now available on the Series 160 printer interface, which is a peripheral controller designed to interface the new Printec-100 line printer with Data General and Digital Computer Controls minicomputers. Mini-System, Inc., Minneapolis, Minn.

CIRCLE NO. 352

Barrier block

Complete electrical and physical specifications on twenty-three series of barrier terminal blocks are listed in a 16-page catalog. The catalog also lists marker strips, fanning strips and other hardware designed to increase the usefulness of these terminal blocks. Terminal blocks that are stocked for immediate delivery are indicated. Cinch Connectors, an Operation of TRW Electronic Components, Elk Grove Village, Ill.

CIRCLE NO. 353

Rf products

A general catalog of the company's complete product line details information on the following: rf subsystems, (receiver front ends, i-f amplifiers with optional L.O. and i-f frequencies; multicouplers and rf distribution systems and custom thick-film microelectronics for conversions from discrete circuitry. Also included in the new general catalog is a short form catalog on solid state broadband amplifiers, a facilities brochure, and data sheets on the complete amplifier line. Optimax Inc., Colmar, Pa.

CIRCLE NO. 354

Power modules

A line of heavy current switching with fingertip ease is described in a product bulletin. Switchcraft, Inc., Chicago, Ill.

CIRCLE NO. 355

Microwave antenna

A catalog describes a wide selection of microwave antennas including calibrated omnidirectional, calibrated directional, calibrated directional log periodic, uncalibrated antennas as well as antenna accessories. Polarad Electronic Instruments, Lake Success, N.Y.

CIRCLE NO. 356

Data sets

Models 7201A and B data sets, functionally and interface compatible with Bell System 201A and B models, are described in a bulletin. Ambac Industries, Tele-Dynamics Div., Fort Washington, Pa.

CIRCLE NO. 357

Rf power transistor

RF Power Transistors, publication RFT-700J, contains data on a line of rf power transistors. A quick-selection guide, which employs a bar chart of frequency allocations in conjunction with power-vs-frequency curves, shows the entire line of rf types. To facilitate comparison and selection of devices, types are tabulated by application. RCA Solid State Div., Somerville, N.J.

CIRCLE NO. 358

Data sets

The full family of DigiNet data communications equipment is described in a 10-page brochure. Covered are acoustic couplers, modems, wideband data systems, multiplex units and data concentrators. Thumbnail sketches and photos of the equipment are included as are specifications and descriptions. GE, Lynchburg, Va.

CIRCLE NO. 359

SCRs

A line of fast turn-off SCRs with very low turn-on losses is described in a brochure. The brochure contains complete electrical specifications, device ratings and characteristics and 12 graphs showing operation of the units under various high-frequency conditions. A dimensioned outline drawing and a photograph are also included. International Rectifier Corp. Semiconductor Div., El Segundo, Calif.

CIRCLE NO. 360

I-f amps

A four-page product bulletin lists an expanded line of standard log amplifiers for radar and communications applications. Features, photos and improved specifications for standard and miniature models and new Hybrid IC and Super Log Series are listed. Reduced prices on many models are also included. A log amplifier test set is described and a technical statement on understanding log amplifiers is also included. RHG Electronics Laboratory, Inc., Farmingdale, N.Y.

CIRCLE NO. 361

bulletin board

Monsanto Commercial Products Co. has announced the first published **guarantee program** for the major portion of its **light emitting diodes**. The guarantee covers a period of ten years of the life of the equipment, whichever comes first. Termed the "GaAsLITE Guarantee," the new program covers the major portion of Monsanto's listed product line, including the most popular devices in visible discrete LEDs, numeric and alpha-numeric displays, and opto-isolators.

CIRCLE NO. 362

Price reductions

Versatec has reduced prices of **controllers for 18 mini and midi-computers** up to 33%. The reduction of controller costs is part of the firm's long-range objective to make this method of nonimpact hard copy output highly desirable for the mini and midi-computer user. Controllers are available for DEC's PDP 8, 9, 11, 12 and 15; HP's 2100, 2114, 2115 and 2116; and Data General's Nova and Super Nova series. Other controllers are available for Varian's 620 and 622; Xerox's Sigma 2, 3, 5 and 7; IBM's 1800; and Honeywell's 316 and 516. The controllers are applicable to Versatec's standard 80 and 132 column printers, plotters and combination printer/plotters. Depending upon the computer model, the controllers' prices range from \$900 to \$4500.

CIRCLE NO. 363

Sycor, Inc. has announced an OEM price reduction of as much as 33% on its **Model 125 digital cassette recorder**. As a result, the 1000 character per second recorder now is available at a price as low as \$600 in quantities of twenty-five or more. The price reduction is intended to broaden Sycor's customer base to incorporate many smaller OEMs.

CIRCLE NO. 364

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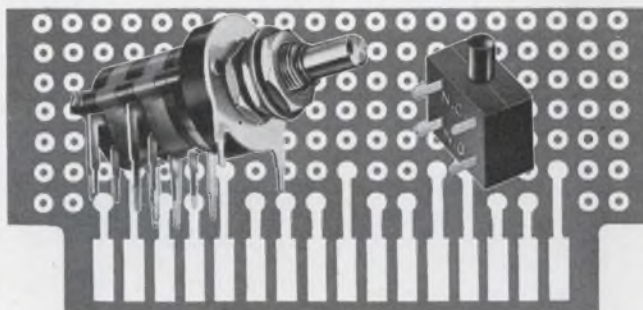
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INFORMATION RETRIEVAL NUMBER 63



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Like to know more? Write or phone for our latest general engineering catalog. Grayhill, Inc., 565 Hillgrove Ave., La Grange, Ill. 60525, (312) 354-1040.

Grayhill

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INFORMATION RETRIEVAL NUMBER 64

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50 Essex Street
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CIRCLE NO. 171

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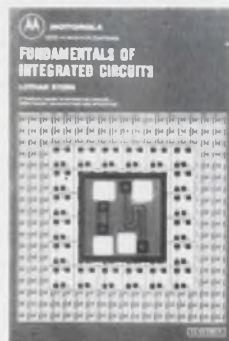


New P.A.R. electrometers offer superior performance at low cost. Model 134, with wide range and high stability, is priced at \$615; Model 135, with self-contained battery power supply, \$675; and Model 136 with digital display and BCD output, \$1125. Drift, offset and noise figures are lowest available in this price range. Other features include guarded input circuits and fast recovery from large overloads. Full line of accessories available. Request new brochure, demonstration or applications assistance. CIRCLE NO. 172

Princeton Applied Research Corporation

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CIRCLE NO. 173

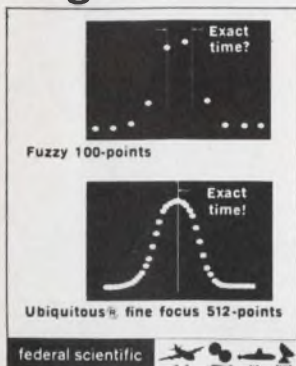
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CIRCLE NO. 174

Federal Scientific Corporation

615 West 131st Street, New York, N. Y. 10027

New Brochure Describes Low-Cost Power Supply Systems



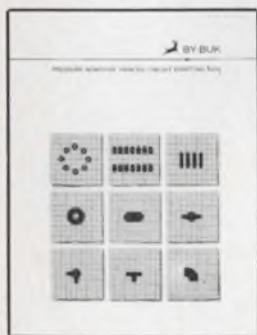
A new brochure by Transistor Devices offers designers and engineers technical data on its expanded range, multiple output, X-L Series of power supplies. Such features as short circuit protection, remote sensing, adjustable outputs and 0.25% regulation, with outputs of 1-30V and current levels of 0.7 to 8 amps give designers a wide selection of models priced from \$48.50 to \$115.00.

CIRCLE NO. 175

Transistor Devices, Inc.

85 Horsehill Road, Cedar Knolls, N. J. 07927
Tel. (201) 267-1900

PC Drafting Aids Catalog



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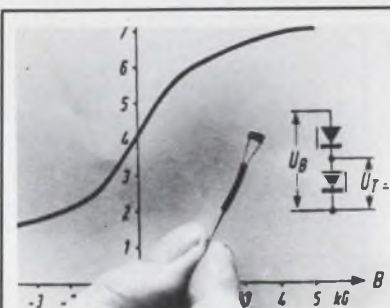
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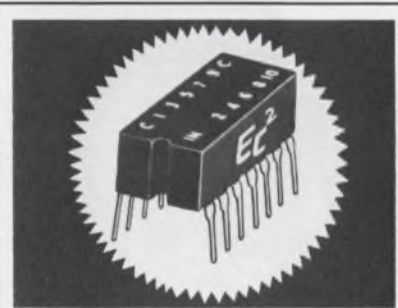
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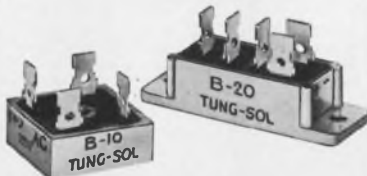


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product index

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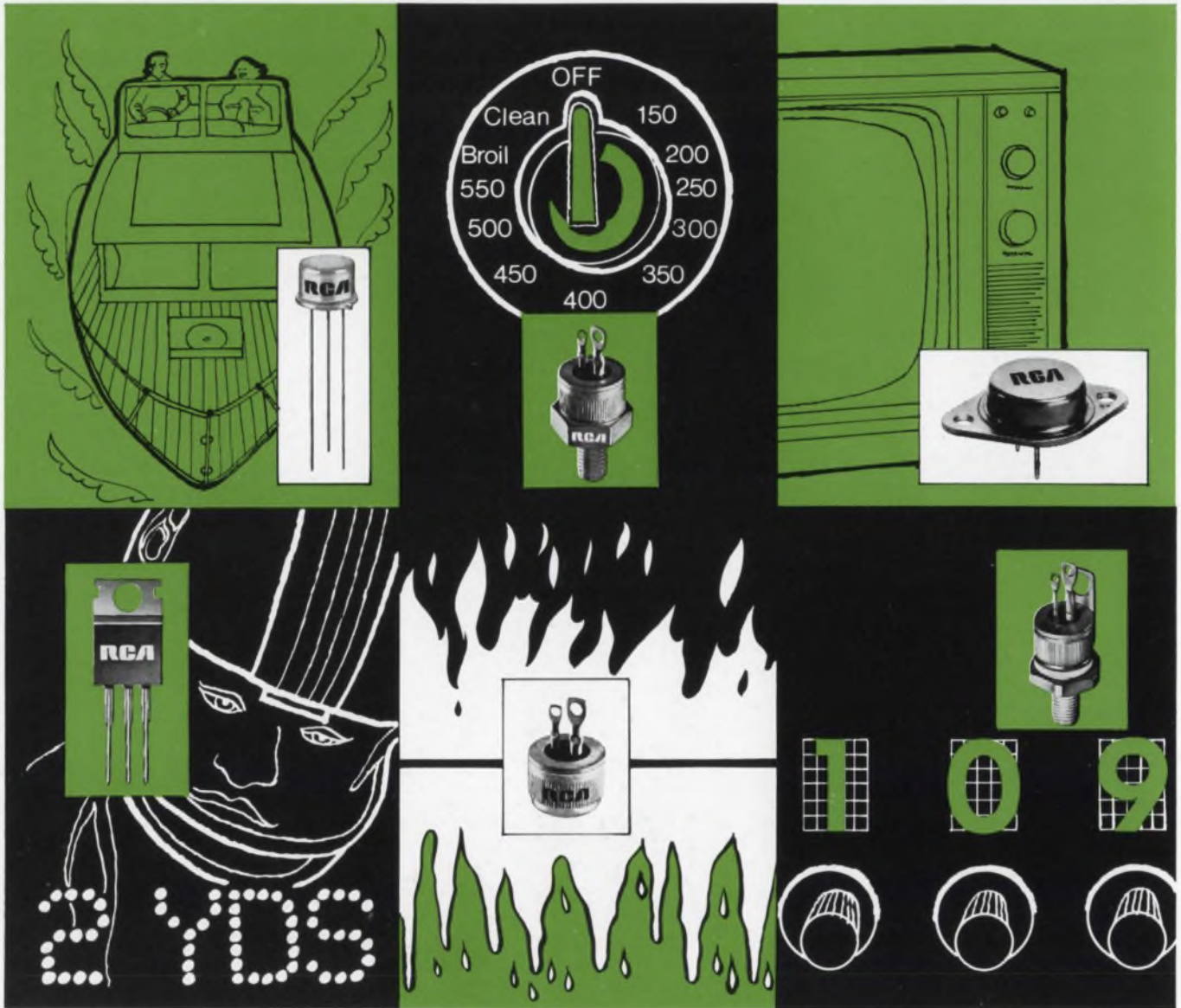


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From simple time and temperature displays to scoreboards in sports arenas, your indicator board circuits should include RCA. For electronic accuracy and solid-state reliability, pick the 40530 family for low-level logic circuits. For heavier surge capability, select plastic VERSAWATT types such as 40668 and 40669.

In home comfort systems — heating, cooling, humidifying, and pollution control equipment — use the solid-state techniques that offer reliability in interfacing low-level logic with high power motor controls. Choose your devices from RCA: 40530, 2N5445, 40918, 40868 and 40869, all designed for new and improved systems.

With 30 A and 40 A triacs to choose from, you can select the proper device to control the high intensity lamp in your photocopier. RCA can easily adapt any standard stud or electrically-isolated stud package to a custom package configuration to meet your needs as well as UL requirements.

For more information on these and other RCA thyristors, see your local RCA Representative or your RCA Distributor. For technical data on specific types, write: RCA Solid State Division, Section 57H-3 /UR15, Box 3200, Somerville, N.J. 08876. 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, Quebec.

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