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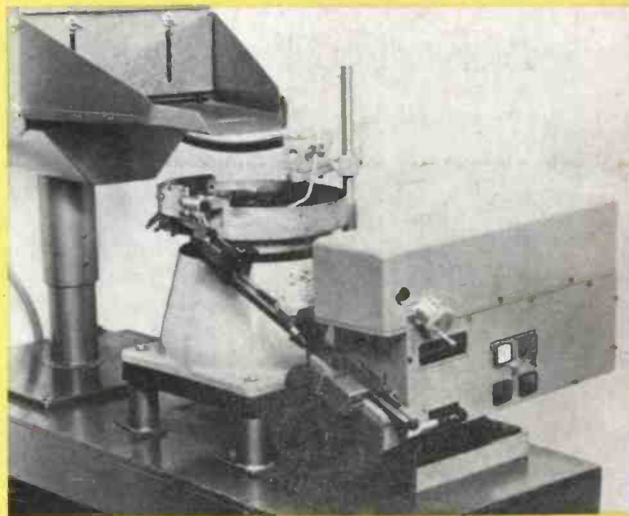
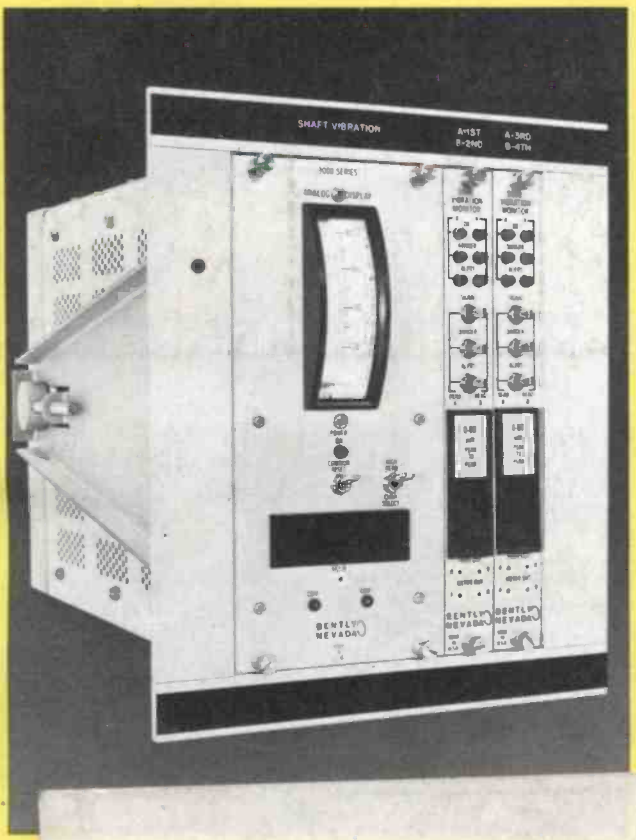
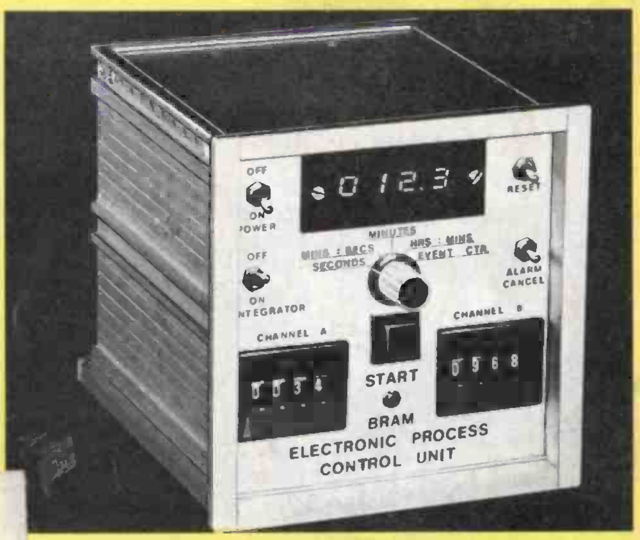




Industrial Maintenance

Microprocessor ALU

Lightning protection



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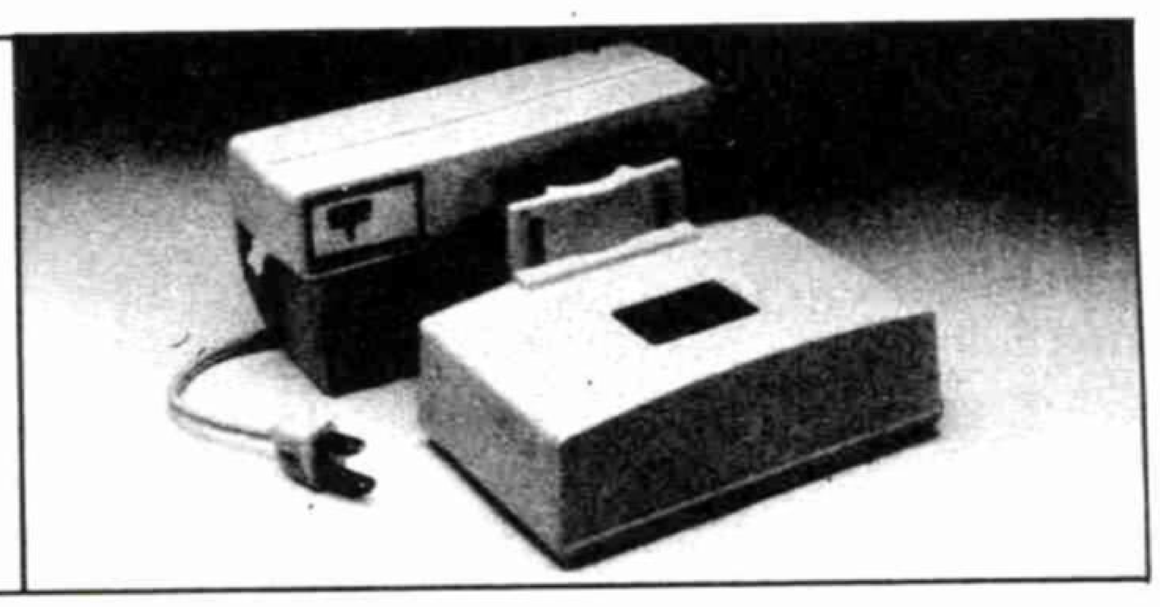
Ask your electronics distributor for more information.

BLONDER TONGUE



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Electronic Servicing

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INTERTEC PUBLISHING CORP.

In October

Electronic Servicing.

Troubleshooting digital industrial equipment; repairing electrocardiograph machines; a technical notebook from Sam Wilson; test lab; and microprocessors.

September, 1979 □
Volume 29, No. 9

Electronic Servicing®

Departments

About the cover

Graphic design by Joy Viscek. Pictures clockwise top left, temperature control, courtesy of United Electric Controls; dimensional inspection, courtesy of Bram International; process timer, courtesy of Bentley Nevada; and shaft vibration, courtesy of Automation Systems.

NBC network is said to have asked AT&T and other satellite operators for proposals about carrying NBC TV programs to all its TV affiliates by satellite. Such signal-distribution methods now are possible because the FCC has ended its former restriction against the carrying of any non-government private-line signals by the AT&T Comstar satellite. AT&T has not replied publicly to the inquiry. In a non-related action, the FCC recently authorized the launching of Western Union's third satellite, Westar III. Two other Westar satellites have been in use for some time.

Several TV channels are being broadcast presently from satellite to anyone who has the proper receiving equipment. Many CATV systems carry programs received by a large parabolic antenna and special down-converter. Because this equipment is expensive, COMSAT is attempting to interest manufacturers and programmers in providing multi-channel subscription TV service from satellite direct to a small antenna on each subscriber's roof. Satellite TV reception is being tested now in Japan. Hughes Aircraft Company has delivered an experimental low-cost satellite receiving system to the NASA Goddard Space Flight Center. It is expected to serve as a prototype for mass-produced home satellite systems. Similar satellite developments were described and their future use predicted in the July, 1974 issue of **Electronic Servicing** under the title "Home TV reception direct from satellites."

Sales of videocassette recorders to dealers increased by 26.6% during the first six months of 1979 compared to the same period of 1978. The total was more than 180,000 units. However, sales are expected to accelerate even faster during the fall and early winter. An executive of Sharp has predicted VCR total sales could reach 600,000 units this year. Other manufacturers also are preparing strong sales campaigns.

Magnavision videodisc demonstrations by Magnavox have drawn large crowds at the opening of a new promotion in Minneapolis and at the recent convention of National Electronic Service Dealers Association (NESDA) in Tucson, AZ.

PTS Electronics now rebuilds remote-control transmitters of Admiral, GE, Magnavox, Quasar, RCA Sylvania and Zenith brands. Additional modules for rebuilding include Packard Bell, Advent, Sanyo and Truetone.

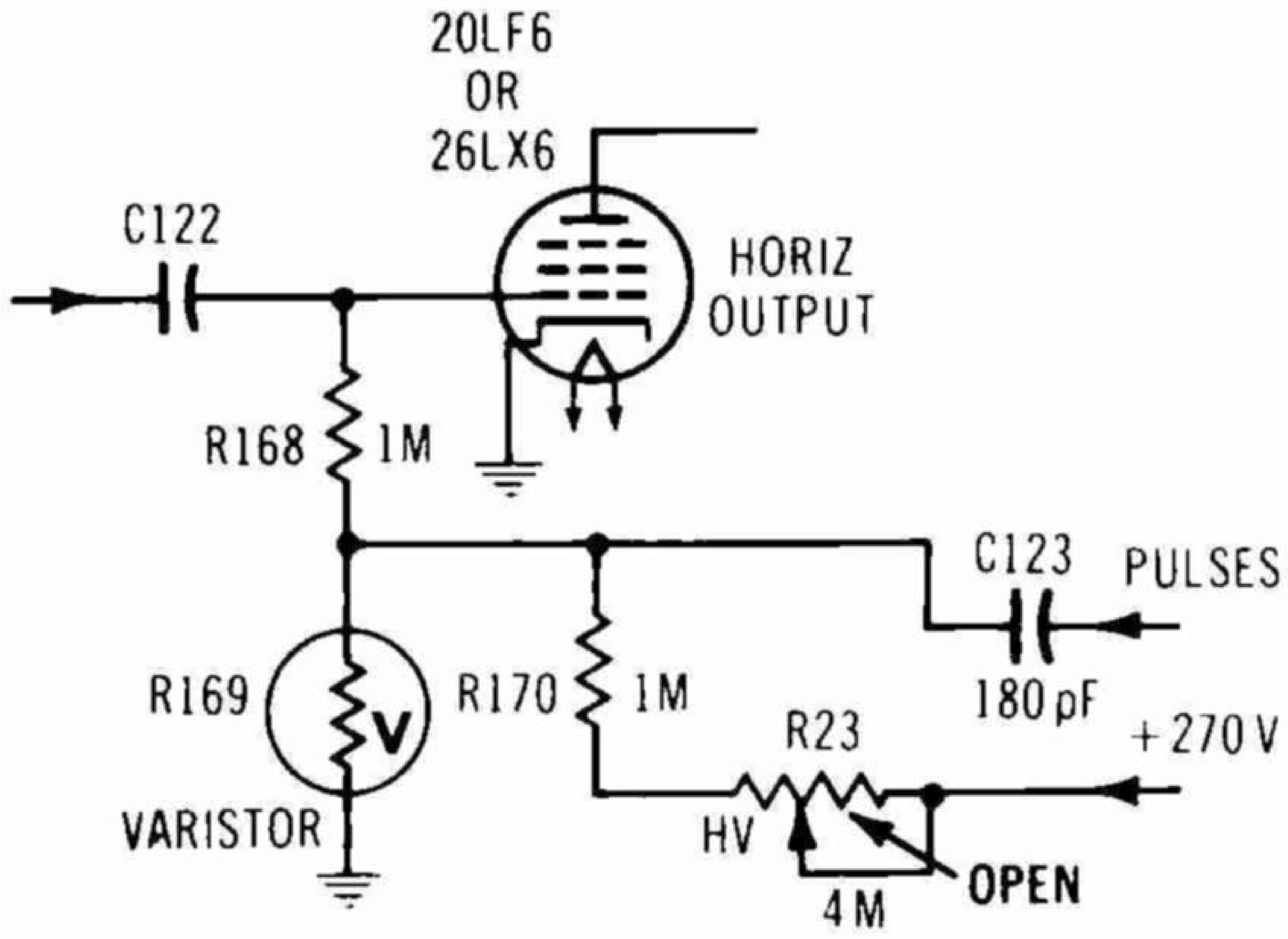
Electronic game sales should continue to increase sharply, according to research by Frost and Sullivan. The $500 million market of 1978 could triple within the next five years.

Inflation is being combatted by Leader Instruments. Prices on 40 of 55 test instruments are not increased, and the other 15 are raised about 6%.

Solec International has introduced a broadcast-band transistor radio that operates from the light of solar energy striking three solar cells mounted on the sloping panel. A switch to internal batteries is possible for operation with low light levels.

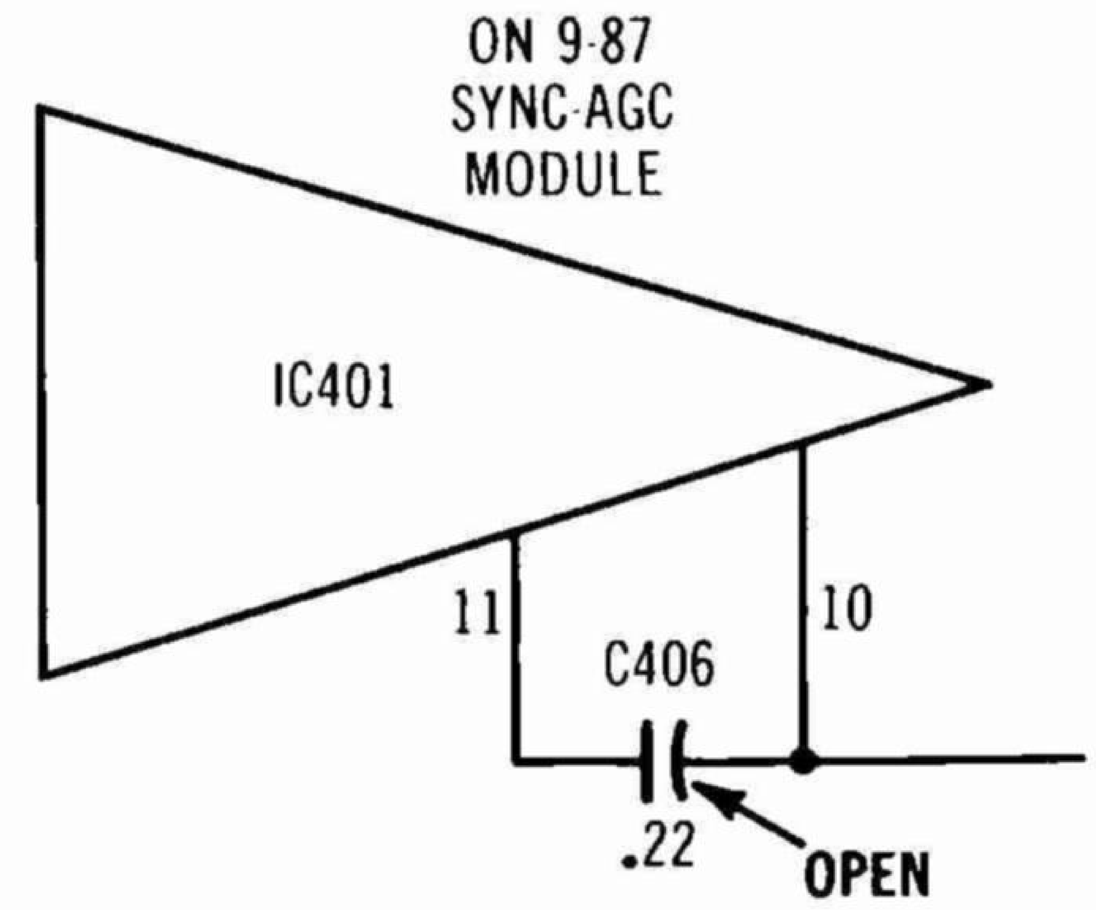
Kikusui International, a wholly owned subsidiary of Kikusui Electronics Corporation of Kawasaki Japan has opened its California office for business. The office is located at 17121 S. Central Ave., Unit #2M, Carson, CA 90746. Kikusui manufactures general electronics testing equipment supplies such as oscilloscopes and ac/dc regulated power supplies. The subsidiary is headed by Kimiaki Miyamoto.

Chassis—Zenith 19CC19
PHOTOFACT—1215-3



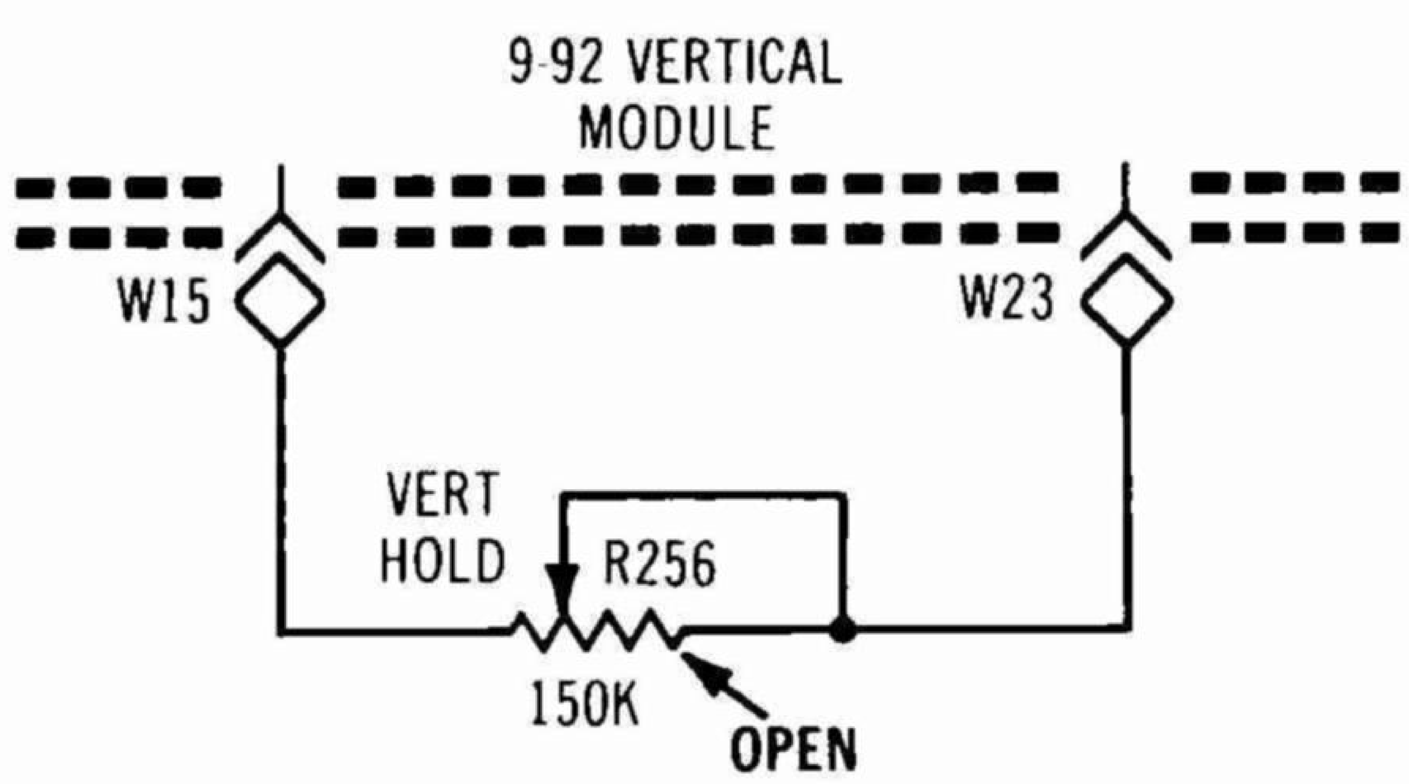
Symptom—Picture 3" narrow at each side, and low boost
Cure—Check HV control R23, and replace it if open

Chassis—Zenith 23FC45
PHOTOFACT—1453-3



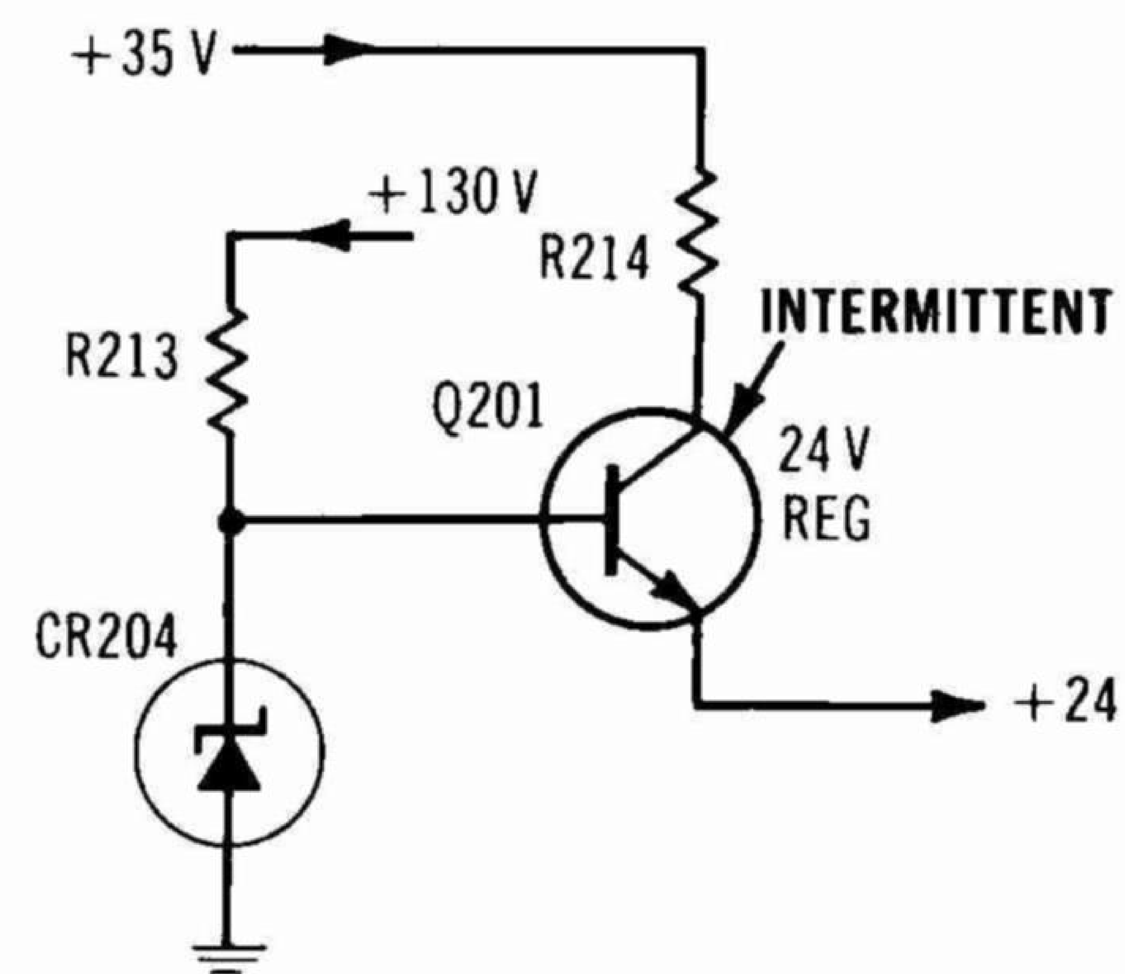
Symptom—Picture flashes, seems to lose locking during flashes
Cure—Check capacitor C406 on the 9-87 module, and replace if open

Chassis—Zenith 17EC45 (19EC45)
PHOTOFACT—1377-3



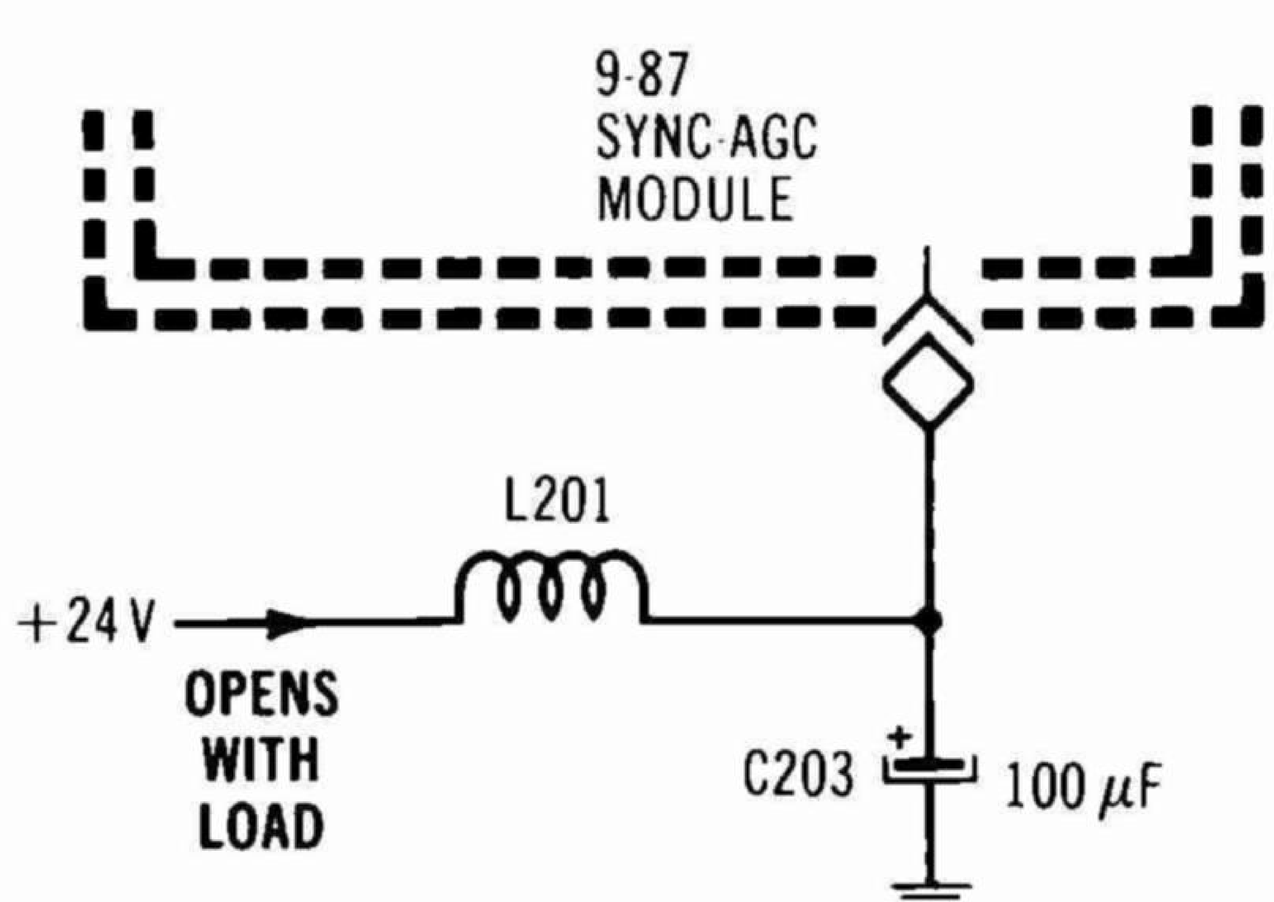
Symptom—No raster, no problems found with dc voltages or waveforms
Cure—Check vertical-hold control R256, and replace it if open

Chassis—Zenith 23HC45
PHOTOFACT—1677-2



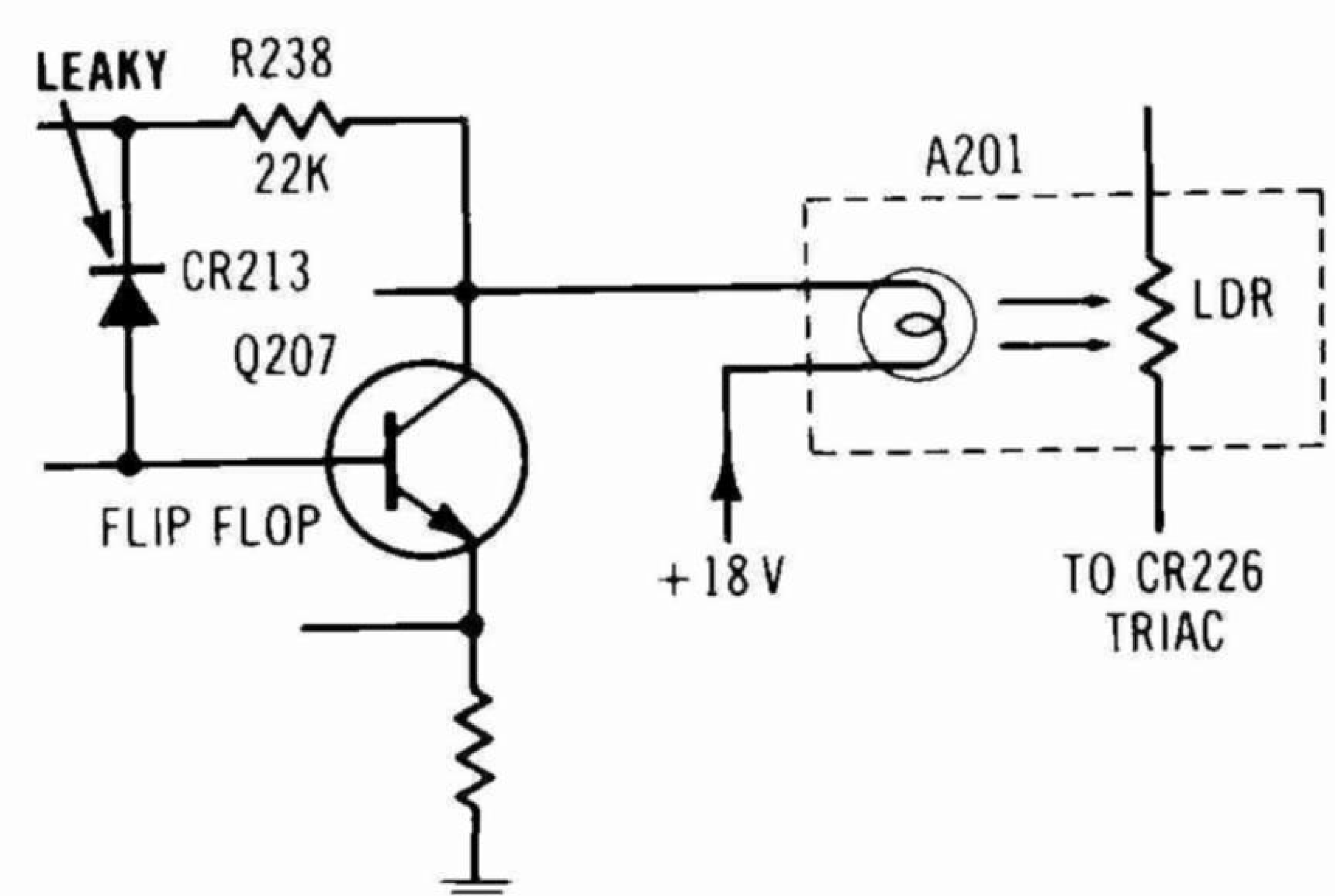
Symptom—Sound and raster intermittent every few hours
Cure—Replace regulator transistor Q201 as a test

Chassis—Zenith 17EC45 (19EC45)
PHOTOFACT—1377-3



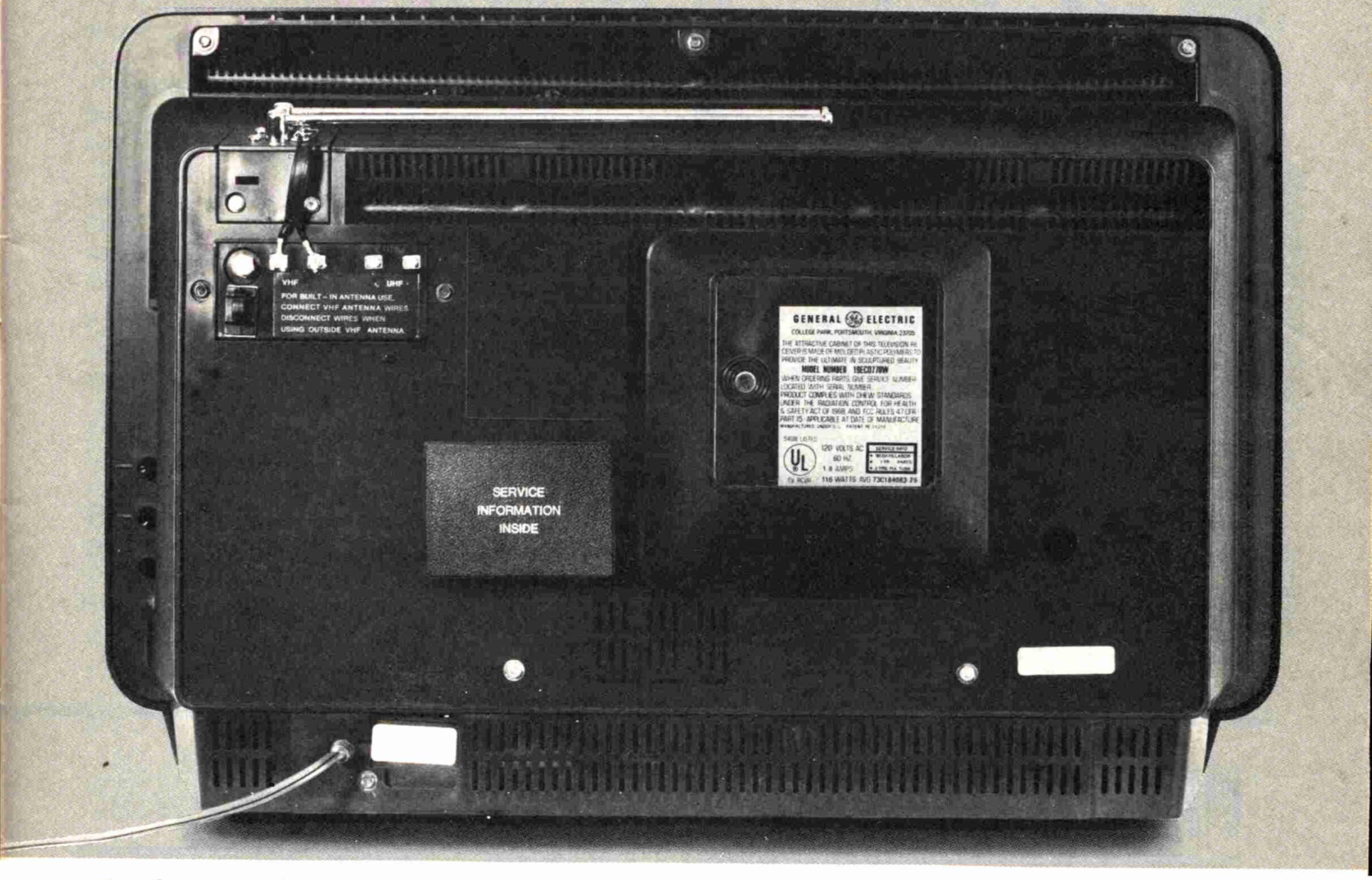
Symptom—Dim raster without video
Cure—Check peaking coil L201 for open circuit during load

Chassis—Zenith E model S94892X remote
PHOTOFACT—1377-3 and others



Symptom—Remote or manual could not turn off power to TV
Cure—Check flip flop diode CR203, and replace it if leaky

CAN YOU FIND THE SERVICE MANUAL IN THIS PICTURE?



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And where you need us.

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reader's exchange

There is no charge for a listing in *Reader's Exchange*, but we reserve the right to edit all copy. Due to the limited amount of space for this department, ads must show no more than *five* items. If you can help with a request, write directly to the reader, not to **Electronic Servicing.**

Needed: Antique radio tube adapter that will enable a WD11 socket to take a 201A. *John Uscinowski, RR#1, Box 379, Greenwich, NY 12834.*

Needed: Remote control kit for Heathkit model GR900 TV. *Jim Nicks, 10219 N. 23rd St., Tampa, FL 33612.*

For Sale: Schober Reverbatape RV-3A for electronic organs, assembled and factory tested, unused, $200. *Neilsen Radio-TV, Central City, NE 68826.*

Needed: Standel Studio-60 amplifier service literature and parts. Will buy literature, or copy and return. *Lee Noga, 306 Goethals, Richland, WA 99352.*

For Sale: Heathkit IT-121 FET/transistor tester, with manual, $50; EICO model 944 flyback transformer and yoke tester, with manual, $30; EICO model 625 tube tester with manual, $20; Electronic Measurement (EMC) model 700 RF-AF crystal-marker/TV-bar generator without manual, needs minor repair, $10. *John Brouzakis, RD2 Box #602B, Charleroi, PA 15022.*

Needed: Schematic for General Electric B/W TV I23-MW (Photofact 97-7). Will buy, or copy and return. *Kincaid TV, 1530 E. Washington St., Charleston, WV 25311.*

Needed: Power transformer for PACO model S-55 scope; a 610-A adapter for an EICO 666 tube tester; and a manual for an RCA model WR-59A TV sweep generator. *Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235.*

Needed: Heathkit model IT-12 visual-aural signal tracer, with service and operation manuals. *John Falk, 813 7th St. West, West Fargo, ND 58078.*

For Sale: B&K-Precision model 415 sweep/marker generator with all probes, cables and book, in mint condition, $325, or best offer. *Charles Gambs, 4701 Lansdown, Corpus Christi, TX 78411.*

For Sale: Complete sets of **PF Reporter** and **Electronic Servicing** from 1959 thru 1972 plus 10 issues of 1973. Best offer plus shipping. *John Styczenski, 1515 S. Monterey Ave., Roselle, IL 60172.*

For Sale or Trade: Sencore FE 21 multimeter, new condition and 180 assorted tubes, new in boxes, $400 or trade for triggered-sweep scope. *Johnnie L. Jones, RR2, Shelbyville, MO 63469.*

Needed: Power transformer, part 32-10123-1 for Philco AM/FM radio model M3850T. *Finck & Vaughan TV, 1105 N. Miami Blvd. Durham, NC 27703.*

For Sale: Heathkit IG-57 post-marker sweep generator, $100; IO-101 vectorscope/color-bar generator, $100; model IM-1212 digital multimeter, $40; model IO-4530 scope, $225; and Conar scope model 255, $150. *Logan's Electronics 623 W. 14th St., Port Angeles, WA 98362.*

Needed: Tech literature and schematic for Fisher stereo model MG-3050. Will copy and return. *J. F. Hoffman, 215 Rockwood Ave., Pittsburgh, PA 15221.*

Needed: Information on source of GE VRII phono cartridges. *Ron East, 1673 Watwood Rd., Lemon Grove, CA 92045.*

For Sale: RCA WO-33A scope, manual, cables, $115; RCA television/FM sweep generator WR-69A, manual $105; RCA RF/IF/VF marker adder WR-70A, manual $45, RCA color-bar/dot/crosshatch generator WR-64A, manual and cables $55. All equipment in excellent condition. *Gene A. Witherspoon, 5721 70th Place, Lubbock, TX 79424.*

Needed: Used PS-915-10 power supply (in good working condition) for Motorola color TV model WU870-EWB chassis C23TS-915-F02. *D. O. Leatherberry, P.O. Box 232, Oxford, NC 27565.*

Needed: Service manual or schematic for Pilot 3000 stereo console. Will buy, or copy and return. *Manuel Davila, 407 Elizabeth, Pekin, IL 61554.*

people in the news

Antenna Specialists has announced several changes in its professional products division sales staff. **Al Dolgosh** has been promoted to the position of product marketing manager, replacing **William R. Randall** who retired July 1. **Mike Sciulli**, previously responsible for sales of communications antennas to the vehicle manufacturing industry has assumed the position of OEM sales manager.

Philip Shevick has been appointed a vice-president of Dynascan and general manager of the B&K-Precision Test Instrument Product Group. The move reflects B&K-Precision's emphasis on design, engineering and product development due to increased penetration of the huge industrial market.

James M. Alic has been named staff vice president, SelectaVision VideoDisc strategic planning. Previously Alic had been with RCA Consumer Electronics division.

Frank Pounds has been appointed president of sales for Workman Electronic Products. Pounds has been Workman's national field sales manager for the past five years.

Jack Weiss has been appointed national sales manager for Panasonic Home Entertainment Systems. Weiss will be responsible for the development and implementation of sales and marketing programs for the company's compact stereos and matched component products. Prior to joining Panasonic, he was employed by A&S Department stores.

Paul A. Steele has been named manager of industrial relations at the western division of GTE Sylvania. Steele had been employee relations manager of the company's Eastern Division since 1977.

Audiovox has announced the appointment of **Stephen Trentacoste** to vice president of the company's Hi-Comp division. Trentacoste will be responsible for the development of the Hi-Comp line as well as its numbering system, pricing and marketing approach. Trentacoste has been with Audiovox for five years.

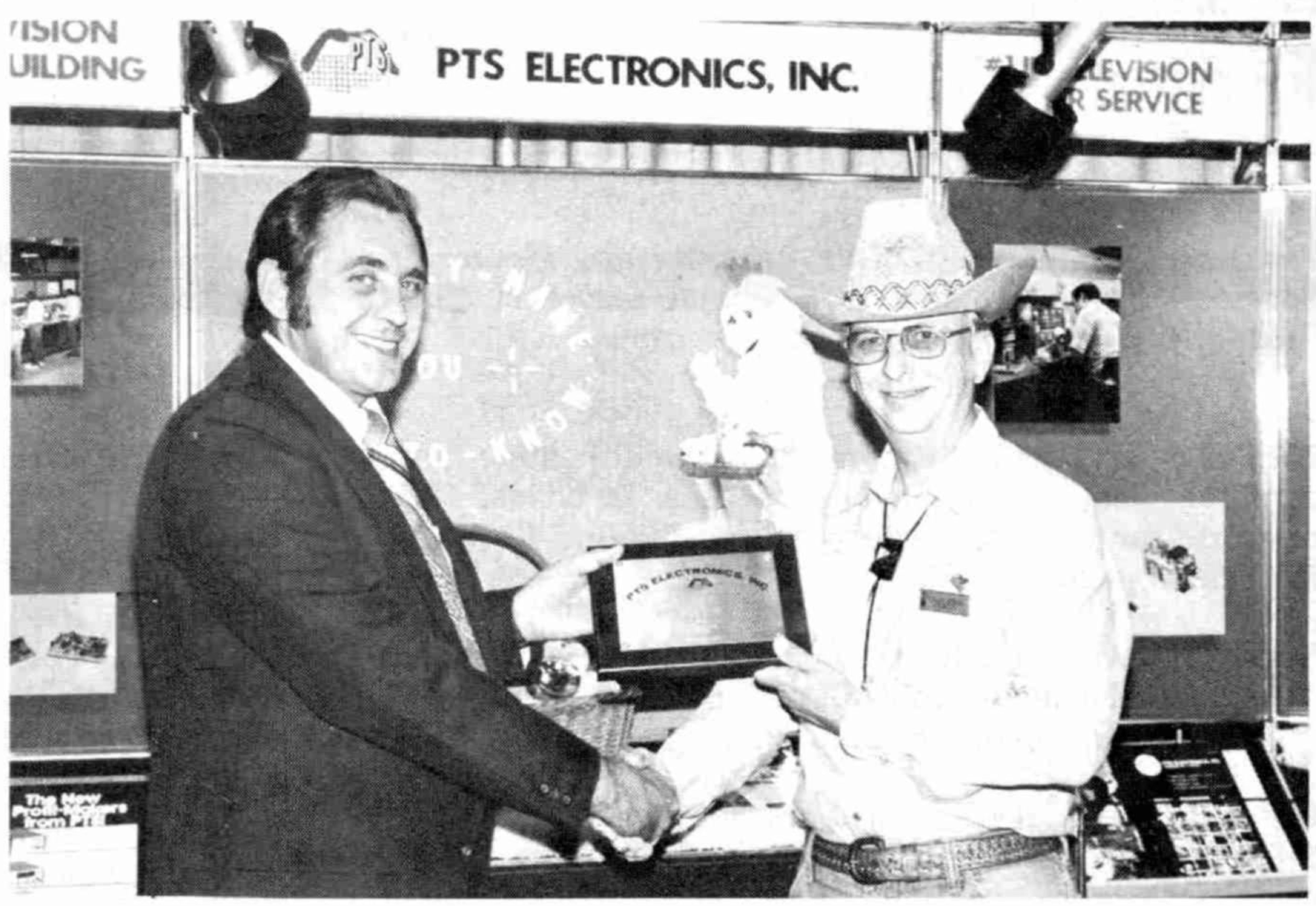
Karen Wynne Cole has been named director of public relations for Sparkomatic. Cole will be responsible for implementing and managing the corporation's public relations effort, creating and disseminating news and product releases and acting as corporate spokesperson and liaison to the media, the industry and the public.

RCA Service Company has named **James J. Badaracco** president. He previously served as division vice president and general manager of RCA distributor and special products division.

Curtis Pickelle has been appointed director of communications for James B. Lansing Sound. Pickelle will direct the company's marketing services operations, including supervision of national advertising and in-house production of dealer coop materials, sales literature and point-of-purchase aids. Prior to joining JBL, Pickelle headed the marketing communications department at Altec Lansing for over three years, most recently as director.

Dean E. Cochran has been appointed manager of distribution products for Switchcraft. Cochran was formerly vice president of national accounts for Mura. He was also distributor sales/marketing for International Importers, where he managed a national distributor program and developed a consumer packaging program.

Philips Test and Measuring Instruments has named **George Schlageter** to the new position of oscilloscope manufacturing manager. **Peter Kucharik** has been appointed quality control manager of the company's new US manufacturing operation.



Nolan Boone (right) was awarded a PTS plaque as the September "PTS Dealer of the Month" by Richard W. King, PTS vice president of marketing, during the western-theme electronic trade show of the NESDA annual convention in Tucson, AZ, August 16. Nolan is chairman of the convention committee and is owner/operator of the Little Rock Electronics Company of Little Rock, AR.

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6BK4C/6EL4A	3.18	17CT3	1.45
6KT8	2.30	4EJ7	1.56
6JS6C	3.15	6AU6A	1.36
17JZ8	1.79	6AW8A	1.87
6BL8/ECF80	1.16	12HL7	2.06
6AQ5A/6HG5	1.43	6BZ6	1.31
5GH8A	1.99	6GY6/6GX6	1.45
6JC6A	1.87	1V2	1.03
6KD6	3.60	17BF11	2.54
38HE7	3.12	6CW5/EL86	1.49
6CG3/6CE3/6CD3	1.55	13GF7A	2.21
6LF6/6MH6	3.42	6LR6	3.27
6MJ6/6LQ6/6JE6C	3.78	6HQ5	2.14
3HM5/3HA5	1.61	6LN8	1.18
12BY7A/12BV7/12DQ7	1.49	6CL3/6CK3	1.69
3DJ3	1.79	5GS7	1.84
6JB5/6HE5/6JC5	2.03	3GK5	1.63
2AV2	1.33	6LF8	2.49
36KD6/40KD6	3.56	21JZ6	2.24
6U10	1.74	31JS6C	3.08
6Z10/6J10	2.57	3BW2/3BS2B/3BT2A	1.79
6EA8	1.65	6LM8	2.06
6EJ7/EF184	1.54	22KM6	3.27
33GY7A	2.74	6KA8	2.06
12AU7A/ECC82	1.27	21HB5A	2.08
3DB3/3CY3	1.85	4LJ8	1.95
6LU8	2.04	6HS8	2.01
6GM6	1.76	25CG3	1.45
6GU7	1.75	5GJ7/LCF801	1.50
6KE8	2.57	5U4GB/5AS4A	1.50
12AT7/ECC81	1.43	6MD8	2.49
6HV5A	3.78	11AF9	2.83
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Publisher's Note

Not long ago a survey of electronics technicians in several age brackets brought some unexpected revelations. It was found that many technicians still do not feel comfortable with certain electronic technology.

Two events seem to cause this problem. (1) Traditional electronics education, while covering theory well, often neglects practical factors. (2) Technology advances so fast that even technicians fresh from training may lose sight. Keeping up seems time-consuming.

The survey identifies three specific areas that hamper today's technicians.

Digital electronics. The usual training leans heavily on binary numbering and calculations. What technicians need most, they feel, is to have digital circuitry explained in a way that relates it to practical dc and signal knowledge they already have.

Solid-state circuitry. It turns out that some technicians still falter over transistors and other solid-state devices. Apparently they have never picked up certain practical techniques that make solid-state easy. It does differ from vacuum tubes; but those familiar with both insist that solid-state is easier to understand and work on.

Test instruments. Not every technician feels at ease with instruments. High on the list of "What I would like to understand better" came the triggered oscilloscope. Probably no single modern-day tool proves more versatile and useful for troubleshooting a broad range of consumer and industrial electronics equipment. A technician whose scope familiarity is limited grows steadily more handicapped around modern electronic gear.

Upgrading seminars

We have a pretty good idea what technicians need. Our next concern: What can be done about it? Several factors come together to offer a solution.

There is a young outfit called *Liaison*, which specializes in meetings, seminars, and convention planning. They search out qualified experts who can develop and present first-rate upgrading curriculums. Liaison then sets up, publicizes and produces a needed seminar or meeting.

A Liaison spokesperson says, "Our programs are for people who need genuine help, not just a get-together. We price our seminars complete with lodging and food in a one-fee package. This adds convenience for companies, and lets us offer efficiently-run training bargains."

When Liaison discovered recently the need for electronics upgrading, that awareness was translated into action. They engaged Forest Belt, well-known writer and editor and one of the best-known seminar instructors in the electronics field, to design a seminar curriculum that would meet all three prime needs.

Thus came about the two 3-day *Forest Belt Seminars* that Liaison will take to St. Louis November 7-9 and 14-16. They will be held at the Henry VIII motel near the airport. Forest Belt and Wayne Lemons, both popular writers in **Electronic Servicing,** will be the major instructors.

ES endorsement

These seminars meet several criteria set by the management of **Electronic Servicing.** They also suit the magazine's philosophy of greater involvement with, and service to, **Electronic Servicing** readers. Hence, **ES** recommends and endorses these special seminars as the most effective upgrading presently available.

The first seminar, November 7, 8, and 9, concentrates on what consumer electronics technicians need. The second one, on November 14, 15 and 16, aims specifically at the industrial electronics maintenance technician. Both seminars deal with digital electronics, with solid-state technology, and with the triggered oscilloscope. But emphasis shifts the second week, to accommodate the kind of systems a factory technician must work on.

As an extra attraction, on the Saturday after each seminar, Liaison offers a separate 1-day seminar teaching videotape recorder servomechanisms. November 10 covers VHS and Beta VCRs; U-matic is added for the November 17 session because it is the more popular format in many commercial video applications. Each VCR servomechanism seminar costs extra, and is separate and independent from the 3-day upgrading seminars. Technicians can enroll for one without necessarily having to attend the other.

What's in the training

If you enroll in either of the 3-day seminars, here's what you can expect.

First comes an entire day of hands-on work with triggered oscilloscopes. Forest Belt conducts a series of exercises that leave you quickly and comfortably familiar with the four control groupings of modern triggered scopes: CRT, dual vertical input, time base, and triggering. You work with specific signals, and come to understand step-by-step how the scope displays them and how to analyze and measure their parameters.

The sessions on triggering are unique. You learn to really understand triggering, how to trigger on any point of any shape of signal, and how to obtain triggering even if you don't know beforehand what a particular signal looks like.

You learn advanced oscilloscope techniques; wideband and high-frequency scopes; pulse waveforms with high repetition rates, slow repetition rates, and very short duty cycles. Toward the final hours, you take up delayed-trigger oscilloscopes, and see how this special feature exposes minute portions of a waveform for close inspection.

If you can imagine yourself feeling absolutely at home with a sophisticated oscilloscope, then you understand the aim of this day-long workshop. The technician who can manipulate a scope wisely holds the key to diagnosis in the most complex consumer or industrial electronic equipment.

Solid-state upgrading/update

It takes effort and time to keep up with solid-state technology. If you're only passingly familiar with practical, fundamental solid-state devices, you could also lose time whenever you're troubleshooting.

So, instructor Wayne Lemons kicks this second day off with a brief and entertaining demonstration of what a solid-state device really is and what it does in a circuit. Technicians come away from this exceptional presentation astonished at their new perspective on solid-state servicing.

Consumer technicians then concentrate on practical tips for troubleshooting solid-state receiving equipment. Maintenance technicians, in their seminar, direct their attention to higher-power devices. In many ways they are like lower-power counterparts; but testing and replacing them takes a slightly different tack.

Finally, you gain some unusual insight into upcoming technology in solid-state. Some devices are only now going into equipment. Learn what they are, what makes them tick, and what kind of circuitry will use them, and gain some hints about troubleshooting bad ones.

Digital electronics for home and industry

This third day, Forest Belt and James R. Manery share instructor responsibilities. You first discover that digital circuitry closely resembles analog circuitry you're already familiar with. Belt demonstrates how truly easy steady-state digital concepts are to understand. You then see how gates work. In a unique way, you learn about truth tables and how to use them for troubleshooting.

Before you hardly realize it, you're engrossed in digital signals. You soon realize that they are no more than steady-state highs and lows with the added element of timing. This is what makes digital circuitry seem complex—before you understand it. You also recognize the importance of a dual-channel triggered oscilloscope for digital troubleshooting. You learn to identify certain digital signals on sight.

Instructor Manery guides you through set-reset (R-S) flip-flops, the D-T stage, and then the ubiquitous J-K flip-flop. Manery explains this complex operation in a way any technician can understand. And since you are prepared it means even more.

Near the end of the day, you deal with digital integrated circuits. Most technicians, even experienced ones, come away surprised at how much easier digital ICs are to service than they thought.

The tough side of VCRs

If one part of the videotape recorder bothers technicians, it's the servomechanism. Add to that the brushless, 3-phase, bilateral-current, electronically commutated, direct-drive dc motor that turns the head cylinder in many video machines today. (Yes, that's right: a 3-phase dc motor.)

Understanding them, and how to troubleshoot them, occupies a fourth day (optional at extra cost). Forest Belt conducts these Saturday sessions. He has come up with unique explanations and demonstrations that remove the mystery from VCR servos, be they VHS, Beta or U-matic.

How to enroll

You'll find an advertisement about these seminars elsewhere in this magazine. Use the coupon and mail your enrollment to Liaison, Box 40821, Indianapolis, IN 46240. Enclose your check or money order, made out to **Liaison,** in payment for the seminar you wish to attend.

Do it right away. All registrations must be made in advance, before November 1. None can be accepted *at the door.* Remember that your fee for either 3-day seminar *includes* three meals a day and breaks, and lodging for the nights of Tuesday through Friday. (Lodging is not included for Saturday VCR servomechanism seminars, and food Saturday at lunch and breaks only.) Lodging is double-occupancy; single occupancy costs you more. Let Liaison know right away if you're attending with someone you wish to room with.

These new Forest Belt Seminars are unique. Nothing else like them is available. Liaison and **Electronic Servicing** are enthused about bringing you this unparalleled opportunity. We hope you and your company can take advantage of them. □

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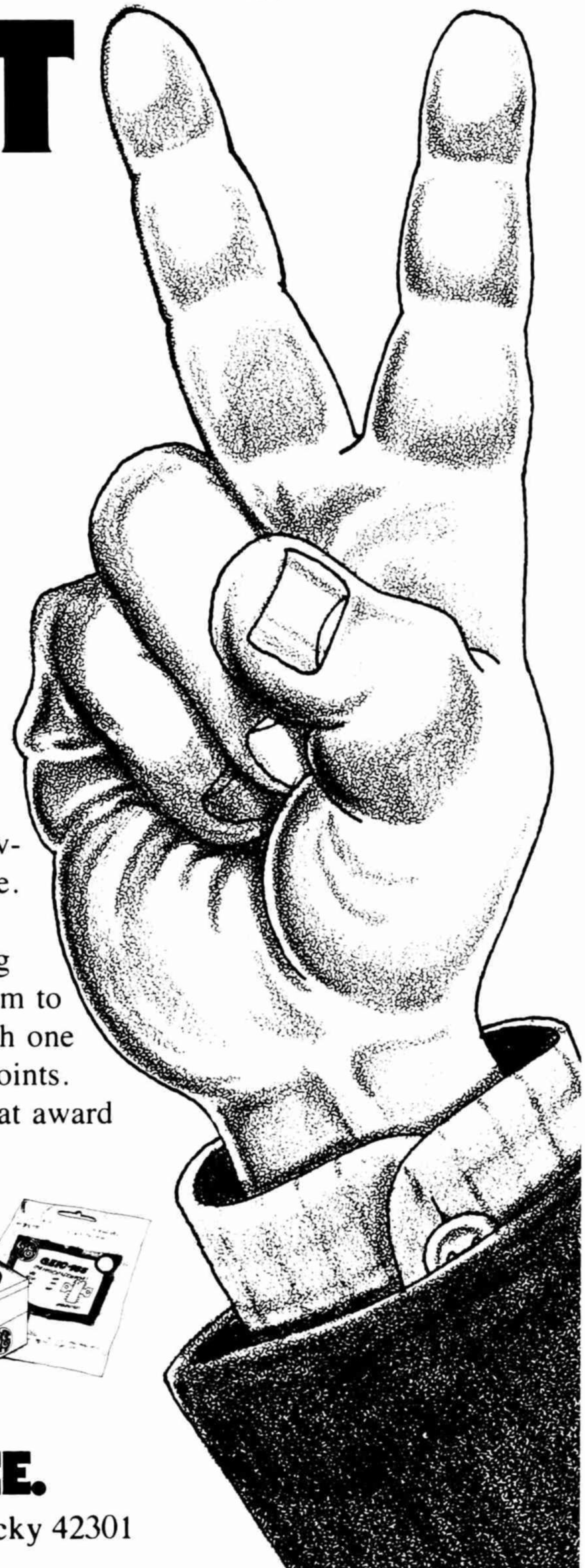

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That means you have twice as many reasons for saving those valuable tags, bags and flaps—and for submitting them to GE "pro plus" Award Headquarters before October 31. Each one will be worth twice its normal value in "pro plus" award points. Which means you can double the rate at which you earn that award or weekend-for-two trip you have in mind.

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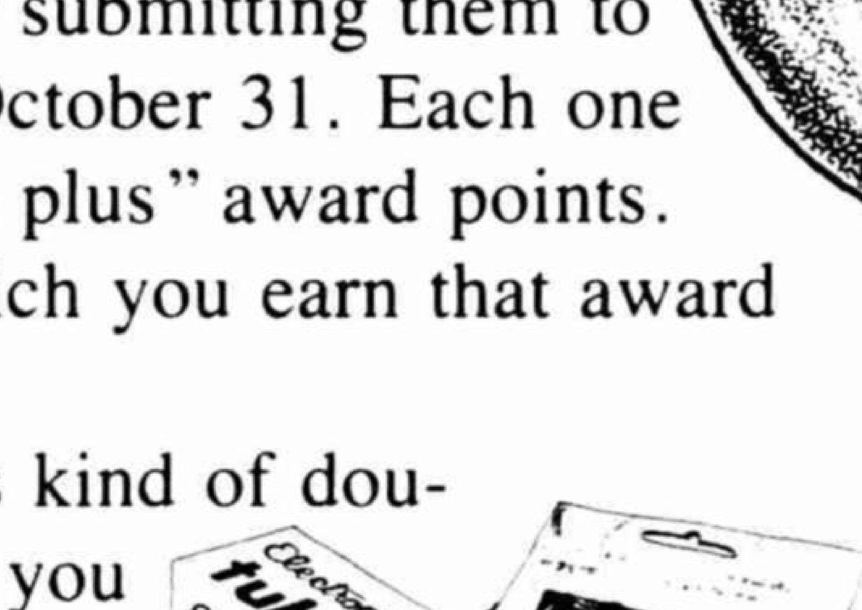

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GENERAL ELECTRIC

ALU...
the microprocessor calculator

By Jack Webster

Mathematical calculations in a microprocessor are performed by the Arithmetic-Logic Unit (ALU). The ALU uses combinations of digital gates to add binary numbers. Sometimes it subtracts binary numbers by addition.

Basic sections of microprocessors that have been described so far in this series are the ROM and RAM types of read-only and read/write memory. The most common codes for operating microprocessors also were discussed. One major section remains—the arithmetic logic unit.

Arithmetic logic unit

As the name implies, the arithmetic logic unit (ALU) can handle binary inputs as though it is any one of many possible logic gates, or a combination of logic gates. In other words, proper programming of an ALU arranges the internal logic gates into the combinations required to do binary mathematics.

For example, a certain code causes an ALU to set up the equivalent of a NOR gate. With inputs A and B, the output is $\overline{A+B}$.

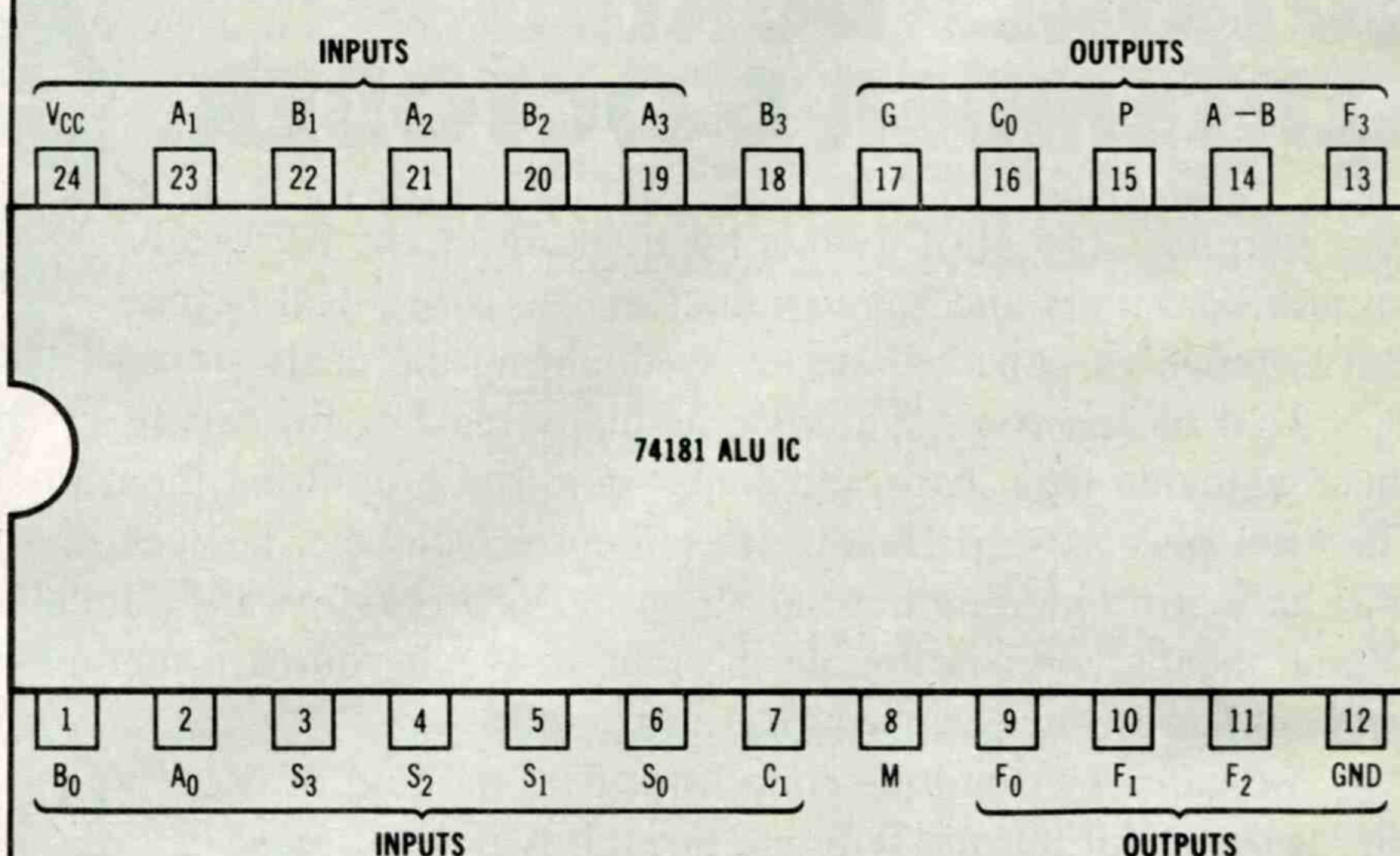
The fundamentals of logic gates were presented as part of the Industrial Electronics series by Sam Wilson in the January through November, 1978 issues of **Electronic Servicing.**

Integrated circuit ALU

A popular ALU is the 74181 IC. Table 1 summarizes the logic capability, and Figure 1 shows the pinout connections.

Programming the 74181 to function as an OR logic gate requires the following logic states:

- a high at the mode-select pin M
- highs at function-selection pins S3, S2 and S1
- a low at function-selection pin S0.



$A_0.A_1.A_2.A_3$	WORD A INPUTS	A − B	COMPARATOR OUTPUT
$B_0.B_1.B_2.B_3$	WORD B INPUTS	P	CARRY PROPAGATE OUTPUT
$S_0.S_1.S_2.S_3$	FUNCTION SELECTION INPUTS	C_1	CARRY INPUT
M	MODE CONTROL INPUT	C_0	CARRY OUTPUT (INVERTED)
$F_0.F_1.F_2.F_3$	FUNCTION OUTPUTS	G	CARRY GENERATE OUTPUT

PINOUT FOR 74181 ALU

Figure 1 The 24-pin 74181 ALU integrated circuit can be used to verify binary mathematical operations.

LOGIC FUNCTION SELECTION				MODE SELECTION	LOGIC FUNCTION
S3	S2	S1	S0	PIN M LOGIC	
0	0	0	0	1	$F = \overline{A}$
0	0	0	1	1	$F = \overline{A + B}$
0	0	1	0	1	$F = \overline{A} \times B$
0	0	1	1	1	$F = 0$
0	1	0	0	1	$F = \overline{A \times B}$
0	1	0	1	1	$F = \overline{B}$
0	1	1	0	1	$F = A \oplus B$
0	1	1	1	1	$F = A \times \overline{B}$
1	0	0	0	1	$F = \overline{A} + B$
1	0	0	1	1	$F = \overline{A \oplus B}$
1	0	1	0	1	$F = B$
1	0	1	1	1	$F = A \times B$
1	1	0	0	1	$F = 1$
1	1	0	1	1	$F = A + \overline{B}$
1	1	1	0	1	$F = A + B$
1	1	1	1	1	$F = A$

74181 ALU LOGIC FUNCTIONS

Table 1 These logic levels applied to the 74181 ALU function-selection and mode-selection pins allow the ALU to duplicate any of 15 gates.

Under those conditions, two inputs (A and B) can produce the proper OR gate A+B output. Lows at both inputs give a low output. and either or both inputs high produces a high output (see Figure 2 for the truth table). Remember that A+B=F is read as *A OR B equals fanout* (output).

A	B	L
0	0	0
0	1	1
1	0	1
1	1	1

A OR B TRUTH TABLE

Figure 2 Any digital device that can operate by this truth table must be an OR logic gate. The 74181 ALU can duplicate an OR and 14 other gates.

INPUTS		OUTPUTS	
A	B	SUM	CARRY
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

BINARY ADDITION TRUTH TABLE

Figure 3 The two input columns and the sum column are the truth table of an EXCLUSIVE OR logic gate. The same two input columns and the carry column are the truth table for an AND logic gate. This suggests that a combination of EXCLUSIVE OR and AND gates could perform the addition of binary numbers.

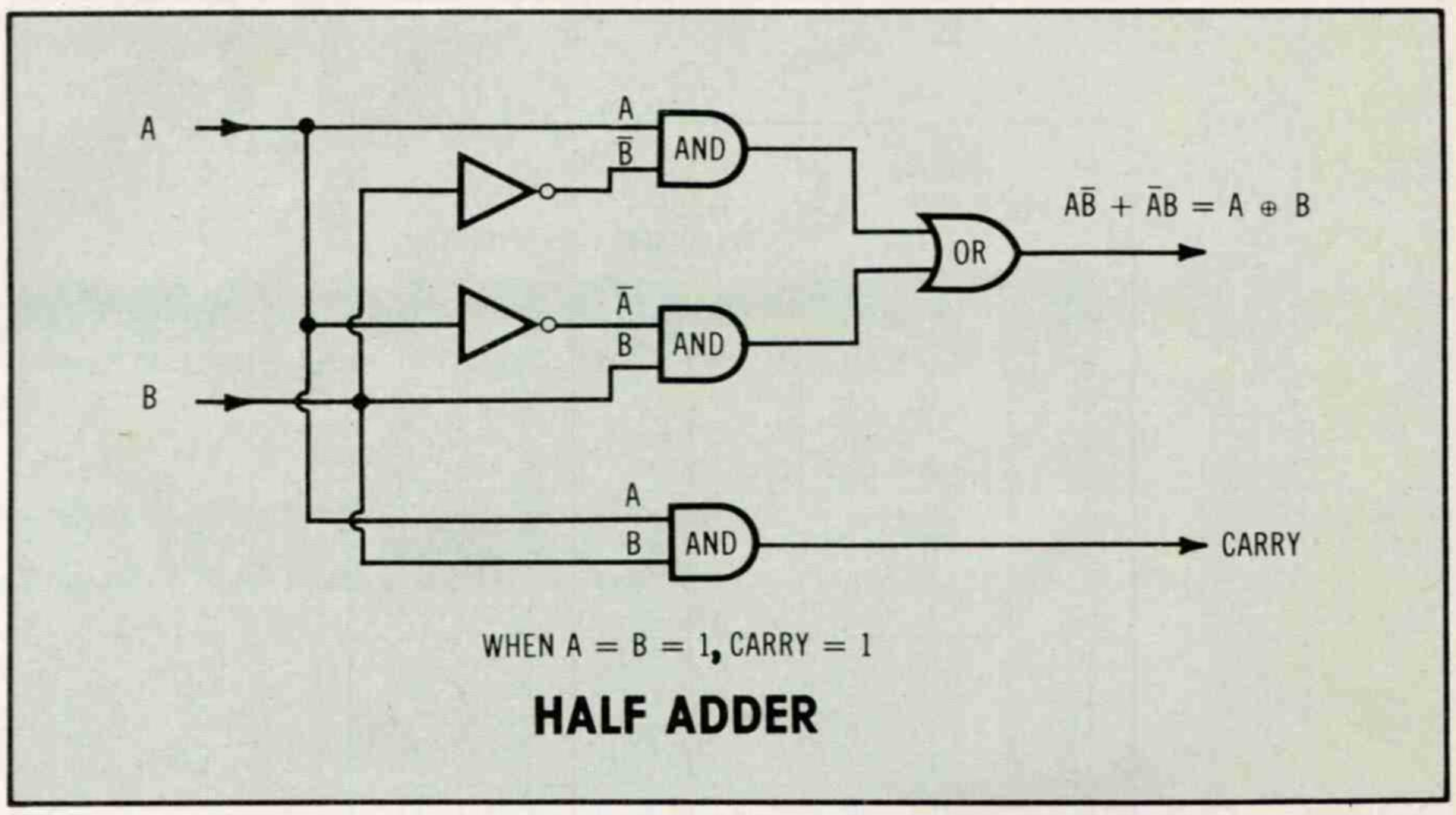


Figure 4 This combination of EXCLUSIVE OR and AND gates is called a half adder. It adds but does not have provision for an input carry.

Arithmetic operations

The 74181 ALU IC can perform 16 arithmetic operations, and each one is accomplished by the use of basic logic gates. Keep in mind that every microprocessor has an ALU inside the IC.

It would be very educational for readers to obtain a 74181 IC and duplicate some of these basic arithmetic operations.

Adding with logic gates

Because there are only two digits in the binary system, these are the only possible sums:

0	0	1	1
+0	+1	+0	+1
0	1	1	10

The sum of 1+1 can be thought of as being 0 with a carry of 1, which is clear in the following example:

Arabic decimal	binary
5	101
+5	+101
10	1010

In the decimal example, the sum of two fives is 10. The zero is marked down and the one is a carry.

Similarly, in the binary example, the two binary numbers in the right column are added by placing the binary 0 in the right column and carrying the 1, thus producing binary 10. This carried 1 is added to the two 0 numbers already in the center column, thus producing a 1 total (1 + 0 + 0 = 1). Next, the binary 1 numbers of the left column are added to produce binary 10. Adding these binary answers together gives binary 1010 as the answer to adding 101 + 101. (Of course, binary 1010 equals decimal 10 [8 + 0 + 2 + 0 = 10].)

A truth table for binary addition is shown in Figure 3. Study it carefully. The two inputs and the sum columns make up an EX-

As a review of binary versus decimal values, remember that a 4-digit binary number has this decimal value:

1 1 1 1 binary number
8 4 2 1 decimal value (total 15)

Only binary 1 numbers have a decimal value, so binary 0010 equals decimal 2 (zero plus zero plus two plus zero), binary 1000 equals decimal 8, and binary 0010 equals decimal 2. Reversing the procedure gives decimal 5 a binary value of 0101, and decimal 2 equals 0010.

Each of two binary 1 numbers (0001 and 0001) equals decimal 1; therefore, both binary numbers added together equal decimal 2 which is binary 0010. This should help clarify why the addition of two binary 1 numbers equal binary 10.

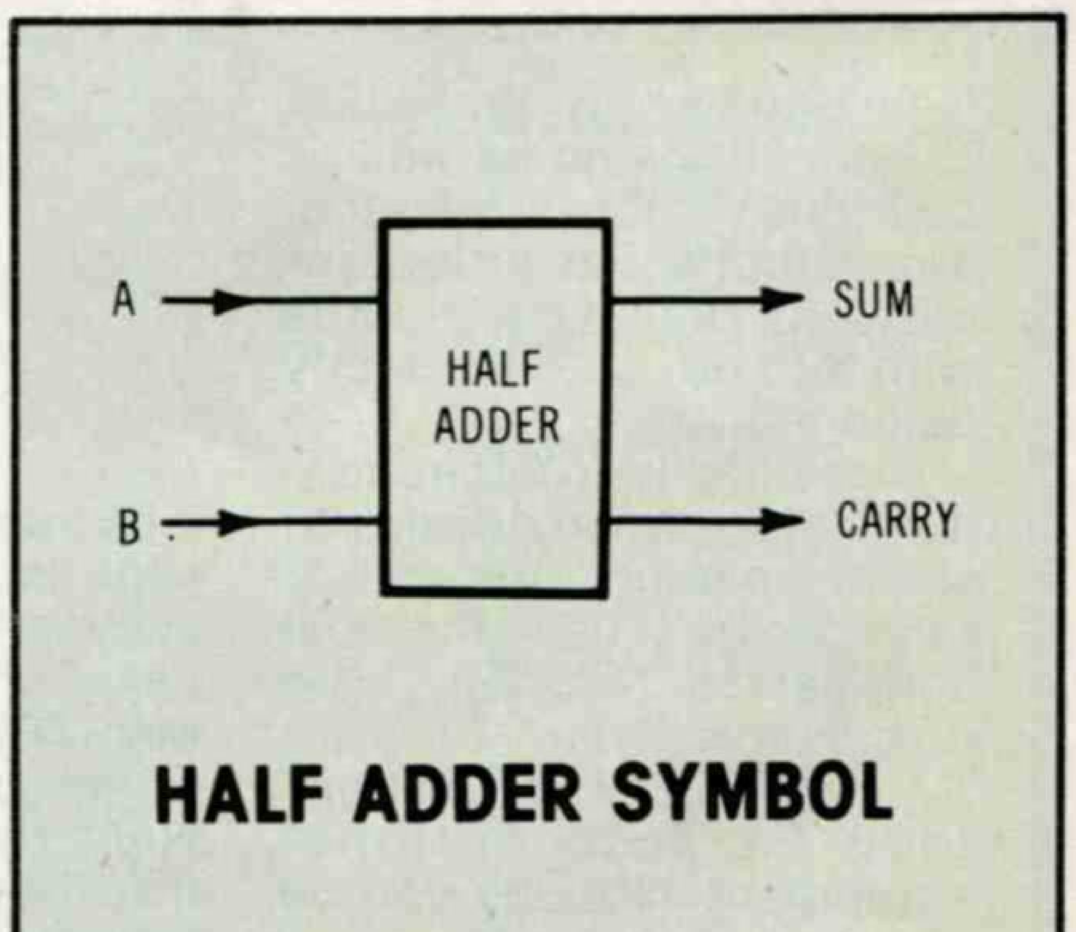


Figure 5 The Figure 4 schematic of a half adder often is replaced by a block symbol on drawings of complex digital circuits.

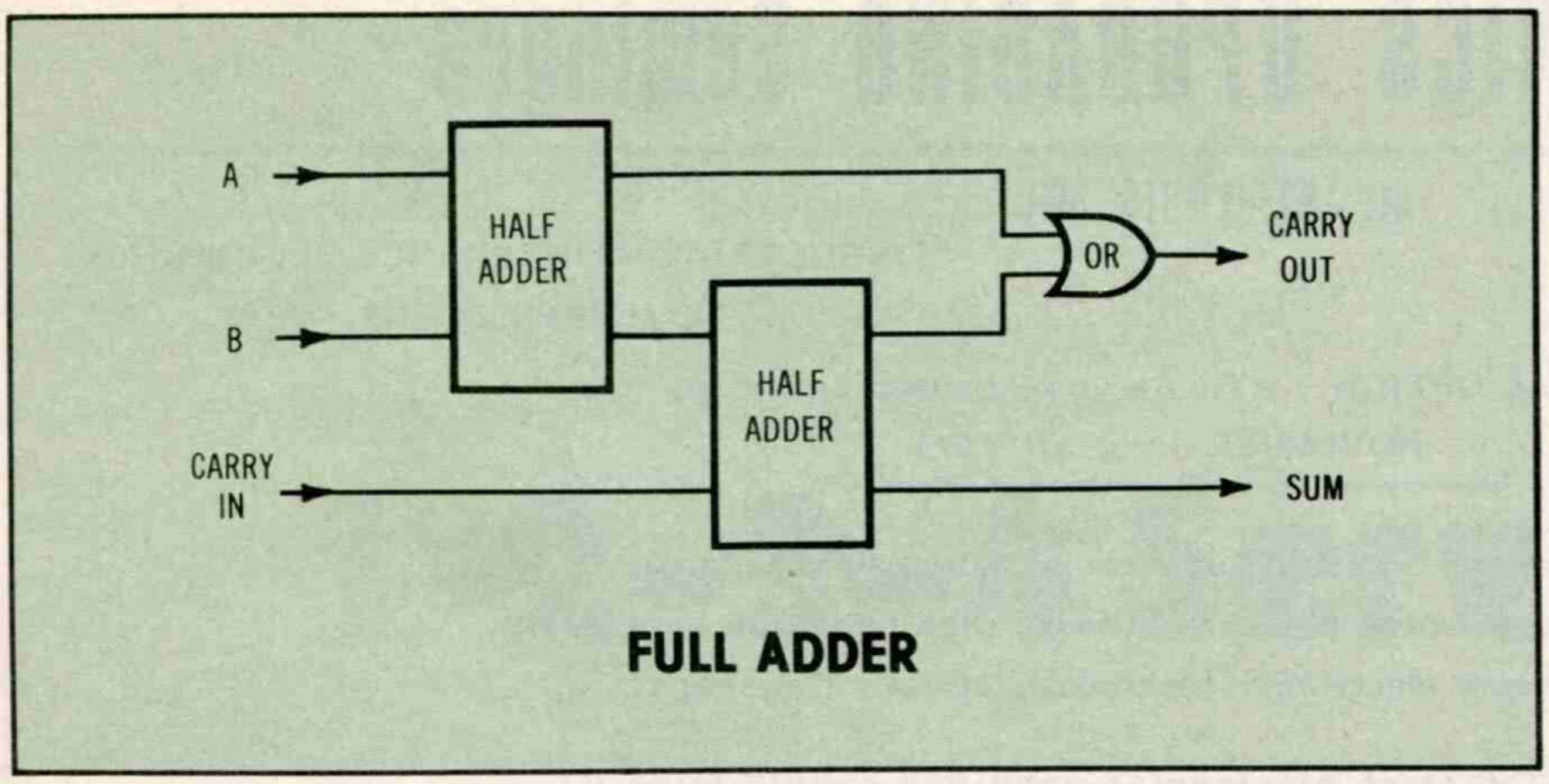


Figure 6 Two half adders can be connected to form a full adder that has provisions to carry input and carry output.

CLUSIVE OR truth table, while the two inputs and the carry columns form an AND truth table.

This combination of logic-gate truth tables suggests that a logic circuit made up of an EXCLUSIVE OR gate and an AND gate can add two binary inputs. Such a circuit is called a *half adder.* Its schematic is shown in Figure 4 and its symbol is in Figure 5.

The term half adder is applied because it does not allow for a 1 carried from a previous circuit. When two half adders are connected as shown in Figure 6, the resulting circuit is called a *full adder.*

Even a full adder is limited to A and B inputs that each have only one digit (single-bit adder). However, full adders can be cascaded to handle binary numbers of any desired word length.

DECIMAL	COMPLEMENT
0	9
1	8
2	7
3	6
4	5
5	4
6	3
7	2
8	1
9	0

DECIMAL COMPLEMENTS

Figure 7 These are the complements of decimal numbers from 0 to 9. Subtractions can be performed by the addition of complements.

Subtraction by addition

All subtraction problems can be performed by addition. This surprises many technicians at first. The importance of subtraction by addition is illustrated by the previous circuit that only adds numbers. After a slight modification, the Figure 6 full adder *can* subtract.

Decimal subtraction by addition— The complements of decimal numbers allow the numbers to be subtracted by addition. Figure 7 shows decimal numbers 0 through 9 and their complementary numbers. *Any decimal number can be subtracted from a larger decimal number merely by adding the complement of the smaller number to the larger number.* Then if the sum has two digits, they must be added together to provide the final answer.

The conventional way to subtract 5 from 9 is as follows:

9 (minuend)
-5 (subtrahend)
4 (difference)

For the addition method, the subtrahend (5) is replaced by its complement (4) before the numbers are added, as shown here:

9
+4
13

This sum has two digits so they must be added to give the final answer: 1 + 3 = 4.

Perhaps an accident allowed the previous problem to work out right. For more proof, solve the following problem:

7 (by conventional
-6 subtraction)
1

By the addition method, the problem becomes:

7
+3 (complement of 6)
10

Addition of 1 and 0 gives 1 as the answer.

This peculiar system even works with larger numbers, such as:

14 (conventional
-8 subtraction)
6

However, the 2-digit number 14 must be added together to form a 1-digit number (because the complements have only one digit).

5 (1 + 4)
+1 (complement of 8)
6 (answer)

Another minor variation allows the method to work with two 2-digit numbers, such as these:

18 (conventional
-13 subtraction)
5

Change it to:

9 (1 + 8)
+5 (1+3 = 4; complement
14 of 4 is 5)

By addition, the answer is 1 + 4 = 5.

The subtraction-by-addition system works correctly with any two numbers that have a single digit as their difference.

Comments

This article proved that digital binary numbers can be added, and also that subtraction of binary numbers can be performed by addition. Methods of using subtraction to accomplish addition of binary numbers will be presented next month. □

1-2-3-4 Servicing simplifies industrial electronics maintenance

One measure of a maintenance technician comes when a breakdown occurs: How long till production is rolling again? Here are some guidelines that speed repair.

By Forest Belt, CET

Logical troubleshooting suits all fields of electronic servicing. Consumer technicians have, for years, used the principles of step-by-step diagnosis called *1-2-3-4 Servicing.*

The concept was formalized in several books. Electronics instructors often teach this approach. It proves sensible to remember and to follow, and in fact makes efficient troubleshooting easy to teach.

Before now, no extra effort had been expended toward applying *1-2-3-4 Servicing* to industrial electronic equipment. Yet, the Diagnose, Localize, Isolate and Pinpoint sequence readily fits every sort of electronic gear. Moreover, each step works as well for digital designs as it does for analog.

Maintenance in a plant or factory embraces more than preventive upkeep. Except where chemical or other accumulations must be cleaned out of equipment periodically, anticipatory troubleshooting may not be possible. Solid-state devices don't offer pre-breakdown clues the way tubes did. The highest proof of a technician's competence, then, may occur only when production halts due to electronic failure.

At such times, the logic of *1-2-3-4 Servicing,* could carry the day. *1-2-3-4 Servicing* has proven, in other fields of electronic servicing, to be a highly dependable method for tracking down obscure breakdowns. Step-by-step testing and reasoning often uncover multiple or "chain" failures that escape conventional symptom/cause diagnosis.

Don't be misled, though. *1-2-3-4 Servicing* does not replace thinking. It contains no magic. It does organize what's inside the equipment you're servicing in a way that encourages you to see interactions. Morever, the 1-2-3-4 approach lays out a direct procedure for hunting trouble. Together, these advanced concepts almost invariably improve the ease with which a technician can pinpoint the exact cause of equipment shutdown.

In case you're not familiar with *1-2-3-4 Servicing,* the following rehash of its principles introduces some new ways to perceive industrial-electronic equipment that you take care of.

SECTIONS come first

An ordinary mind cannot cope all at once with everything that goes on in a piece of electronic equipment. Even one printed-circuit card may contain more than is easy to comprehend. You need, in order to keep your sanity, some sensible way of dividing the equipment down into understandable portions.

Sections comprise the largest logical division for *1-2-3-4 Servicing.* Of course, the question immediately arises: How do you decide what forms a section?

For a general definition, you can say that a *section* is one division of an electronics device in which one particular function or operation takes place.

As an easy example, consider an ordinary radio receiver. It contains an RF section, an IF section, and an audio or AF section. The RF section processes radio-frequency signals; the IF section, intermediate-frequency signals; and the AF section, audio-frequency signals. A power supply section furnishes dc voltages to all the other sections. Figure 1A illustrates how you should think of this radio and its *sections.*

As you may have spotted, the difference between one section and another, in this instance, lies in the kind of signal handled. That, in fact, determines where one section ends and the next begins. After the signal has changed character in one manner or another, a new section takes over.

Applying this concept to an item of industrial electronic equipment should not be difficult. Take a motor controller, for example, one that uses an oscillator to control speed of a split-phase ac motor. Figure 1B illustrates how you divide up the operations in such a system.

A control section and a drive section make up the whole of the electronics system. A potentiometer RPM control lets an operator adjust speed. The control section delivers a set of pulse signals that cause the drive section to send appropriate power (voltage and current) to the motor.

This may seem oversimplified. Yet, when you begin troubleshooting, knowing where the control section ends and the drive section begins will clarify where you should look for certain kinds of trouble. Each section handles a different sort of "signal." Pulse signals dominate the control section; in the drive section you find ac power-line voltages and currents.

STAGES form sections

Breaking an electronics system down into sections presents a vivid picture of its functions. But a section may contain hundreds of parts. That still is too much for effective troubleshooting comprehension. You need to subdivide each section.

STAGES make the natural next step. A section is made up of stages. So what is a stage?

You can think of a *stage* as comprising one active component, such as a transistor or tube, plus the circuitry and components that surround it. Sometimes the main component may actually be a so-called passive device, such as a diode or even an RC network.

A stage acts in some way on the signal fed to it. It may amplify the signal, alter its frequency components, reshape its waveform or duty cycle, invert the signal or pulse polarity, or even attenuate or limit the amplitude. A stage may do almost anything to the signal except change its basic character.

Except, that is, for the *last stage in a section.* The final stage *does* change the character of the signal being handled or processed by a section. This alteration in fact marks the end of the section; and the signal then passes to the next section (or sometimes to several other sections).

Reverting to the simple receiver example, you can see the stages of a typical RF section in Figure 2A. Most radios contain no more than one or two RF amplifier stages in the RF section. Each one builds up the RF signal strength sufficiently to operate a mixer.

An oscillator stage supplies a signal to heterodyne with the incoming (and amplified) RF signal. RF and oscillator signals beat in the mixer stage. That's the final stage in the RF section—because it completely alters the character of the signal. Following the mixer stage, the signal becomes an IF signal, and proceeds to the IF section.

Figure 2B illustrates how an IF section might be formed. You see two IF amplifier stages, a selectivity filter stage, and a demodulator or detector stage. In the demodulator the signal undergoes drastic alteration. It changes from a modulated IF signal into an audio signal alone. The demodulator is, therefore, the final stage in the IF section. The audio signal it develops feeds the AF section.

Applying this same subdividing concept to the control section illustrated in Figure 1B, you see stages of the section laid out in Figure 2C.

An oscillator stage, with a pot to

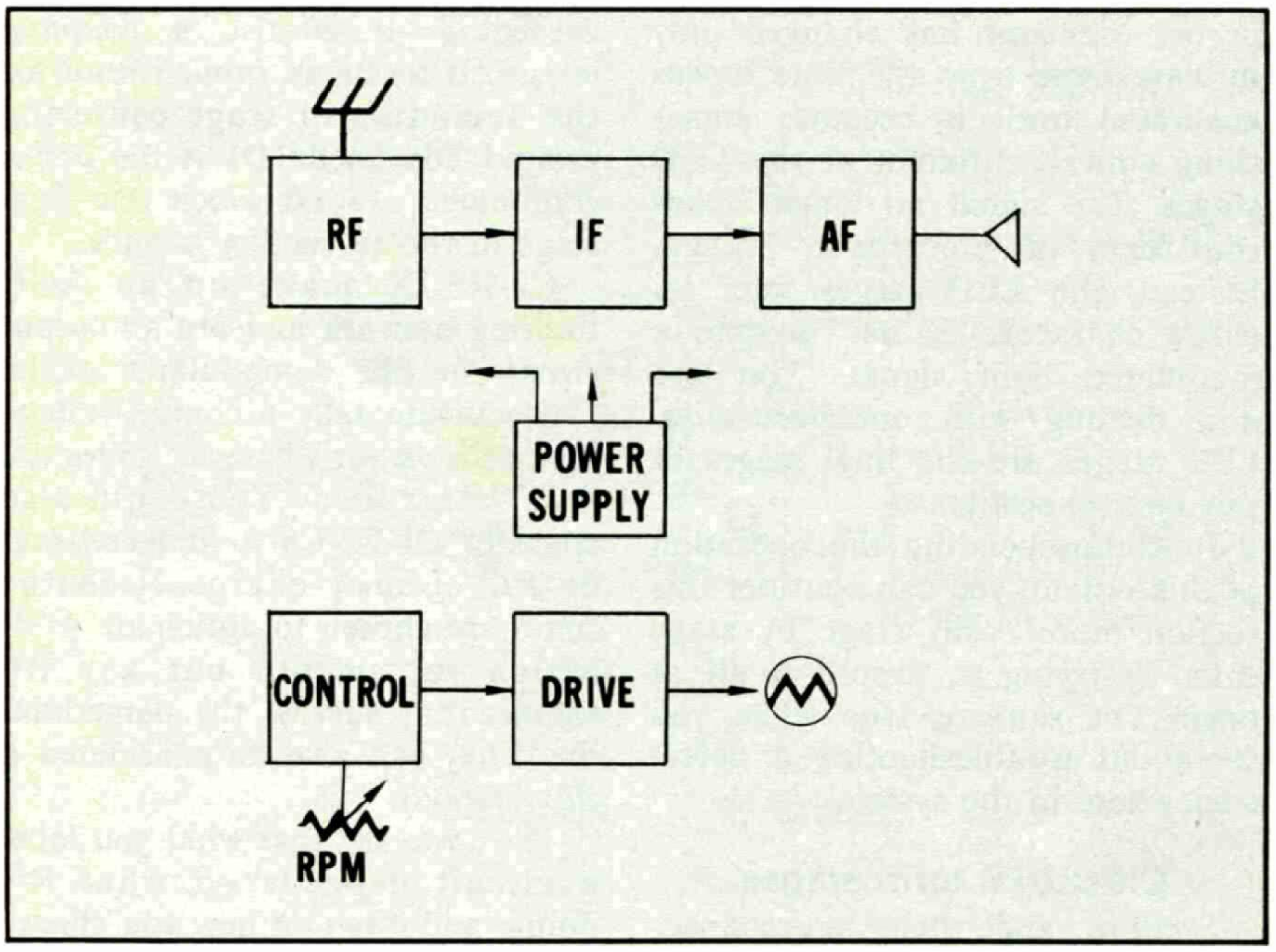


Figure 1 Largest division of equipment for *1-2-3-4 Servicing* is into sections, one for each type of signal or operation.

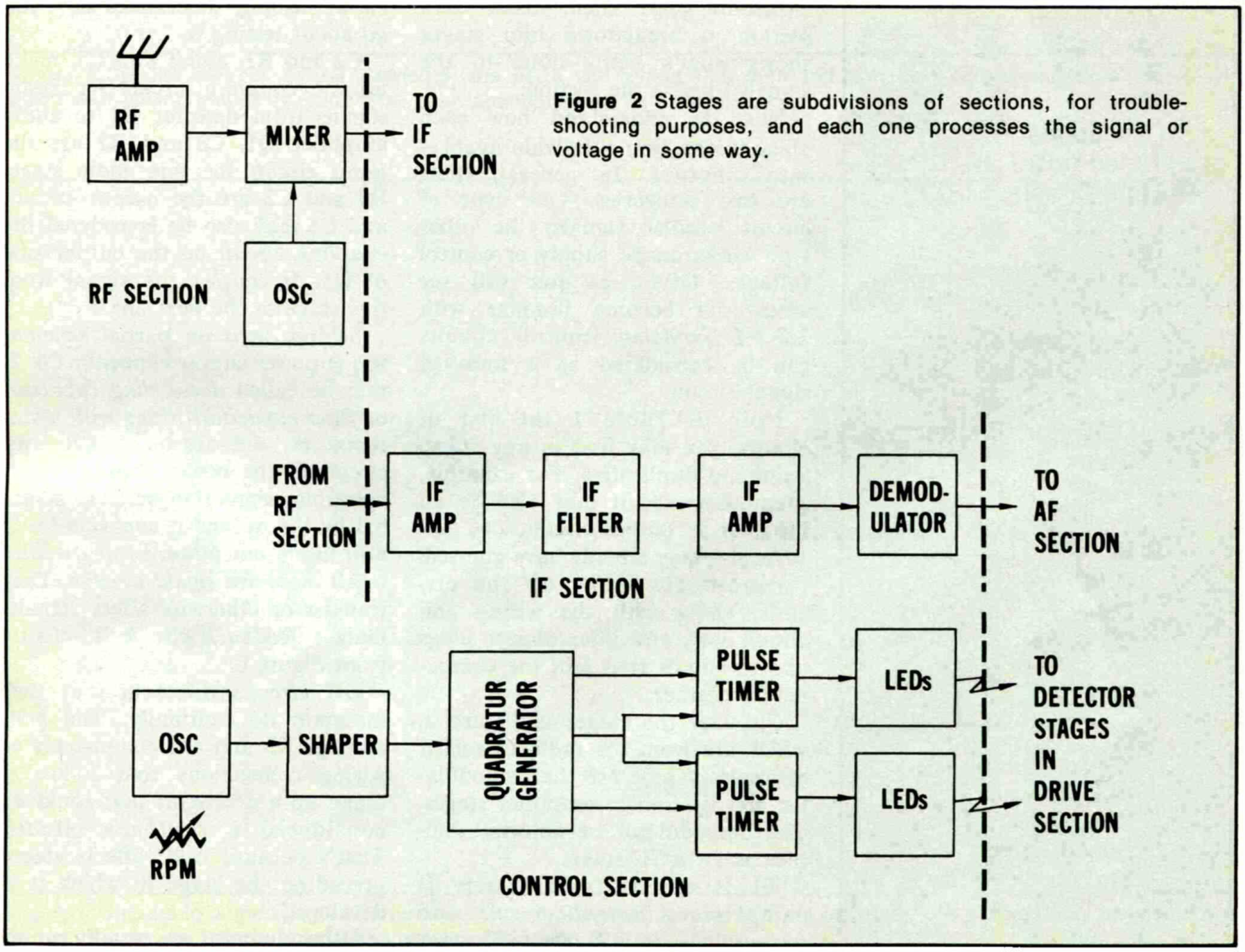


Figure 2 Stages are subdivisions of sections, for troubleshooting purposes, and each one processes the signal or voltage in some way.

manipulate frequency, supplies signal to a shaper stage. A quadrature-signal generator stage produces pulse signals 90° out of phase but with frequency still controlled by the RPM oscillator. A pair of time stages, driven by the quadrature signals, delivers pulses by varying duty cycle (pulse duration compared to *off* time). These pulses are coupled by light-emitting diodes (LEDs) to detector stages in the section that follows.

Note that the signal originating in the oscillator has changed only in waveshape from the time it was generated until it becomes something entirely different at the LED stages. The signal no longer takes the form of electronic pulses. Instead, the LED stages alter its entire character. It has become a modulated light signal. You are now dealing with *optoelectronics.* LED stages are the final stages in this control section.

In comprehending the operation of this system, you can consider this section more easily stage by stage than by trying to absorb it all at once. The same is true when you set about troubleshooting a defect somewhere in the system.

Kinds of Circuits

SIGNAL or PULSE

Input
Output
Feedback
Bypass
Filter
Decoupling
Tuned (LC)
Time Constant (RC)

DC

Supply
- Regulated source
- Unreg source
- Plate, Screen
- Collector, Emitter
- Drain, Source
- Vcc

Bias
- Grid
- Base
- Gate

Control
- AGC
- ACC
- PLL
- Keying
- Speed Drive
- Etc.

CIRCUITS form stages

Sections and their interconnections illustrate the relationships of various functions in a piece of electronic gear. Then, inside each section, a breakdown into stages shows what's being done to the signal(s) inside the section.

Next, to understand how each stage works, you subdivide again—into CIRCUITS. In general, there are two categories. One type of circuit handles signals; the other type works on dc supply or control voltages. Often, as you will see when you become familiar with *1-2-3-4 Servicing,* control circuits can be considered as a form of signal circuit.

Note in Table 1 the list of circuits you may find in any stage. Some are duplicative. For example, a coupling circuit may also be an input or an output circuit.

As you may already have guessed, COMPONENTS make up the circuits, along with the wiring and circuit foils and interconnect plugs and terminals that join the components together.

Consider the stages in Figure 3, which are from the radio of earlier examples. These are the demodulator and first audio amplifier stages. The demodulator or detector doubles as an AGC stage.

T1 is an IF transformer. It comprises a *tuned circuit* and *output circuit* for the IF stage preceding. It is also a *coupling circuit.* It forms an *input circuit* for the demodulator stage centering around D1. Diode D1 is the *active* component around which this final stage of the IF section is built.

C1-R5-C6 make up an AGC filtering network and are an *output circuit* for the demodulator diode, and coincidentally a control-voltage *input circuit* for whatever stages are AGC-controlled. You could also consider C1-R5-C6 a *time-constant* or *RC circuit*; charge-discharge times are chosen to anticipate AGC action yet smooth out any RF signals that survive the demodulator. They can also be considered a *filter circuit.*

Thus you see that what you label a circuit depends on what it's doing, and often on how you choose to look at it during a particular time. And the way you see each circuit usually determines how you go about testing it.

C2 and R1, along with C3, make up the *coupling circuit* for audio signals from detector D1 to audio amplifier Q1. C3 and R2 are the *input circuit* for this audio stage. R4 and C5 are the *output circuit,* and C5 may also be considered the *coupling circuit* on the output side of Q1. It couples the signal from this stage to the next one.

Seldom seen on partial schematics is power-supply capacitor C4. It may be called *decoupling capacitor* or *filter capacitor.* Along with series resistors, C4 forms a filtering circuit in the power supply, which decouples signals to or from stages fed by the dc line it connects to. It also filters out power-supply ripple.

All these are *signal circuits.* They transfer or otherwise affect signals. Only a *feedback circuit* is missing from Figure 3.

DC circuits differ in that they maintain dc continuity. The path through R5 and any components or wiring connections that follow it make up a dc circuit that could be considered a *feedback* circuit. That's because AGC affects stages preceding the stage in which it is developed.

Other dc paths are usually supply

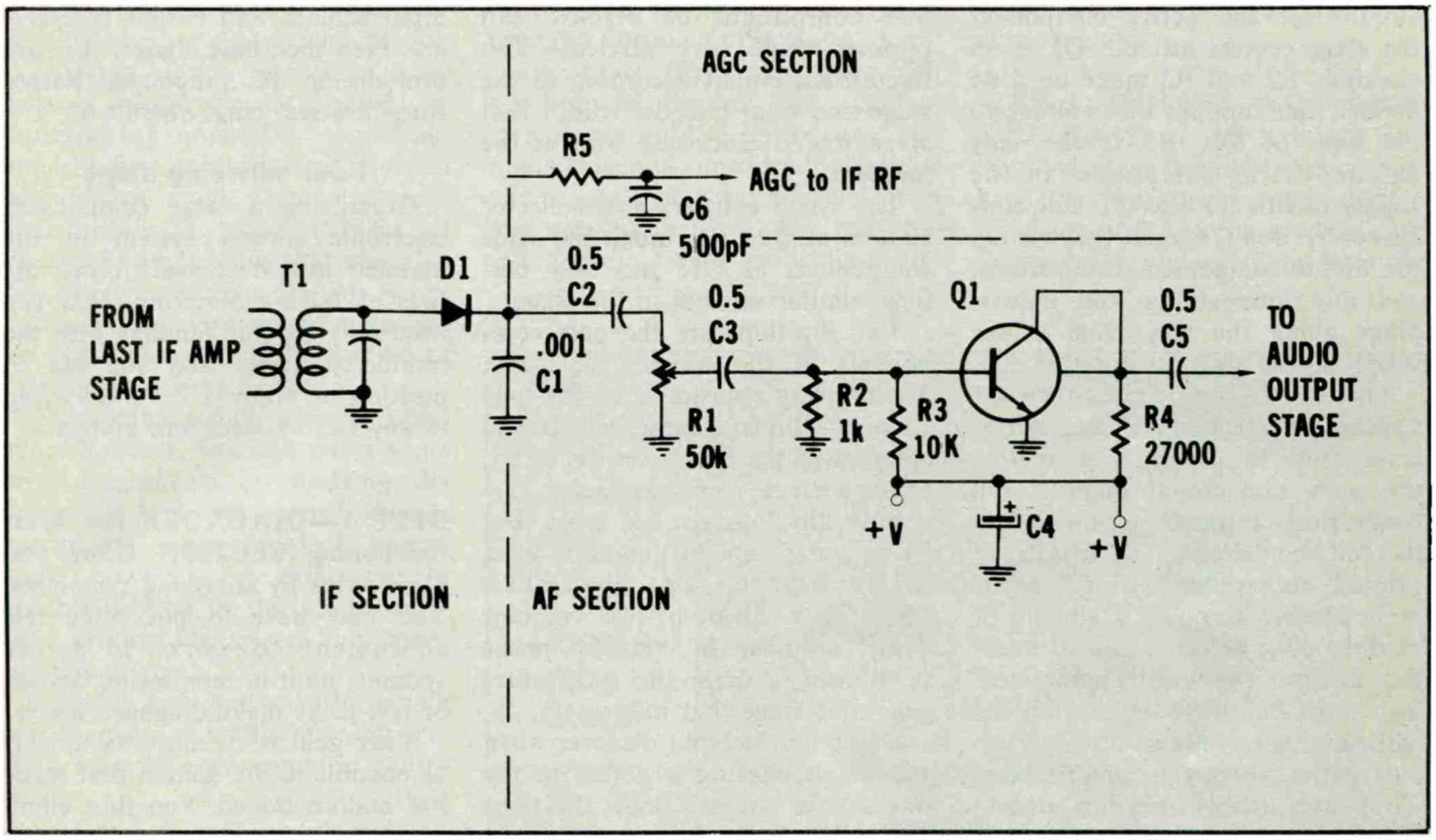


Figure 3 Circuits are, for *1-2-3-4 Servicing,* the parts and wiring that surround the main component of a stage. Old practice of calling stages "circuits" has been abandoned for this technique.

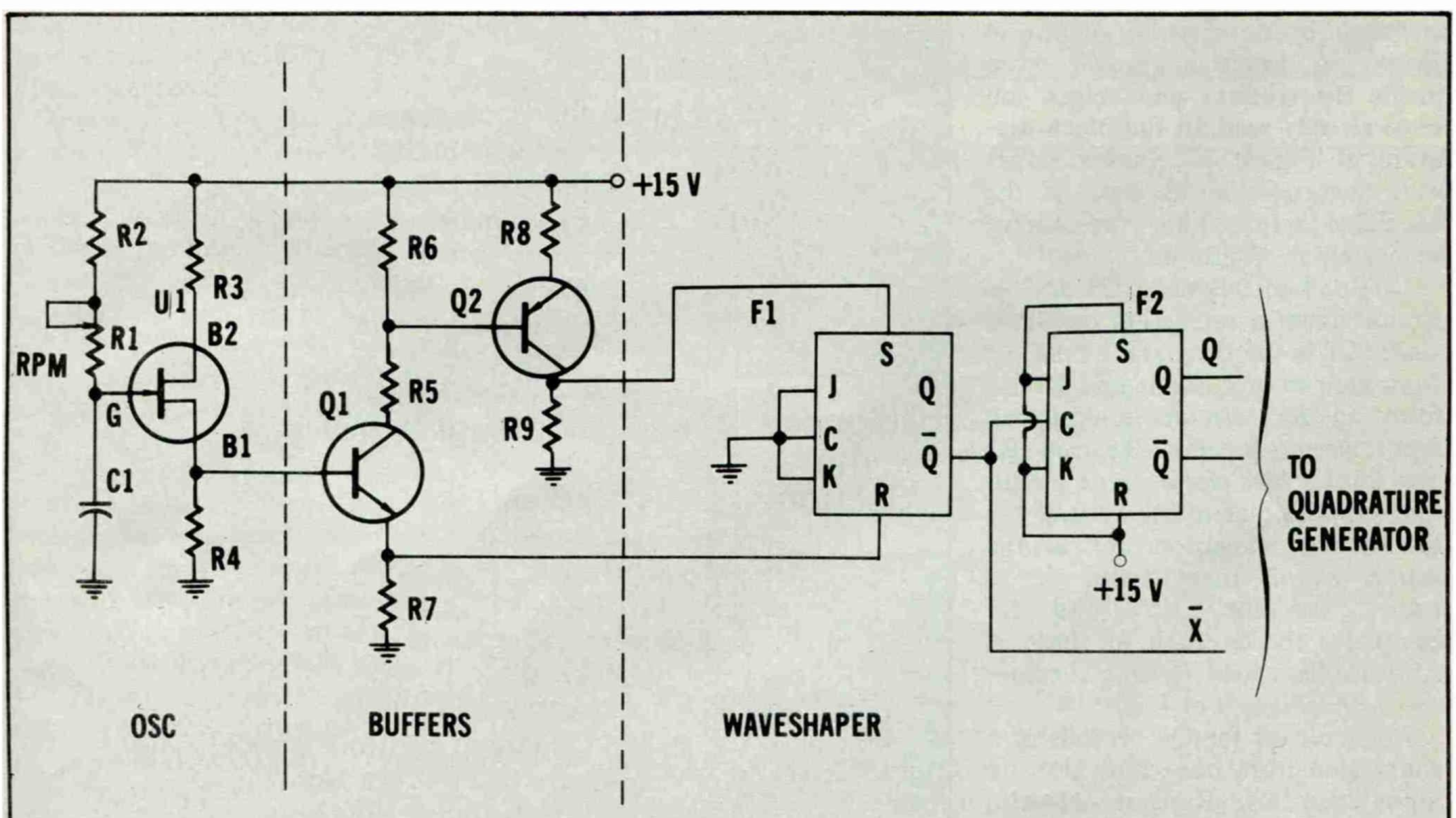


Figure 4 Circuits in some stages of an industrial control system. Where ICs are involved, whole stage may be inside one IC, and all circuits may be merely the wiring connecting IC into section.

circuits for the active component the stage centers around. Q1 is an example. R2 and R3 make up a dc divider that supplies bias voltage to the base of Q1. R5 is the only dc-conducting component in the supply circuit for the Q1 collector. However, don't forget the wiring, the foil-to-component connections, and any intercabling and chassis plugs along the way from power supply to the stage in question.

The emitter supply circuit for Q1 appears on a schematic as a direct connection to ground. In reality, the path may be through a foil connection, a socket terminal and its foil connection, a length of printed or regular wiring, maybe even passing through a chassis or module plug before actual connection to chassis ground is completed. You must be aware of, and on the alert for, these not-so-obvious circuit paths when you troubleshoot. They are often where a defect hides.

Circuits in industrial equipment differ little. You must see them either as signal circuits, as control circuits (which may act like signal circuits), or dc circuits. Figure 4 shows an example, drawn from inside the sections and stages you have already seen. In the block diagram of Figure 2C, buffer stages were incorporated as part of the oscillator stage. They are shown separately in Figure 4.

Unijunction transistor U1 and its circuits form a relaxation oscillator stage. C1 is the discharge capacitor from gate to ground; it and R1-R2 form an *RC circuit,* making an *input circuit* for U1. R1 and R2 also form a *bias circuit,* a dc circuit that supplies bias to the base of the unijunction transistor. R3 is the *supply circuit* that carries dc to base 2 of the UJT, and R4 completes the dc path for base 1. Also, R4 as a load resistor becomes the *output circuit* of U1.

Input circuit for Q1 consists of a connection from base 1 of U1 and input load R4. Resistor R4 also makes up the bias circuit for the base of Q1. You can't find much better examples than these of how one component or circuit can perform duplicative services. You name each circuit according to the stage and what purpose within that stage you're concerned with at the moment.

The base, emitter, and collector circuits of Q2 carry much the same components as Q1, and they perform similar services in the stage.

Two flip-flops are the only components in the waveshaper stage. Their wiring appears to be the only circuitry. But in a sense, R9 and R7 are part of the input circuits of F1, to the set and reset terminals.

Both flip-flops are J-K types. But F1 is wired up to function as a simple R-S flip-flop, and F2 is wired as a divide-by-two counter. Their outputs, in various phase relationships, drive the quadrature generator stage that follows.

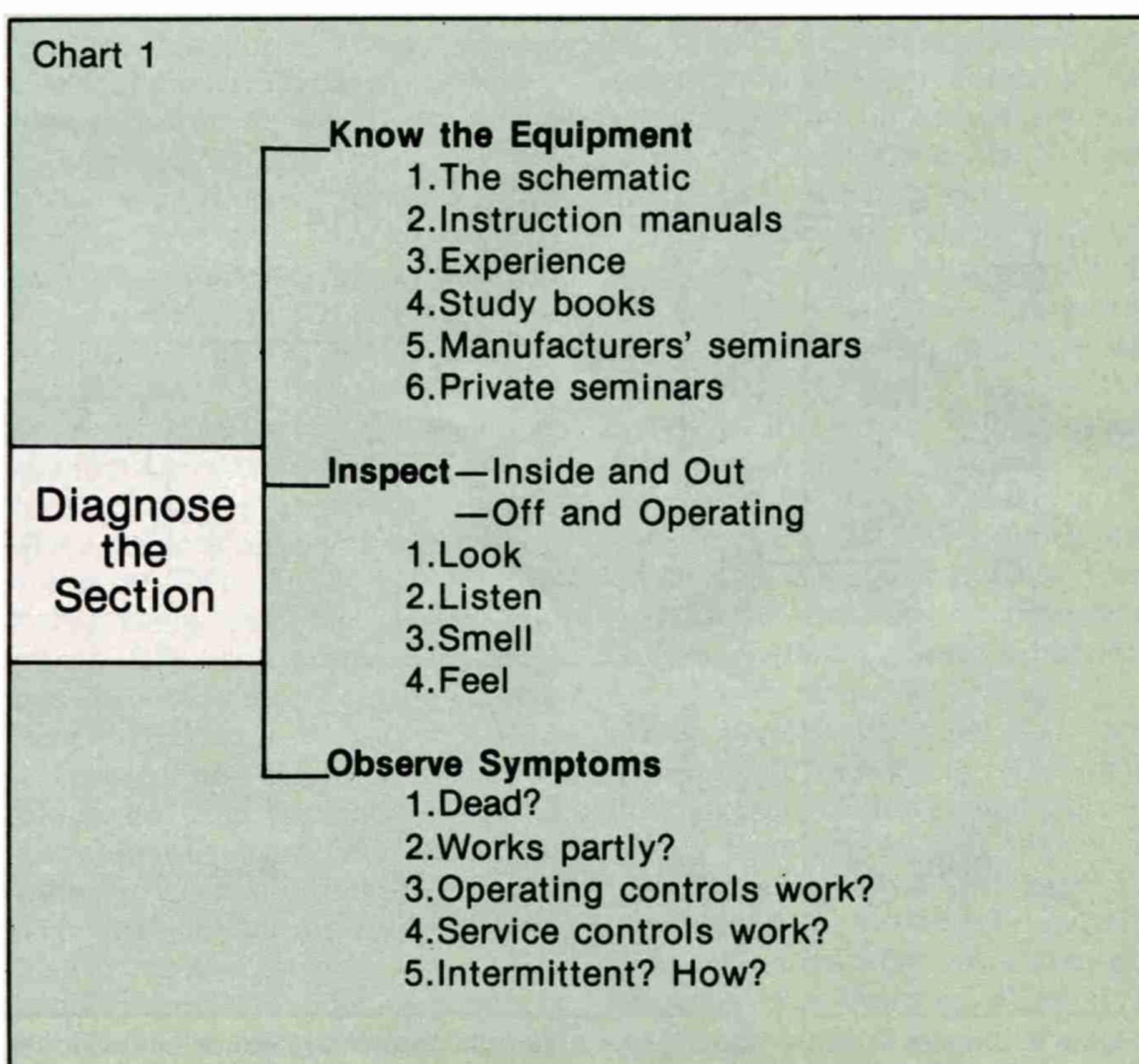
One other fact you discover when you begin chasing a defect in the waveshaper stage: Both flip-flops are inside a single integrated circuit. You can actually troubleshoot them only by checking dc supply, input signals, and output signals—and even then only signals that are brought to IC pinpoints. Rather simplifies servicing, doesn't it?

Four servicing steps

Organizing a large complicated electronic control system in the manner just described forms the bias of *1-2-3-4 Servicing.* Now you need only become familiar with the numbered steps, and you are in position to apply *1-2-3-4 Servicing* to any factory electronic system.

STEP 1—DIAGNOSE the Malfunctioning SECTION Often you can do this by analyzing symptoms. You may have to put some test equipment to work. In larger systems, built-in monitoring devices or test jacks make diagnosis easier.

Your goal is to move as quickly as possible to the section that really has malfunctioned. You thus eliminate time wasted in sections that would work okay if the bad one were operative.



Devise tests that inform you quickly whether a particular section is working or not. The time to do this is when the equipment is functioning normally, especially when it first goes on-line. You can often learn much from the team that installs a complex piece of electronic gear. Notes that record a few key measurements or waveforms during normal operation can be worth their weight in gold when the system breaks down.

Even without such advance planning, however, you can make some wise assessments by studying the schematic and the manufacturer's instruction manual. Most important, however, at this step in troubleshooting, is the act of mentally dividing the system into manageable sections.

Chart 1 lists methods by which you diagnose a malfunctioning section, even in very complex equipment.

STEP 2—LOCATE the Faulty STAGE Even here, you can still make some quick and accurate decisions if you are familiar with equipment operation and will observe symptoms carefully. Chart 2 offers suggestions.

Generally, however, troubleshooting know-how enters here. Injection troubleshooting is the same for analog (linear) or digital circuitry. Of course you need a generator that supplies the needed signal. Adjustable pulse generators make excellent injection sources. If you buy one, choose the kind that lets you adjust pulse duration and duty cycle over a wide range.

Signal tracing generally proves more popular than injection. An oscilloscope can track down just about any signal function (or malfunction). If you're not comfortable with a high-quality, dual-trace, triggered oscilloscope, take steps to get that way. No other instrument will be of more value to you in locating a faulty stage in a complex control system.

In certain transistor stages, voltage tests are some help. But as a rule, you should deal with signals, either analog or digital, when tracking down a faulty stage.

Do locate the faulty stage. Do not hunt haphazardly for a defective component. There are too many stages in most equipment for you to *guess* your way to a defect in any reasonable time. Go into the job logically, and you'll have the system back on-line as quickly as anyone could.

STEP 3—ISOLATE the Defective CIRCUIT When you have the one troubled stage located, you almost have the breakdown cured. Often, the stage may be on a module card that you can replace. Then hunt the

Chart 2

Locate the Stage

- **Observe Symptoms**
  1. Dead?
  2. Operating poorly how?
  3. Try associated controls
- **Signal Tests**
  1. Injection—signal generators
     —pulse generators
     —from similar device
  2. Tracing —oscilloscope
     —dvm and probe
     —logic probe
     —special tracer
- **Voltage Tests**

Chart 3

Isolate the Circuit

- **Signal Tests**
  1. Input circuits
  2. Output circuits
  3. Feedback circuits
  4. Bypass/decoupling circuits
  5. Waveshaping/timing circuits
- **DC Voltage Tests**
  1. Tube—plate, screen, grid
  2. Bipolar transistor—base, emitter, collector
  3. Field-effect transistor—gate, drain, source
  4. Integrated circuit—Vcc, outputs, control

defective circuit and part at your leisure.

Unfortunately, small factories seldom stock spare boards for their control systems. You're faced with chasing the trouble all the way to the specific part that caused the stoppage. So, you isolate the defective circuit. That way, you don't have to make tests in a lot of unnecessary circuitry.

Chart 3 lists the ways you might go about it most expeditiously. These techniques apply to tubes, to transistors of various types, and to integrated circuits.

In coupling circuits, you obviously test for signals. In supply circuits, it's dc faults you're looking for.

Probably the most difficult to test are feedback circuits. Yet, there's a simple technique. Take one end loose. Make sure signal drives the network, either from the stage that furnishes the feedback or from a generator. Then see if the signal appears at the other end. Also verify that the feedback network properly affects the signal.

Decoupling and bypass circuits are often overlooked. They're easy to test. You have two methods. One, connect an oscilloscope across the bypass capacitor; there should be little or no signal across it. Two, bridge a good capacitor across the suspected one and see if that cures the malady.

STEP 4—PINPOINT the Bad Part
As often as not, the quickest way is by substituting a new part. Any well-equipped factory maintenance department stocks spare parts for its systems. Without parts, expect delays when breakdowns do occur.

However, larger and more expensive components compel you to make sure. Chart 4 offers suggestions for pinpointing which part has become defective.

You can test some parts with signal tests, like a capacitor you suspect of being open. Or with dc tests, as perhaps a capacitor or transistor you suspect of leakage. Instruments that test specific parts can be handy, but the maintenance technician with ingenuity doesn't need every instrument in the catalog.

However, certain instruments save a lot of time. Transistor testers, capacitor checkers, and the like are worth their cost only if the save time and speed repairs. Too, you can do some preventive troubleshooting with a leakage checker, if there are periods when the system is shut down long enough for maintenance tests.

Every time a new system is installed in your plant, figure out what new instruments are needed to test it and its parts. You could be severely handicapped if you have to "make do" when testing parts that fail regularly or even occasionally.

Chart 4

Pinpoint the Part

- **Signal Tests**—parts in signal circuits
  1. Tracing
  2. Injection
- **DC Voltage Tests**—parts in DC circuits
  1. In-line voltage tests (use Ohm's and Kirchhoff's Laws)
  2. Tests in nearby circuits (for parts connected in between)
  3. Remember interaction (grid-plate, base-emitter-collector, etc)
- **Individual Parts Tests**—All parts
- **Substitution**
  1. Limit to parts normally carried as spares

Pulling it all together

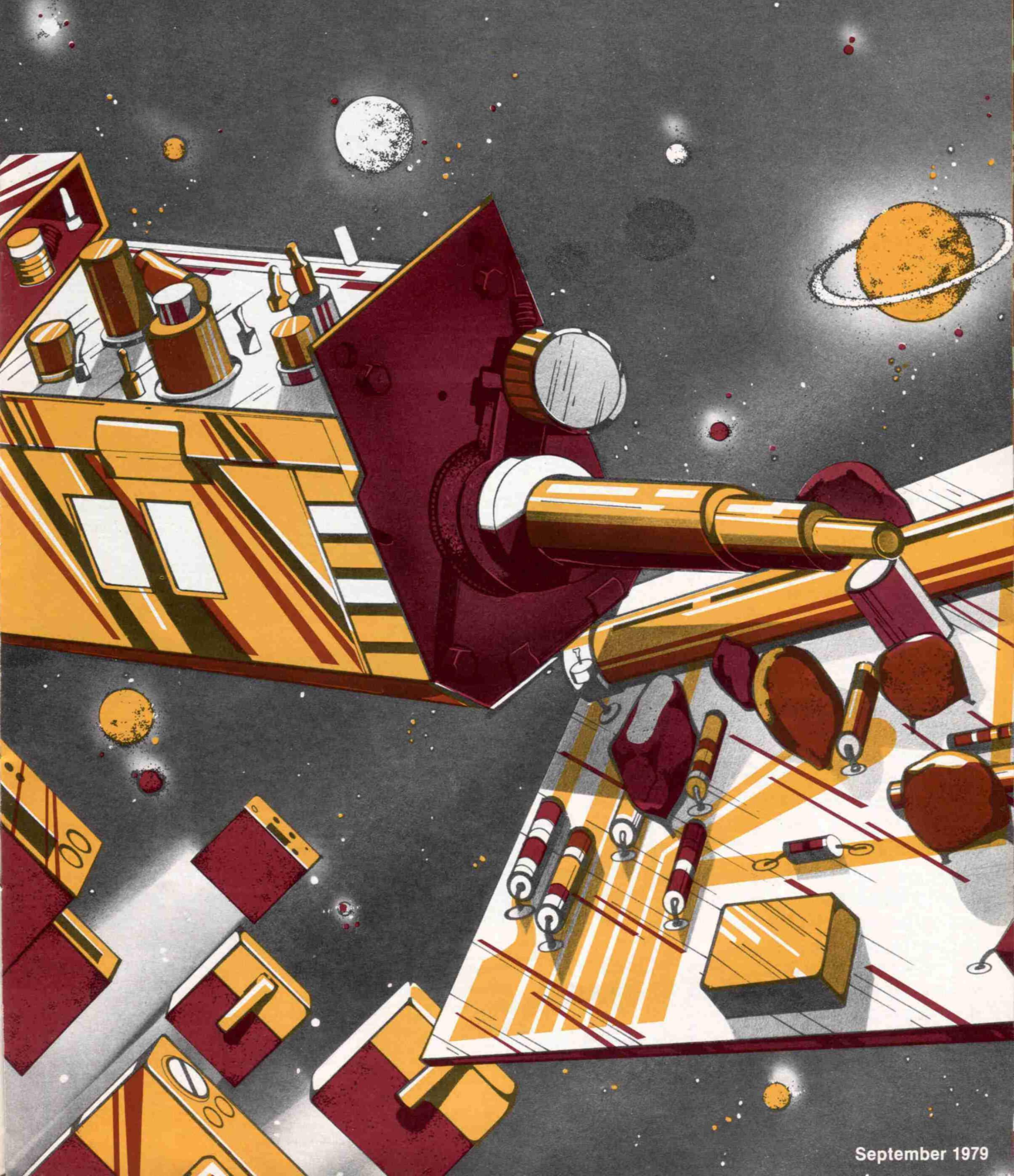
By now you probably see how basic and fundamental *1-2-3-4 Servicing* is. If you're a top-notch technician who uses this kind of good-sense automatically, bravo! This serves as a review, and corroborates that you're on the right track.

If you're just entering the field of industrial maintenance, however, you'll find *1-2-3-4 Servicing* about the most helpful tool that could be put into your hand.

As we said at the beginning, *1-2-3-4 Servicing* does not constitute a panacea. It performs no miracles. Only *you* can turn yourself into a grade-A maintenance technician. You do that by observing these pointers:

- Learn intimately the systems you must maintain. Attend manufacturer seminars if they're available. Insist that the manufacturer supply manuals you can study. Read books that describe your company's control systems, and the processes being controlled.
- Keep yourself up-to-date technologically. You can't survive among factory electronics without a deep practical knowledge of solid-state, of digital electronics, and of LSI techniques.
- Know how to use modern instruments, in particular the triggered oscilloscope, adjustable pulse generators, logic probes, and the newer, even more sophisticated timesavers for control-systems testing.
- Find and adopt a logical troubleshooting method—if not *1-2-3-4 Servicing*, then another. You cannot keep your factory running smoothly if you use haphazard troubleshooting. □

tuner times



September 1979

Adding new chapters

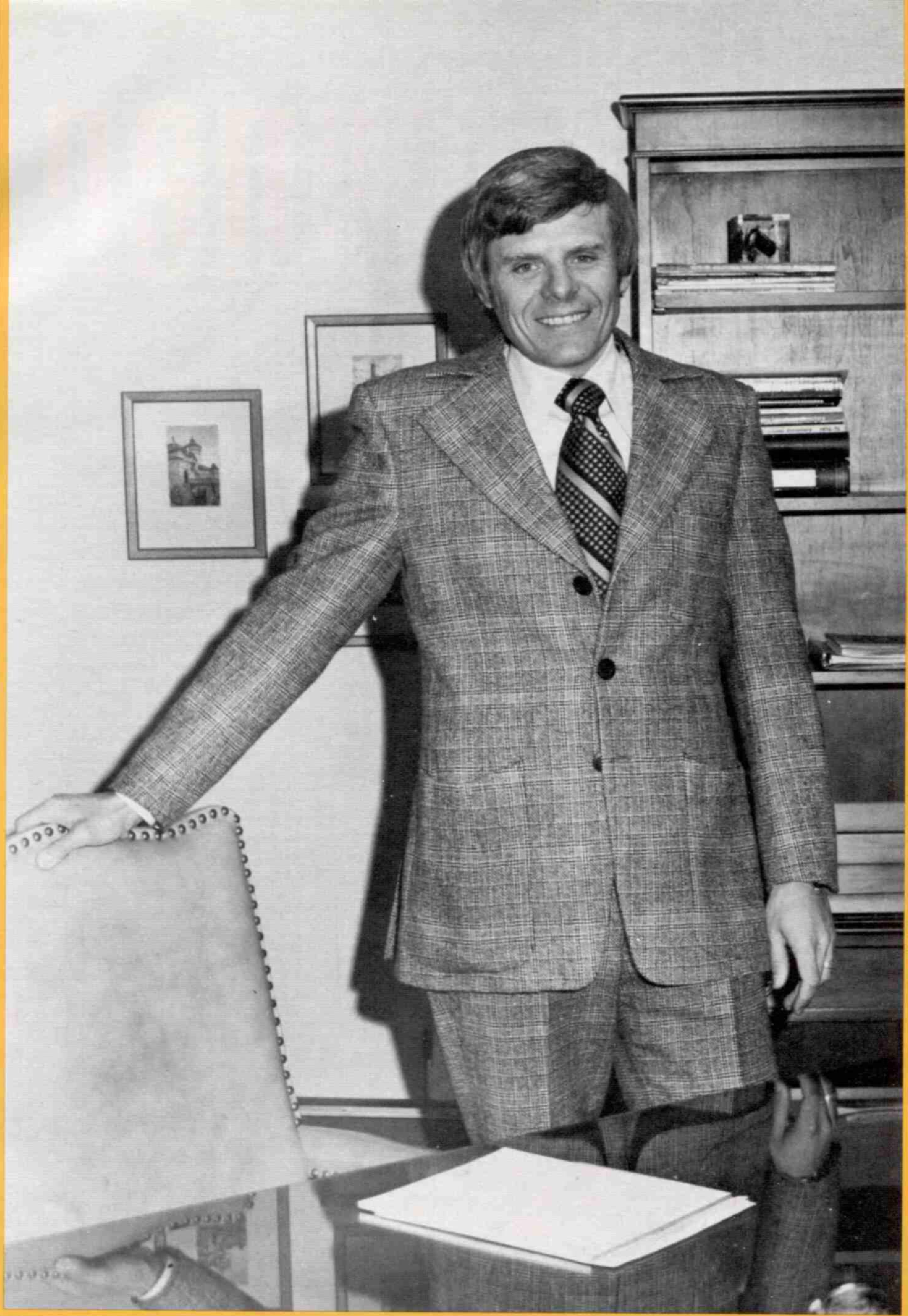
Behind every successful business lies a unique story. Sometimes of struggle. Sometimes of luck. Sometimes of brains, relentless pursuit of a dream or dogged determination. But always a story of people. Corporate histories are really stories about people—people with ideas that prove sound and profitable.

PTS Electronics is no exception.

We have a story.

And considering the short time in which we've had to write it, we think it's unique. It's a story with a series of beginnings. Perhaps that is the key to our success. PTS is constantly expanding its horizons, investigating and pursuing new realms. New chapters are being added to the story daily. Even now we're pioneering new products, new departments, new divisions as we renew that original commitment to move onward and upward.

But to begin at the beginning...



Roland Nobis, President

The PTS story begins with a restless, young engineering school graduate from Nuremburg, Germany. After four years with Grundig, the largest manufacturer of TV sets in Europe, 22-year-old Roland F. Nobis let curiosity and adventure get the best of him. On September 13, 1962, he arrived in the United States.

Hampered only by a lack of the English language, Nobis responded to a job offer at Sarkes Tarzian, Inc. in Bloomington, a small community nestled in the hills of southern Indiana. Two years later, Nobis joined RCA, working in television engineering.

But restlessness prevailed. Nobis soon began his own service business on the side, naming his first company Rono-Tuner. A sizeable business developed. Nobis then purchased Precision Tuner Service, leaving RCA to pursue his own business full time.

The firm was soon recognized as the number one tuner service throughout the country. But shipping time was a problem so the first branch was born in California. Efficiency and productivity were improved and the transportation problem was solved. That success led to the opening of other branches.

In 1971, Teltron Tuner Service, a major supplier of tuner parts in Denver, was purchased, along with the complete line of Coleman Electric TV parts. With this acquisition, Nobis' company entered the replacement parts business and officially became PTS Electronics, Inc.

PTS developed and manufactured the first 83-channel tuner analyst. Enthusiastic acceptance of this first PTS product led to the development, production and marketing of a complete line of portable tuner analysts, field strength meters, power supplies, and a semiconductor and component analyzer.

Then came the challenge of module technology. PTS met it and is now the nation's leading source for rebuilt modules of all types and makes.

Continued expansion and diversification led to the distribution and development of a PTS semiconductor replacement line, sprays, lubricants, and other chemical products for the electronic industry, a variety of electronic parts and components and a complete line of tools and soldering equipment.

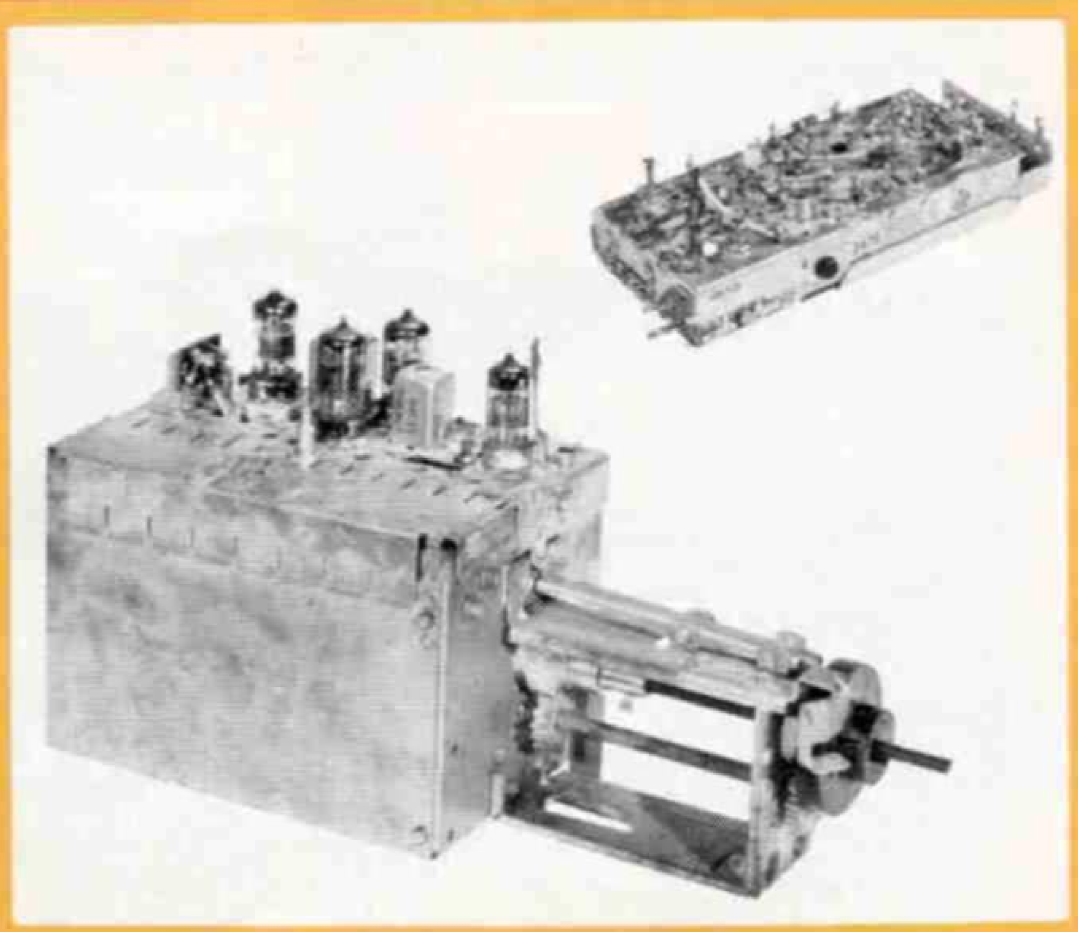
Further expansion led to the development of PTS associate companies: D & M, a tool and die and plastic injection molding firm, and ATR, a coil and subassembly manufacturing plant.

PTS' corporate headquarters in Bloomington now comprise more than 45,000 square feet of production and office facilities. Over 42 company-owned and staffed branches are located in major metropolitan areas across the country. PTS employs almost 500 engineers, technicians, managers and support personnel. Annual sales of products and services are currently about $10 million and rapid, consistent growth is anticipated.

And PTS isn't stopping its onward and upward drive. Insight into the need for more products, services, and employment led to the organization in early 1979 of an aggressive, competent PTS marketing department under the direction of Richard W. King, Vice President/Marketing. The PTS Research and Development Department was also organized. At the present time, some 20 projects for the research and design of future PTS products are actively pursued. The future holds as much if not more promise.

PTS executed a license agreement with the Indianapolis Center for Advanced Research (ICFAR) in April 1979 for the production design, manufacturing, marketing and servicing of an advanced ultrasound medical electronics system.

Sales from this major project are expected to exceed $100 million over the next eight years. Upon successful establishment of medical ultrasound facilities, PTS is looking into the future with forthcoming new ultrasound systems including transkull brain scanning, ultrasound surgery and other systems.



The first tuners repaired by PTS were like the bulky RCA model, circa 1950, shown above. Next to it is a modern UHF/VHF combo varactor electronic tuner.

Tuner Times updates the services, products, facilities and people of PTS Electronics, Inc., the world's largest independent tuner/module repair company.

Corporate headquarters:
P.O. Box 272
Bloomington, IN 47402
Roland Nobis, President

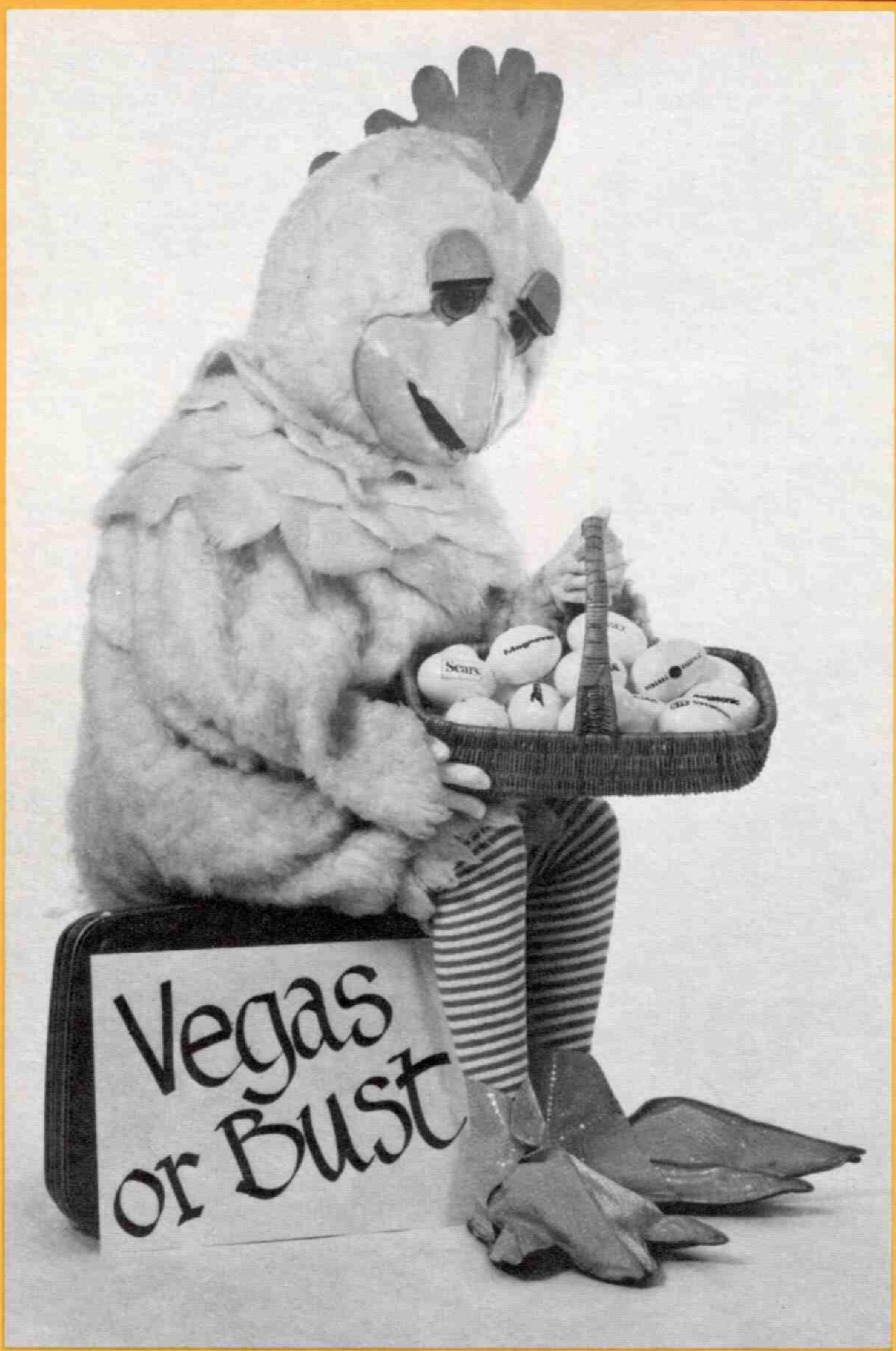
Future expansion is being considered in the area of video records and cameras, projection TV and prerecorded video cassettes for the consumer and commercial markets.

All this has been accomplished in about 15 years. It started with a voyage across the Atlantic, fulfilling a young man's curiosity and adventures. It has developed into an internationally known electronics company, which has the leadership, management and organizational structure with a solid financial basis to become one of the largest electronics corporations in the country. And the story has really just begun.

Module Price Guide Available

Inserted in this issue of **Tuner Times** is the PTS Module Price Guide, effective Oct. 1, 1979. Remove this Guide and keep it for handy reference.

Electronic Distribution Show eggstravaganza



Chicken Man, ready to fly the Bloomington coop.

Hugging Prez and Mrs. Prez (Roland and Rosie Nobis).

Greeting guests at EDS.

The whole flock gathers for a photo.

PTS ELECTRONICS, INC.

MODULE PRICE AND INFORMATION GUIDE

EFFECTIVE OCTOBER 1, 1979

REBUILT MODULE PRIC

Admiral

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
A8911-1	Sound	3.50	13.95	17.45
A8912-1	Signal Proc.	3.00	10.95	13.95
A8912-2	Signal Proc.	3.20	9.15	12.35
A8913-1	Horiz. Osc.	2.00	7.95	9.95
A8914-1	Video/Chroma	2.00	12.95	14.95
A8915-1	Vert.	•	7.95	9.95
A8916-1,2	Chroma	2.00	18.95	20.95
A8917-1	Power	2.50	14.95	17.45
A8918-1,2,3	IF	6.00	14.95	20.95
A8919-1,2,3,4	IF	6.00	17.20	23.20
A8920-1,3	Sound	6.00	11.95	17.95
A8921-1	Signal Proc.	5.00	11.95	16.95
A8922-1,2	Chroma	6.00	17.20	23.20
A8923-1,2,3,4,5	Video/Color	5.20	14.90	20.10
A8924-1,4	Horiz.	4.40	12.60	17.00
A8925-1	Vert.	4.40	12.60	17.00
A8926-1,4	Pwr. Sply.	6.25	12.60	18.85
A8926-3,5	Pwr. Sply.	4.25	10.95	15.20
A8929-1	Pulse Proc.	3.20	9.15	12.35
A8932-1	Vert.	5.25	12.95	18.20
A8933-1,3	Horiz.	5.20	14.90	20.10
A8934-1	Chroma	6.00	17.20	23.20
A8935-1,2,3,20	IF	9.00	19.95	28.95
A8936-1,2	Signal Proc.	3.20	9.15	12.35
A8937-1	Video/Color	5.20	14.90	20.10
A8939-1	Horiz.	6.25	14.95	21.20
A8940-1,2,3,22	IF	15.00	32.15	47.15
A8941-1,2,3	Chroma	13.00	26.40	39.40
A8942-1,2	Video	7.00	11.45	18.45
A8943-1	RGB	7.00	12.60	19.60
A8944-1	Vert./Horz.	11.00	24.95	35.95
A8945-1,2	High Voltage	19.00	51.95	70.95
A8950-2	IF/Video	•	33.95	43.95
A8951-2,3,4,5,6,7	RGB/Horz.	11.00	22.95	33.95
A8952-1,2,3,4	Vert.	10.00	17.95	27.95
A8954-1,2,3,4,6	Pin Cushion	10.00	17.95	27.95
A8968-1	Fuse Panel	2.00	5.70	7.70
A8980-21	Logic	21.60	46.95	68.55
A8981-1,2,20	Remote	21.60	56.95	78.55
A8996-1	Vert./Horz.	13.00	26.40	39.40
Admiral Remote Transmitters				
R-200TA	Remote Trans.	9.00	19.95	28.95
R300TA	Remote Trans.	9.00	19.95	28.95
R400TA	Remote Trans.	9.00	19.95	28.95
S-366AN	Remote Trans.	9.00	19.95	28.95
S-376AN	Remote Trans.	9.00	19.95	28.95
X-325A	Remote Trans.	9.00	19.95	28.95
X-376AN	Remote Trans.	9.00	19.95	28.95

General Electric

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
EP75X6	Vert.	•	12.60	17.00
EP75X10	AFC	•	6.85	8.85
EP75X11	Vert.	•	12.60	17.00
EP75X12	AFC	•	9.15	11.15
EP93X37	IF/AFC	•	17.20	21.20
EP93X38	Video Amp.	•	12.60	17.00
EP93X39	Chroma Out.	•	14.90	20.10
EP93X40	Audio	•	10.30	12.30
EP93X41	Chroma	•	14.90	18.10
EP93X42	Vert.	•	14.90	20.10
EP93X43	Pwr. Sply.	3.20	9.15	12.35
EP93X44	Signal Cond.	•	11.45	15.45
EP93X45	Horz. Buffer	•	9.15	10.35
EP93X46	H.V. Reg.	•	12.60	17.00
EP93X56	Main Crt. Brd.	14.80	42.50	57.30
EP93X64	Conv.	2.80	8.00	10.80
EP93X67	Vert.	•	14.90	20.10
EP93X68	Pwr. Sply.	3.20	14.90	18.10
EP93X69	Horz.	4.40	12.60	17.00
EP93X70	Chroma/Video	6.00	17.20	23.20
EP93X72	IF/Audio	•	17.20	23.20
EP93X74	Video	•	12.60	17.00
EP93X75	Vert.	•	14.90	20.10
EP93X76	Vert.	4.40	12.60	17.00
EP93X78	One Touch Brd.	•	6.85	8.05
EP93X79	RGB Out	•	14.90	20.10
EP93X80	Pwr. Sply.	3.20	9.15	12.35
EP93X86	Vert.	4.40	12.60	17.00
EP93X88	Vert.	5.20	14.90	20.10
EP93X89	Chroma	5.20	14.90	20.10
EP93X91	Pwr. Sply.	5.20	14.90	20.10
EP93X92	Horz.	5.20	12.60	17.80
EP93X93	Color/Video	6.00	17.20	23.20
EP93X95	YM-Diode Rect.	3.20	11.45	14.65
EP93X99	Sound	4.00	10.30	14.30
EP93X100	Conv./Pincushion	2.80	12.60	15.40
EP93X101	YM-VIR	11.20	32.15	43.35
EP93X102	Drive	5.20	14.90	20.10
EP93X103	Vert.	•	14.90	20.10
EP93X108	Color/Video	6.00	17.20	23.20
EP93X113	Color/Video	6.00	17.20	23.20
EP93X115	Regulator	4.00	12.60	16.60
EP93X118	Pwr. Sply. Reg.	5.20	14.90	20.10
EP93X120	YC/YM Remote	11.20	32.15	43.35
EP93X130	Color/Video	6.00	17.20	23.20
EP93X131	YM-VIR	11.20	32.15	43.35
EP93X132	VIR	11.20	32.15	43.35
EP93X142	Remote	11.20	32.15	43.35
ES75X1	Sound	•	6.85	8.85
General Electric Remote Transmitters				
EP62X39	Remote Trans.	9.00	19.95	28.95
EP62X50	Remote Trans.	9.00	19.95	28.95
EP62X89	Remote Trans.	9.00	19.95	28.95

*Dud Modules presently with no purchase value.

Magnavox

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
612003-1,102,202	Audio Out	•	4.55	5.30
612004-1,101	Sound Det.	•	4.55	5.30
612032-1,101	Video Out	•	4.55	5.30
612034-1,101	Chroma Demod	2.80	8.00	10.80
612036-1,101	Signal Proc.	•	9.15	12.35
612041-1,101	Chroma Proc.	•	8.00	10.80
612046-2,101,102, 202	Audio Out.	•	4.55	5.30
612047-1,101,202	Sound Det.	•	4.55	5.30
612062-1,2,101,102, 201,202	Audio Out.	•	4.55	5.30
703428-002, 003,004	IF	5.20	14.90	20.10
703502-1,2,3,4,20, 22,201	"A" Panel	10.00	22.95	32.95
703502-5,6,7, 66,601	"A" Panel	10.00	22.95	32.95
703503-1,2,3,10, 11,101,102	"B" Panel	12.00	25.95	37.95
703504-1,2,11,101	"C" Panel	12.00	24.95	36.95
703505-1,2,22,201	"D" Panel	13.00	27.95	40.95
703506-1,11,101	"E" Panel	8.00	15.50	23.50
703507-1	H.V. Reg.	2.40	6.85	9.25
703508-1,2	Videomatic	2.40	6.85	9.25
703549-1,2	Video IF	•	15.95	20.95
703550-1	AFT	•	10.30	13.90
703551-1,2,3	Video Delay	•	6.50	8.10
703552-1,2,3,4,5	Video Out	•	4.55	5.30
703553-1	Vert. Osc./Driver	3.00	7.95	10.95
703554-1	Horiz. Osc./Driver	•	11.95	15.95
703556-1,2,3,4	H.V. Reg.	2.00	6.50	8.50
703574-1,2,3,11, 101,102,	"D" Panel	13.00	26.95	39.95
703575-1,11,101	"C" Panel	11.00	21.95	32.95
703576-1,11, 101,102	"D" Panel	13.00	27.95	40.95
703576-2,22 201	"D" Panel	13.00	27.95	40.95
703577-2	H.V. Reg.	•	6.85	9.25
703607-1	AGC Interface	2.80	8.00	10.80
703616-1	Vert. Osc./Driver	4.40	12.60	17.00
703626-1	IF	6.25	13.50	19.75
703636-1,2,3	IF	6.25	13.50	19.75
703637	AFT	1.75	4.50	6.25
703638-1,2	AGC/Sync.	•	6.95	8.95
703639-1,2	Audio Out	2.00	6.95	8.95
703640-1,2,3,5	Low Level Video	2.25	7.95	10.20
703641-1	Videomatic	4.80	13.75	18.55
703642-1,2	Chroma Proc.	3.25	9.95	13.20
703643-1,2	Chroma Proc.	3.25	9.95	13.20
703644-1,2,3,4	RGB/CRT	•	13.15	17.40
703644-5,6,7	RGB/CRT	4.25	13.15	17.40
703645-1	Horz.	4.00	10.50	14.50
703646-1	Vert.	4.00	14.95	18.95
703647-1,2,3	Retrace/Screens	•	8.95	11.45
703647-5,6,7	Retrace/Screens	2.50	8.95	11.45
703648-1	Pwr. Sply.	•	10.95	14.45
703653-1,2,3,4,5,7	Horz. Scan/H.V.	•	31.95	40.95
703653-6	Horz. Scan/H.V.	•	31.95	40.95
703656-1,2,3,4	Videomatic	3.00	9.50	12.50
703660-1,2	120 Volt Reg.	3.00	9.95	12.95
703661-1	24/250 Volt Sply.	3.00	7.95	10.95
703662-1	Video Delay	2.00	6.95	8.95
703662-2,3	Video Delay	2.00	6.95	8.95
703663-1,2	Chroma Demod.	2.00	6.95	8.95
703664-1	Chroma Proc.	3.00	8.95	11.95
703665-1,2	RGB Out	3.00	7.95	10.95
703667-1,2,3	Vert. Osc./Driver	6.00	13.95	19.95
703668-1	Horz. Osc./Driver	7.60	21.80	29.40
703727-1,2,3,4,5	Audio Out	3.60	10.30	13.90
703743-1,2	Chroma	4.25	11.50	15.75
703744-1,2	Regulator	6.00	12.95	18.95
703745-1	Horz. Osc.	4.00	9.50	13.50
703762-1	Horiz. Osc.	7.60	21.80	29.40
703850-1	IF	6.25	13.50	19.75
704081-1	Remote Trans.	3.60	11.45	15.05
704082-1	Remote	•	17.20	23.20
704084-1	Remote	8.80	25.25	34.05
704090-1	Remote Trans.	7.00	19.95	26.95
Magnavox Remote Transmitters				
704037-1	Remote Trans.	9.00	19.95	28.95
704041-1,2	Remote Trans.	9.00	19.95	28.95
704060-1	Remote Trans.	9.00	19.95	28.95
704081-1	Remote Trans.	9.00	19.95	28.95
704085-1	Remote Trans.	9.00	19.95	28.95
704089-1	Remote Trans.	9.00	19.95	28.95
704090-1	Remote Trans.	9.00	19.95	28.95

Montgomery Ward

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
62661550	IF	6.00	14.95	20.95
62750944	IF	6.00	17.20	23.20
62745533	Sound	6.00	11.95	17.95
62745541	Signal Proc.	5.00	11.95	16.95
62745568	Chroma	6.00	17.20	23.20
62745576	Video/Color	5.20	14.90	20.10
62775491	Video/Color	5.20	14.90	20.10
62745584	Horz.	4.40	12.60	17.00
62745592	Vert.	4.40	12.60	17.00
62745606	Pwr. Sply.	6.25	12.60	18.85
62775513	Pwr. Sply.	4.25	10.95	15.20
62775483	Vert.	5.25	12.95	18.20
62775505	Horz.	5.20	14.90	20.10
62775475	Chroma	6.00	17.20	23.20
62811439	IF	9.00	19.95	28.95
62811447	Signal Proc.	3.20	9.15	12.35
62811463	Video/Color	5.20	14.90	20.10
62811471	Horz.	6.25	14.95	21.20
62775521	RGB/Horz.	11.00	22.95	33.95
62774932	Vert.	10.00	17.95	27.95
62775548	Pin Cushion	10.00	17.95	27.95

Philco

Module Number	Part No	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
ACTC01	69-1000	Act/VVC	2.40	6.85	9.25
CDBC01	69-1013	Chroma/Blkg.	•	6.95	10.95
CIFC01,02	69-1003/-1026	Chroma-IF	•	6.95	10.95
HOAC01	69-1006	Horz.	•	9.95	15.95
HOBC01	69-1017	Horz. Osc./AFC	3.20	9.15	12.35
HVRC01	69-1005	H.V./Reg.	4.00	6.95	10.95
LLVC01,02, 03	69-1011/-1022 -1029	Video Amp.	4.00	6.95	10.95
PSBC01	69-1019	Pwr. Sply.	5.00	7.95	12.95
PSMC01,02	69-1007/-1025	Pwr. Sply.	•	7.95	12.95
RGBC01,02	69-1004/-1028	Video Output	•	7.95	12.95
SAGCO1,02 03,04	69-1014/-1023 -1024/-1031	AGC/Sync.	•	6.95	10.95
SCRC01	69-1012	Subcarrier	•	6.95	10.95
SDAC01	69-1002	Sound	•	9.95	15.95
VIFC01,02	69-1010/-1030	Video IF	•	10.95	18.95
VRAC01,02 03	69-1015/-1016 -1021	Vert. Osc./Out	•	10.95	18.95
VRBC01	69-1018	Vert. Osc.	4.00	11.45	15.45

Quasar

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
1-65534E82	B-IF	•	14.90	29.10
1-65534E83	P-FTI	•	8.00	16.00
1-65534E84	D-Audio	•	8.00	16.00
1-65534E85	E-Video Pre-amp	•	12.60	25.30
1-65534E86	S-Chroma	•	14.90	29.10
1-65534E87	L-Video Drive	•	11.45	21.45
1-65534E88	M-Video Output	•	11.45	21.45
1-65534E89	DA/F-Horz.	18.50	16.05	34.55
1-65534E90	GA/RA-Pin Cushion	•	8.00	16.00
1-65534E91	H-Conv.	•	16.05	31.25
1-65534E92	T-FTL	•	8.00	16.00
1-65534E97	K-AFC	•	8.00	16.00
1-68662E55	HA-Conv.	•	10.30	23.10
1-68662E56	FA-Defl.	15.00	11.45	26.45
1-68662E57	BA-IF/Audio	•	16.05	34.55
1-68662E58	ZA-Reg.	•	8.00	16.00
1-68662E59	CA-Signal	23.40	19.50	42.90
1-68662E60	KA-AFC	•	8.00	16.00
1-68663E99	A-UHF Tuner	•	17.20	32.25
1-68665E16	YA-Remote	•	12.60	28.20
1-68665E32	JA-Sew. Mod.	23.40	19.50	42.90
1-68665E33	VA-Vert.	15.00	11.45	26.45
1-71675E66	NA-Conv.	13.80	10.30	24.10
1-71676E17	LA/MA-Signal	24.00	19.50	43.50
1-71677E25	BC-IF	19.00	16.05	35.05
1-71677E26	FC-Horz.	20.00	16.05	36.05
1-71677E27	HC-Conv.	13.40	10.30	23.70
1-71677E28	SC-Color	25.50	20.65	46.15
1-71677E29	UC-U/V Tuners	4.00	21.80	49.60
1-71677E30	YC-Remote	16.80	12.60	29.40
1-71677E31	ZC-Sply.	13.40	11.45	24.85
	TA-Signal	23.40	19.50	42.90
	WA-Signal	•	19.50	42.90
	SA-Signal	•	19.50	42.90
1-71679E68	CC-Color	25.50	20.65	46.15
1-71681A28	SF-Supermodule	105.00	36.75	141.75
Quasar Remote Transmitters				
TRT 5	Remote Trans.	9.00	19.95	28.95
TRT 6	Remote Trans.	9.00	19.95	28.95
TRT 9	Remote Trans.	9.00	19.95	28.95
TRT 12	Remote Trans.	9.00	19.95	28.95

RCA

(Color TV)

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
MAA001A/130753	Sound	•	6.85	10.25
MAB002A/132581	Pwr. Sply.	•	5.95	8.95
MAB003A/133563	Pwr. Sply.	•	5.95	8.95
MAB003B/133563	Pwr. Sply.	•	5.95	8.95
MAC001A/139546	Chroma 1	•	14.95	24.95
MAC002A/134007	Chroma 1	•	12.60	20.00
MAC002B/138697	Chroma 1	•	12.60	20.00
'MAD001A/132579	Kine Drive	•	6.85	10.25
MAE001A/132580	Chroma 11	•	11.45	16.75
MAE001B/136691	Chroma 11	•	11.45	16.75
MAG001A/132585	Vert.	•	11.45	17.85
MAG001B/135871	Vert.	•	11.45	17.85
'MAG004A/139340	Vert.	7.40	14.90	22.30
MAH001A/132582	Horz.	•	11.45	17.85
MAH001B/145259	Horz.	•	11.45	17.85
MAH004A/137604	Horz.	•	11.45	17.85
MAH004B/139042	Horz.	•	11.45	17.85
MAH004C/145260	Horz.	•	11.45	17.85
MAH007A/140068	Horz.	•	11.45	17.85
MAH008A/139657	Horz.	•	11.45	17.85
MAH009A/140502	Horz.	•	12.60	20.10
MAK001A/132586	IF/AFT	•	17.20	25.70
MAK001B/137186	IF/AFT	•	17.20	25.70
MAK001C/141154	IF/AFT	•	17.20	25.70
MAK002A/140069	IF/AFT	10.75	21.95	32.70
MAL001A/132584	Video/Sync.	•	9.15	13.35
MAL001B/137187	Video/Sync.	•	9.15	13.35
MAN002A/133455	Audio Out	•	5.95	8.95
MAP001A/134397	Motor Cont.	•	11.45	13.45
MAZ001B/137366	Memory	•	11.45	13.45
MCA001B/141603	Clock Display	9.60	39.05	48.65
MCC001A/141220	Chroma	•	15.95	21.95

'(RCA) NOTE: These modules were manufactured via two methods—discrete component and ceramic incapsulated. The ceramic version cannot be rebuilt; if an exchange is not available, the module will be returned unrepaired. Ceramic incapsulated modules have no dud value.

ES AND DUD VALUES

RCA

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
MCD001A/141222	Kine Drive	*	10.95	14.95
MCF001A/141844	Ultrasonic Filter	*	8.00	12.60
MCH001A/141223	Horz./Vert.	*	18.95	26.95
MCH001B/145261	Horz./Vert.	*	18.95	26.95
MCH002A/141484	Horz./Vert.	*	18.95	26.95
MCH002B/145262	Horz./Vert.	*	18.95	26.95
MCK001A/141224	IF/AFT	11.40	21.95	33.35
MCK002A/142285	IF	11.40	21.95	33.35
MCL001A/141221	Video/Sync.	*	14.90	22.10
MCL002A/142286	Video/Sync.	11.40	17.20	28.60
MCP001A/141605	Remote Pwr. Sply.	11.00	33.95	44.95
MCP001B/142356	Remote Pwr. Sply.	11.00	33.95	44.95
MCP002A/143376	Remote Pwr. Sply.	11.00	33.95	44.95
MCR002A/141417	Remote	12.00	18.35	30.35
MCR003B/145164	Remote Amp.	10.00	26.95	36.95
MCS001A/141219	Sound	*	9.95	12.95
MCT001A/141610	Command	9.60	42.50	52.10
MCU001A/141609	UHF-Tuning	11.00	39.95	50.95
MCV001A/141608	VHF-Tuning	11.00	35.95	46.95
MCX001A/141427	Remote	9.00	17.20	26.20
MCY001A/141606	Remote Pre-amp.	6.40	9.15	15.55
MCY003A/145152	Pre-amp.	5.00	11.85	16.95
MCZ001B/141607	Post. Amp.	6.40	9.15	15.55
MDC001A/142706	Color	8.00	17.20	25.20
MDD001A/142703	Kine Drive	*	11.45	16.75
MDG001A/142705	Vert.	6.00	14.90	20.90
MDH001A/142708	Horz.	*	11.95	14.95
MDH001B/143447	Horz.	*	11.95	14.95
MDL001A/142707	Lum./Sync.	*	14.90	22.30
MDL001B/145256	Lum./Sync.	*	14.90	22.30
MDL002A/142840	Lum./Sync.	*	14.90	22.30
MDS001A/142704	Sound	3.20	9.15	12.35
MDS001B	Sound	3.20	9.15	12.35
MSC001A/143745	Tuning Control	11.00	30.95	41.95
MSC002A/143746	Tuning Control	11.00	34.95	45.95
MSC003A/143747	Tuning Control	11.00	34.95	45.95
MST001A/143686	U/V Tuning	11.00	34.95	45.95
PW4000A	VTCA	10.00	32.15	42.15
10T131	Cont. Center	16.00	39.95	55.95
VTCA2B	Tuning	10.00	38.95	48.95
MAF001A/129701	IF	*	8.00	12.00
MAF001B/133415	IF	*	8.00	12.00
MAF001C/133158	IF	*	8.00	12.00
MAF001D/139289	IF	*	8.00	12.00
MAF002A/131952	IF	*	11.45	15.45
MAF003A/134766	IF	*	11.45	15.45
MAF004A/137326	IF	*	11.45	15.45
MAF005A/139753	IF	*	14.90	18.90
MAF006A/140703	IF	*	14.90	18.90
MAG007A/141007	Vert.	*	11.45	15.45
MAG008A/140700	Vert.	*	11.45	15.45
MAH002A/132540	Horiz.	*	9.15	13.15
MAH003A/134769	Horiz.	*	9.15	13.15
MAI001A/140525	Sound	*	6.85	10.85
MAI001B/136014	Sound	*	6.85	10.85
MAI001C/140525	Sound	*	6.85	10.85
MAL002A/134767	Video/Sync.	*	6.85	10.85
MAM001A/129700	Video	*	6.85	10.85
MAN001A/132538	Audio Out	*	6.85	10.85
MA0001A/132539	Vert.Pwr.Sply.	*	11.45	15.45
PM200A/140067	Sound	*	6.85	10.25

RCA Remote Transmitters

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
CRK6A/10B102	Remote Trans.	11.00	31.95	42.95
CRK7B/10B141	Remote Trans.	11.00	31.95	42.95
CRK8A/10B142	Remote Trans.	11.00	31.95	42.95
CRK9A,C/143356	Remote Trans.	11.00	31.95	42.95
CRK10A/143354	Remote Trans.	11.00	31.95	42.95
CRK11E/143355	Remote Trans.	11.00	31.95	42.95
CRK12/143358	Remote Trans.	11.00	31.95	42.95
CRK13A,B/143354	Remote Trans.	11.00	31.95	42.95
CRK14C/143361	Remote Trans.	11.00	31.95	42.95
CRK18A/143352	Remote Trans.	11.00	24.50	35.50
CRK19A,D/143365	Remote Trans.	11.00	24.50	35.50
CRK20A/143363	Remote Trans.	11.00	24.50	35.50
CRK23/143366	Remote Trans.	11.00	24.50	35.50
CRK24A/143368	Remote Trans.	9.00	16.95	25.95
CRK24C/143370	Remote Trans.	9.00	16.95	25.95
CRK25A/143369	Remote Trans.	9.00	16.95	25.95
CRK26A/145143	Remote Trans.	9.00	16.95	25.95
DAP Unit/10T0131	Remote Trans.	16.00	39.95	55.95

Sears/Warwick

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
35-32600-1	IF	8.80	25.25	34.05
35-32601-1	IF	8.80	25.25	34.05
35-32602-1	IF	8.80	25.25	34.05
35-32603-1	IF	8.80	25.25	34.05
35-32604-1	IF	8.80	25.25	34.05
35-32605-1	IF	8.80	25.25	34.05
35-32606-1	IF	8.80	25.25	34.05
35-32900-1	Sound	8.00	22.95	30.95
35-39300-1	IF	8.80	25.25	34.05
35-39301-1	IF	8.80	25.25	34.05
35-39302-1	IF	8.80	25.25	34.05
35-39303-1	IF	8.80	25.25	34.05
35-39600-1	Sound	8.00	22.95	30.95
35-39601-1	Sound	8.00	22.95	30.95
35-39602-1	Sound	8.00	22.95	30.95
35-39650-1	Chroma	8.00	22.95	30.95
35-39750-1	Deflection	8.00	22.95	30.95
35-40850-1	Deflection	11.20	32.15	43.35
35-41200-1	Chroma	8.00	22.95	30.95
35-41201-1	Chroma	8.00	22.95	30.95
35-41202-1	Chroma	8.00	22.95	30.95
35-42350-1	IF	8.80	25.25	34.05
35-42351-1	IF	8.80	25.25	34.05
35-42500-1	Chroma	8.00	25.25	33.25
35-42501-1	Chroma	8.00	25.25	33.25
35-42550-1	Color/Video	8.00	25.25	33.25
35-42600-1	Deflection	8.00	22.95	30.95
35-42601-1	Deflection	8.00	22.95	30.95
35-42602-1	Deflection	8.00	22.95	30.95
35-42850-1	Power Supply	7.20	21.80	29.00
35-42851-1	Power Supply	7.20	21.80	29.00
35-42852-1	Power Supply	7.20	21.80	29.00
35-42853-1	Power Supply	7.20	21.80	29.00
35-42950-1	Deflection	8.00	22.95	30.95
35-42951-1	Deflection	11.20	32.15	43.35
35-42952-1	Deflection	11.20	32.15	43.35
35-45200-1	IF	8.80	25.25	34.05
35-45201-1	IF	8.80	25.25	34.05
35-45250-1	IF	8.80	25.25	34.05
35-45251-1	IF	8.80	25.25	34.05
35-45450-1	IF/Audio/Video	11.20	32.15	43.35
35-45550-1	IF/Audio/Video	11.20	32.15	43.35
35-45601-1	Color/Video	8.80	25.25	34.05
35-45602-1	Color/Video	8.80	25.25	34.05
35-45650-1	Vert./Horz.	11.20	32.15	43.35
35-45651-1	Vert./Horz.	11.20	32.15	43.35
35-45652-1	Vert./Horz.	11.20	32.15	43.35
35-45653-1	Vert./Horz.	11.20	32.15	43.35
35-45654-1	Vert./Horz.	11.20	32.15	43.35
35-45655-1	Vert./Horz.	11.20	32.15	43.35
35-45656-1	Vert./Horz.	11.20	32.15	43.35
35-45657-1	Vert./Horz.	11.20	32.15	43.35
35-45658-1	Vert./Horz.	11.20	32.15	43.35
35-45700-1	Pwr. Sply.	5.20	14.90	20.10
35-45701-1	Pwr. Sply.	5.20	14.90	20.10
35-45702-1	Pwr. Sply.	5.20	14.90	20.10
35-46500-1	Color/Video	8.00	25.25	33.25
35-46501-1	Color/Video	8.00	25.25	33.25
35-46502-1	Color/Video	8.00	25.25	33.25
35-46550-1	IF	*	25.25	34.05
35-46600-1	Chroma	8.00	25.25	33.25
35-46601-1	Chroma	8.00	25.25	33.25
35-46602-1	Chroma	8.00	25.25	33.25
35-46750-1	Sound	8.00	22.95	30.95
35-46751-1	Sound	8.00	22.95	30.95
35-46850-1	Vert./Horz.	11.20	32.15	43.35
35-46852-1	Vert./Horz.	11.20	32.15	43.35
35-46853-1	Vert./Horz.	11.20	32.15	43.35
35-46854-1	Vert./Horz.	11.20	32.15	43.35
35-46856-1	Vert./Horz.	11.20	32.15	43.35
35-47500-1	Color/Video	8.00	25.25	33.25
35-47501-1	Color/Video	8.00	25.25	33.25
35-47550-1	Deflection	8.00	22.95	30.95
35-47551-1	Deflection	11.20	32.15	43.35
35-48350-1	Color/Video	8.00	25.25	33.25
35-48500-1	Deflection	8.00	22.95	30.95
35-48550-1	IF	8.80	25.25	34.05
35-48551-1	IF	8.80	25.25	34.05
35-48600-1	Pwr. Sply.	7.20	21.80	29.00
35-49153-1	Color/Video	8.00	25.25	33.25
35-49157-1	Color/Video	8.80	25.25	33.25
35-49250-1	Pwr. Sply.	5.20	14.90	20.10
35-49251-1	Pwr. Sply.	5.20	14.90	20.10
35-49252-1	Pwr. Sply.	5.20	14.90	20.10
35-49253-1	Pwr. Sply.	5.20	14.90	20.10
35-49257-1	Pwr. Sply.	5.20	14.90	20.10
35-49300-1	Color/Video	8.80	25.25	34.05
35-49350-1	Color/Video	8.80	25.25	34.05
35-49353-1	Color/Video	8.80	25.25	34.05
35-49355-1	Color/Video	8.80	25.25	34.05
35-49357-1	Color/Video	8.80	25.25	34.05
35-49450-1	Pwr. Sply.	7.20	21.80	29.00
35-49451-1	Pwr. Sply.	7.20	21.80	29.00
35-49455-1	Color/Video	8.80	25.25	34.05
35-49501-1	Deflection	8.00	22.95	30.95
35-50351-1	IF/Audio/Video	11.20	32.15	43.35
35-50352-1	IF/Audio/Video	11.20	32.15	43.35
35-50353-1	IF/Audio/Video	11.20	32.15	43.35
35-50500-1	Pin Cushion	*	14.90	20.10
35-50850-1	Vert./Horz.	11.20	32.15	43.35
35-51200-1	IF	8.80	25.25	34.05
35-51201-1	IF	8.80	25.25	34.05
35-51301-1	CRT Driver	5.20	14.90	20.10
35-51350-1	CRT Driver	5.20	14.90	20.10
35-51400-1	IF/Audio/Video	11.20	32.15	43.35
35-51401-1	IF/Audio/Video	11.20	32.15	43.35
35-51402-1	IF/Audio/Video	11.20	32.15	43.35
35-51403-1	IF/Audio/Video	11.20	32.15	43.35
35-51550-1	Color/Video	8.80	25.25	34.05
35-51552-1	Color/Video	8.80	25.25	34.05
35-51553-1	Color/Video	8.80	25.25	34.05
35-51554-1	Color/Video	8.80	25.25	34.05
35-51601-1	Vert./Horz.	11.20	32.15	43.35
35-51603-1	Vert./Horz.	11.20	32.15	43.35
35-51604-1	Vert./Horz.	11.20	32.15	43.35
35-51650-1	Pwr. Sply.	5.20	14.90	20.10
35-51651-1	Pwr. Sply.	5.20	14.90	20.10
35-51652-1	Pwr. Sply.	5.20	14.90	20.10
35-51800-1	Color/Video	8.80	25.25	34.05
35-51802-1	Color/Video	8.80	25.25	34.05
35-51803-1	Color/Video	8.80	25.25	34.05
35-51804-1	Color/Video	8.80	25.25	34.05
35-51850-1	Vert./Horz.	11.20	32.15	43.35
35-51851-1	Vert./Horz.	11.20	32.15	43.35
35-55200-1	Vert./Horz.	11.20	32.15	43.35
35-56751-1	Vert./Horz.	11.20	32.15	43.35
35-57050-1	Vert./Horz.	11.20	32.15	43.35
35-57950-1	Vert./Horz.	*	32.15	43.35
35-58401-1	Color/Video	8.80	25.25	34.05

Sylvania

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
32-35994-3,5,6	IF	18.00	26.40	44.40
32-35996-2,3	Chroma	18.00	26.40	44.40
32-37505-2,4	Deflection	18.00	26.40	44.40
32-37505-3	Deflection	*	26.40	44.40
32-39202-3	Chroma	18.00	26.40	44.40
32-39213-2,4	Deflection	18.00	26.40	44.40
32-39221-4	IF	18.00	26.40	44.40
32-39221-5	IF	18.00	26.40	44.40
32-39758-6	Remote Rec.	18.00	26.40	44.40
32-41658-3	Deflection	18.00	26.40	44.40
32-41662-4	Interface	6.00	11.45	17.45
32-41836-2	Chroma	18.00	26.40	44.40
32-41838-2	Chroma	18.00	26.40	44.40
32-43059-1	Interface	6.00	11.45	17.45
32-43062-3	IF	18.00	26.40	44.40
32-43068-1,3	Chroma	18.00	26.40	44.40
32-43974-1	Deflection	18.00	26.40	44.40
32-43977-1	V.I.R.	18.00	26.40	44.40
32-45066-1	IF	18.00	26.40	44.40

Sylvania Remote Transmitters

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
RC 5	Remote Trans.	9.00	19.95	28.95
RC 9	Remote Trans.	9.00	19.95	28.95
RC 11	Remote Trans.	9.00	19.95	28.95
RC 13	Remote Trans.	9.00	19.95	28.95
RC 14	Remote Trans.	9.00	19.95	28.95
RC 15	Remote Trans.	9.00	19.95	28.95
RC 16	Remote Trans.	9.00	19.95	28.95
RC 17	Remote Trans.	9.00	19.95	28.95
RC 19	Remote Trans.	9.00	19.95	28.95

Wells-Gardner

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
P-154	Pix/Sound	5.00	26.95	31.95
P-155	Chroma	5.00	23.95	28.95
P-156	Deflection	7.60	21.80	29.40
P-157	H.V.	13.60	51.70	65.30
P-158	Power Supply	2.40	6.85	9.25
P-169	Chroma	7.60	21.80	29.40
P-176	Pix/Sound	7.60	21.80	29.40
P-177	Deflection	7.60	21.80	29.40
P-180	Pix/Sound	7.60	24.95	32.55
P-181	Chroma	7.60	25.95	33.55
P-182	Deflection	7.60	21.80	29.40
P-183	H.V.	13.60	51.70	65.30
P-200	Pix/Sound	8.00	22.95	30.95
P-201	Chroma	7.20	21.80	29.00
P-202	Deflection	7.20	21.80	29.00
P-203	H.V.	13.60	51.70	65.30
P-206	AFT	3.00	9.95	12.95
P-211	H.V.	13.60	51.70	65.30
P-236	Pix/Sound	7.60	25.95	33.55
P-241	Deflection	7.60	21.80	29.40

Zenith

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
9-26	Chroma Amp.	4.00	12.60	16.60
9-27	Sub-Carrier	9.00	12.60	21.60
9-27X	Sub-Carrier	9.00	12.60	21.60
9-37	Chroma	11.00	12.60	23.60
9-47	Chroma Amp.	4.00	12.60	16.60
9-48	Video	3.60	9.15	12.75
9-49	Chroma	5.40	11.45	16.85
9-57	Horz.	4.60	10.30	14.90
9-70	Horz.	4.60	10.30	14.90
9-76	Sync./AGC	3.20	9.15	12.35
9-78	Vert. Osc./Driver	*	9.15	12.35
9-79	Varactor Cont.	*	11.45	17.65
9-82	Chroma	3.20	9.15	12.35
9-83	Vert.	5.00	6.85	11.85
9-86	Chroma	*	11.45	19.35
9-86-01	Chroma	12.00	12.60	24.60
9-86-02	Chroma	*	12.60	22.60
9-87	Video	*	9.15	12.95
9-87-01	Video	*	9.15	12.95
9-88	Luminance	2.80	8.00	10.80
9-88-01	Luminance	2.80	8.00	10.80
9-88-02	Luminance	2.80	8.00	10.80
9-88-03	Luminance	*	10.30	14.70
9-88-06	Luminance	4.40	10.30	14.70
9-89A,B,C,D,E,F	Video	4.40	12.60	17.00
9-89-01	Video	4.40	12.60	17.00
9-90	Horz.	*	8.00	12.80
9-90-01	Horz.	4.00	11.45	15.45
9-90-02	Horz.	*	11.45	16.45
9-91	Video	3.60	9.15	12.75
9-92	Vert.	*	12.60	22.40
9-92B	Vert.	*	12.60	22.40
9-92C	Vert.	*	12.60	22.40
9-94	Horz./Vert.	*	8.95	13.95
9-95	Video Out/AGC	1.00	8.95	9.95
9-97	Chroma	11.00	12.60	23.60
9-100	Horz./Vert.	5.00	8.95	13.95
9-101	Video Out/AGC	1.00	8.95	9.95
9-103	Audio	*	11.45	15.45
9-103-01	Audio	4.00	11.45	15.45
9-103-02	Audio	4.00	11.45	15.45

*Dud Modules presently with no purchase value.

MODULE PROGRAM/POLICIES AND DEFINITIONS

DUD VALUE

This is the amount that PTS will pay for the purchase of dud modules, except broken modules and modules missing parts. In addition, PTS may refuse to purchase some types of modules when there is an adequate stock and/or when a module is of type that cannot be rebuilt. PTS will not be reponsible for the return of any modules received that are not on the price list.
*Dud Modules presently with no purchase value.

REBUILDING/EXCHANGE PRICE

The rebuilding/exchange price includes all parts and labor involved in the rebuilding of a module (except for broken and/or missing parts), and each module carries a one-year limited warranty. (Prices may vary in some parts of the country.)

OUTRIGHT PURCHASE PRICE

This is the purchase price for modules where there is no exchange involved. Purchases such as this are entirely dependent on the stock available at the time an order is received at our Bloomington, Indiana Module Rebuilding Center. By written request, you may wish to make a standing order for modules currently not available: such orders will be filled as these modules become available. (Prices may vary in some parts of the country.)

Zenith

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
9-103-03	Audio	4.00	11.45	15.45
9-103-04	Audio	*	11.45	15.45
9-107	Audio	4.00	11.45	15.45
9-107-01	Audio	4.00	11.45	15.45
9-115	Horz./Vert.	5.00	8.95	13.95
9-120	Vert.	6.00	14.90	20.90
9-120-01	Vert.	6.00	14.90	20.90
9-121-01	Video	*	17.20	23.20
9-122-02	Pwr. Sply.	6.60	6.85	13.45
9-122-04	Pwr. Sply.	2.40	6.85	9.25
9-123	Pwr. Sply.	*	6.85	9.25
9-123-01	Pwr. Sply.	*	6.85	9.25
9-126-01	Zoom	4.70	12.60	17.30
9-147	Vert.	*	12.60	23.60
9-151	U/V Tuner/IF	10.00	26.95	36.95
9-151-01	U/V Tuner/IF	10.00	26.95	36.95
9-152	Vert./Chroma	8.00	22.95	30.95
9-153	Pwr. Sply./Horz.	10.00	24.95	34.95
9-154	L.V./Pwr. Sply.	6.00	13.95	19.95
9-155	Video	4.00	10.95	14.95
9-157	Secondary Controls	6.25	5.95	12.20
9-157-01	Secondary Controls	6.25	6.95	13.20
9-159	Zoom	7.00	10.95	17.95
130-9	Remote Rec.	*	16.95	22.95
150-3	AFC	*	5.95	11.00
150-4	AFC	*	5.95	11.00
150-6	AFC	*	5.95	11.00
150-12	IF	5.00	14.90	19.90
150-14	IF	5.00	14.90	19.90
150-17	IF	5.00	14.90	19.90
150-18	IF	5.00	14.90	19.90
150-20	IF	5.00	14.90	19.90
150-22	IF	*	14.90	19.90
150-28	IF	5.00	14.90	19.90
150-31	IF	5.00	14.90	19.90
150-32	IF	5.00	14.90	19.90
150-37	IF	5.00	14.90	19.90
150-39	IF	*	14.90	19.90
150-41	IF	*	14.90	19.90
150-103	IF	5.00	14.90	19.90
150-104	IF	12.40	14.90	27.30
150-106	IF	12.40	14.90	27.30
150-108	IF	12.40	14.90	27.30
150-110	IF	5.00	14.90	19.90
150-112	IF	12.40	14.90	27.30
150-114	IF	5.00	14.90	19.90
150-115	IF	5.00	14.90	19.90
150-116	IF	5.00	14.90	19.90
150-152	IF	5.00	14.90	19.90
150-156	IF	5.00	14.90	19.90
150-158	IF	5.00	14.90	19.90
150-160	IF	5.00	14.90	19.90
150-162	IF	12.40	14.90	27.30
150-164	IF	12.40	14.90	27.30
150-166	IF	12.40	14.90	27.30
150-170	IF	5.00	14.90	19.90
150-176	IF	5.00	14.90	19.90
150-180	IF	5.00	14.90	19.90
150-182	IF	5.00	14.90	19.90
150-184	Video/IF	5.00	14.90	19.90
150-186	Video/IF	5.00	14.90	19.90
150-188	IF	5.00	14.90	19.90
150-190	Video/IF	*	14.90	19.90

*Dud Modules presently with no purchase value.

Zenith

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
150-191	Video/IF	5.00	14.90	19.90
150-201	Sound	3.20	9.15	12.35
150-204	Sound	3.20	9.15	12.35
150-206A	Sound	3.20	9.15	12.35
150-208	Sound	3.20	9.15	12.35
150-208X	Sound	3.20	9.15	12.35
150-211	Sound	*	9.15	12.35
150-214	Sound	*	9.15	12.35
150-215	Sound	3.20	9.15	12.35
150-217	Sound	3.20	9.15	12.35
150-219	Sound	3.20	9.15	12.35
Zenith Remote Transmitters				
S68933	Remote Trans.	9.00	19.95	28.95
S68936	Remote Trans.	9.00	19.95	28.95
S69843	Remote Trans.	9.00	19.95	28.95
S83596	Remote Trans.	9.00	19.95	28.95
S86500	Remote Trans.	9.00	19.95	28.95
S87861	Remote Trans.	9.00	19.95	28.95
S92968	Remote Trans.	9.00	19.95	28.95
S93255	Remote Trans.	9.00	19.95	28.95
S94463	Remote Trans.	9.00	19.95	28.95
S94828	Remote Trans.	9.00	19.95	28.95
S98663	Remote Trans.	9.00	19.95	28.95

Packard Bell, Miscellaneous, Remote Transmitters

Packard Bell (The below listed modules only)

Module Number	Description	Dud Value	Dealer Exchange Price	Dealer Outright Price
RPM-1	High Voltage	8.00	44.80	52.80
DFM-1	Horz./Vert.	5.20	26.40	31.60
CRM-1	Color	5.20	26.40	31.60
AUM-1	Audio	3.20	11.45	14.65
VIM-1	Video	5.20	25.25	30.45
IFM-1	I.F.	5.20	26.40	31.60
Miscellaneous				
Advent	I.F. used in Projection unit	5.20	15.10	20.30
Sanyo	IF/VHF combo	11.00	28.15	39.15
Sanyo	I.F. only	7.50	17.20	24.70
Truetone	IF/VHF combo	11.00	28.15	39.15
Truetone	I.F. only	7.50	17.20	24.70

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Welcome to Westfield!

A new address and newfound room: that's the news from Westfield!

PTS-Springfield turned into PTS-Westfield last fall when the servicenter and regional offices incorporated and moved into a new and larger facility at 800 Union St.

PTS supervised construction of the facility to insure ample space to house the large inventory and to accommodate current and future repair/rebuilding services.

Available services include tuner repair, rebuilt module exchange, tuners and tuner parts, accessories and a complete line of test instruments.

Westfield also serves as one of four primary rebuilding centers for PTS' new service—CATV converter and MATV amplifier repair.

Murl Reeves, regional vice president and servicenter manager, has logged 16 years in the industry, including experience with RCA. He opened the Springfield branch for PTS. Wife Phyllis assists with the branch's bookkeeping and correspondence.

The sky's the limit!

Anyone who thinks corporate planes are reserved for Blue Chip companies should take a look in the PTS hangar.

The blue, gold and white Cessna 310II housed there is proof positive that corporate planes are becoming more and more important to "onward and upward" companies like PTS. Especially PTS—since the plane is also used for their associate companies D & M Tool Corporation and ATR Coil Company.

The six-seater, twin engine, turbo-charged Cessna has logged about 22,000 air miles since its purchase in April.

It gives PTS executives travel flexibility, time savings, allows them to keep in touch with

Pilots King, Nobis and Murphy

PTS' 42 servicenters located nationwide, fills the service gap caused by ground miles, plays a major role in the three companies' sales and marketing efforts and is also responsible for keeping executives abreast of new ideas and methods by allowing easy attendance at seminars and conclaves.

It is an important link with customers, enabling PTS to expeditiously respond to inquiries, public relations and negotiations. The Cessna has a cruising speed of 190 knots (220 mph) and a range of about 1,400 miles. Its special equipment includes weather radar, flight director, area navigation, and is a big step up from the first PTS plane, a Beech Bonanza. The Cessna affords more room, the added safety factor of a second engine and a speed increase of some 46 mph.

And piloting? No problem! PTS has three licensed individuals—president Roland Nobis, vice president Dick King and Ray Murphy, manager of manufacturing.

PTS' Cessna. One company's solution to service cutbacks by commercial airlines, slower highway speeds, scattered operations and the commitment to constantly expand to new horizons.

'The replacement module vs. repair-it-yourself dilemma'

by Dick King, Jack Craig and Phil Collier
PTS Electronics, Inc.

It happens every day.

The phone rings. It's a frantic customer. The set's on the blink. The preliminary diagnosis: defective module. The dilemma: do you repair it yourself or replace it?

In today's rapidly changing service industry, service dealer/technicians must continually look for new ways to increase their profits in order to stay in business. Here are two ways to increase your profits. The first is improving your productivity; the second is reducing your inventory costs.

We know that time is money! It is important to stay as productive as possible and reduce diagnostic time spent on each repair job. With today's great number of module sets in the field, you need to take advantage of the serviceability feature for which they were designed.

Consider the fact that a technician can spend considerable time just locating the defective component when he could have replaced the module and completed the repair in much less time. This also could prove to be a very costly mistake in replacement parts as well as labor. Many replacement transistors and IC's cost as much as or more than an exchange module.

Subsequently, there are two important questions that come to mind when the repair involves an intermittent failure: did the component you replaced really cure the condition or will you have to make a costly call-back for the same problem? Using a rebuilt module eliminates the possibility of using an incorrect parts substitution, the need of finding exact replacement parts, and will substantially reduce call-backs.

This is where replacement modules and, more specifically, PTS rebuilt modules, can be profitable for you.

Let's look at some of the advantages of using PTS rebuilt modules rather than repairing your own modules. Since we pioneered module rebuilding and grew to be the largest independent module rebuilder, we have acquired years of module diagnostic experience, component failure histories, and rebuilding techniques. We use components that are equivalent to or better than the originals—proven from experience to be of higher quality and reliability. The component failure history provides us with a detailed list of parts most likely to fail. We utilize this information as part of an ongoing module updating and preventative maintenance program, automatically replacing potentially defective components to insure extended life, reliability, and performance of our rebuilt modules to equal or even exceed that of a new one.

In addition, all modules are cleaned in a specially developed solution to remove dirt and dust and to clean the contacts. Also, compare the warranty. Your repaired module may or may **not** have a warranty on the component replaced. A PTS rebuilt module has a one-year limited warranty on the entire module board.

An extensive module inventory is available through all of PTS' 42 servicenters and stocking distributors throughout the United States. This availability at a local level will minimize your repair parts inventory, thus reducing your cost of doing business.

While we must admit that there are times when a minor module repair would seem justifiable, more often replacement of the defective module is more profitable in the long run. PTS rebuilt modules can indeed save you time and money—and increase your overall profitability.

New faces, new places

Meet Tony. Tony McIntosh was appointed technical director/quality control and design in May. With PTS at Bloomington for two years, Tony has a solid background and proficiency in tuner and CATV/MATV rebuilding. He is a graduate of United Electronics Institute. Wife Diane is employed as a computer operator in the shipping department.

Meet Jerry. Jerry Best became PTS' first in-house accountant in June when he accepted the post of controller/accountant. An Indiana University graduate with a business major in accounting, Jerry passed his CPA exam in 1972 and was certified in 1974. He will supervise accounting for PTS, affiliated companies and all servicenter locations as well as handle corporate taxes. His family includes wife Judy and two children.

Meet Jeff. Jeff Hamilton was named new regional sales manager in June. Jeff's duties include general line, MRO and industrial distributor sales in the midwest. He will also assist with policy and program decision making in the marketing department. Jeff earned his bachelor's degree in marketing from Indiana University and has solid management experience.

New service! A new service is now available at PTS-Metairie. Pick up and delivery service is being provided within a 15-mile radius of the servicenter, including greater New Orleans. The new service is good for all PTS services and is made for a nominal charge.

New location for Atlanta customers. PTS-Atlanta closed its Georgia-based servicenter last February and relocated its services in Charleston, S.C. The new address is 1736 Savannah Hwy. 17, P.O. Box 30511, Charleston, S.C., 29407, (803) 571-7651.

Meet Dave. John David Tucker assumed duties of general manager at PTS-St. Louis in May in a reorganization of the servicenter. With PTS at Bloomington for two years, Dave has a strong background in electronics and business administration. He reorganized the shop to provide same-day service and put emphasis on customer needs. The branch is located at 8456 Page Blvd., (314) 428-1299.

Meet Doug. The new man at PTS-Davenport is Douglas Arthur, who was named general manager in June. With PTS for almost two years, Doug was previously a technician at the Omaha servicenter. He holds an electrical engineering degree. The servicenter is located at 2024 E. River Dr., (319) 323-3975.

Servicenter Locations

MIDWEST

Home office
BLOOMINGTON, IN 47401
5233 S. Hwy. 37, P.O. 272
812-824-9331

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5682 State Road
216-845-4480

KANSAS CITY, KS 66106
3119A Merriam Lane, P.O. 6149
913-831-1222

MINNEAPOLIS, MN 55408
815 W. Lake St., P.O. 8458
612-824-2333

ST. LOUIS, MO 63130
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314-428-1299

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313-862-1783

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P.O. 1435
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CINCINNATI, OH 45216
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513-821-2298

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7211 Fond du Lac
414-464-0789

COLUMBUS, OH 43227
4005A E. Livingston
614-237-3820

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317-631-1551

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319-323-3975

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402-571-4800

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P.O. 30511
803-571-7651

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904-389-9952

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301-565-0025

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704-332-8007

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205-323-2657

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3614 Lamar Ave., P.O. 18053
901-365-1918

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3118 E. Princess Anne Rd.
804-625-2030

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504-837-7569

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813-839-5521

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213-634-0111

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5220 N.E. Sandy Blvd.
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503-282-9636

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215-352-6609

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257 Riverview Ave. W., P.O. 4130
412-761-7648

ELMWOOD PARK, NJ 07407
158 Market St., P.O. 421
201-791-6380

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214-753-4334

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4509 N.W. 10th, P.O. 74917
405-947-2013

HOUSTON, TX 77207
4326 Telephone Rd., P.O. 26616
713-644-6793

Farewell to a friend. All of us at PTS will miss Ralph Everman, who died recently. Ralph had served as the company's accountant since the beginning.

The New Profit-Makers from PTS!

PTS MSP-501 Regulated Microprocessor Power Supply

This state-of-the-art regulated 5VDC/5A power supply is designed to meet the power supply requirements of most microprocessors with excellent load, line voltage variation and transient regulations. The supply is preset to 5VDC and includes front panel screwdriver adjustment, 4.5V to 6.0VDC. **$99.95** User Net.

Features

Continuous up to 5 amp. output.
New hybrid regulator and output circuitry for high reliability.
Noise and ripple: less than 10 mv.
Short-circuit current limiting.
Power line variation and transient protection.
Adjustment: front panel screwdriver voltage adjustment, 4.5 VDC-6.0 VDC.
Six-month limited warranty.

PTS DG-2 Regulated Digital Power Supply Digital Voltmeter

High-current power supply with up to 5 amp. regulated output over entire 0 to 25 VDC range with polarity switch. Ideal for servicing and/or operating automotive electronic equipment, televisions, stereos, radios, microprocessors, telephone equipment, electronic cash registers, security systems, video recorders and other electronic devices. Exceptionally reliable, stable and efficient operation. Digital ± 200 VDC voltmeter for monitoring the internal supply voltage or an external voltage. **$195.95** User Net.

Features

Hybrid regulator and output circuitry for reliable, efficient operation.
Noise and ripple: less than 10 mv.
Load regulation: 0-5 Amp, 100 mv typical.
Polarity switch: +0 to +25 volts and -0 to -25 volts.
Digital voltmeter: ± 200 VDC accurate to .05%; indicates polarity.
Meter selection switch: Power supply output voltage or external voltage monitoring.
Voltage range switch: 0-15 VDC and 15-25 VDC
Vinyl black cabinet.
Six-month limited warranty.

PTS DG-5 Regulated Voltage Control Center/Digital Voltmeter

High-current features of the DG-2 plus it independently produces three additional variable low current DC voltages. Excellent for multiple voltage requirements such as all critical control voltages for TV electronic/varactor tuners. Digital ± 200 VDC voltmeter can be selected to monitor any of the four output voltages or an external voltage. Polarity switches for all four supplies are provided. **$269.95** User Net.

Features

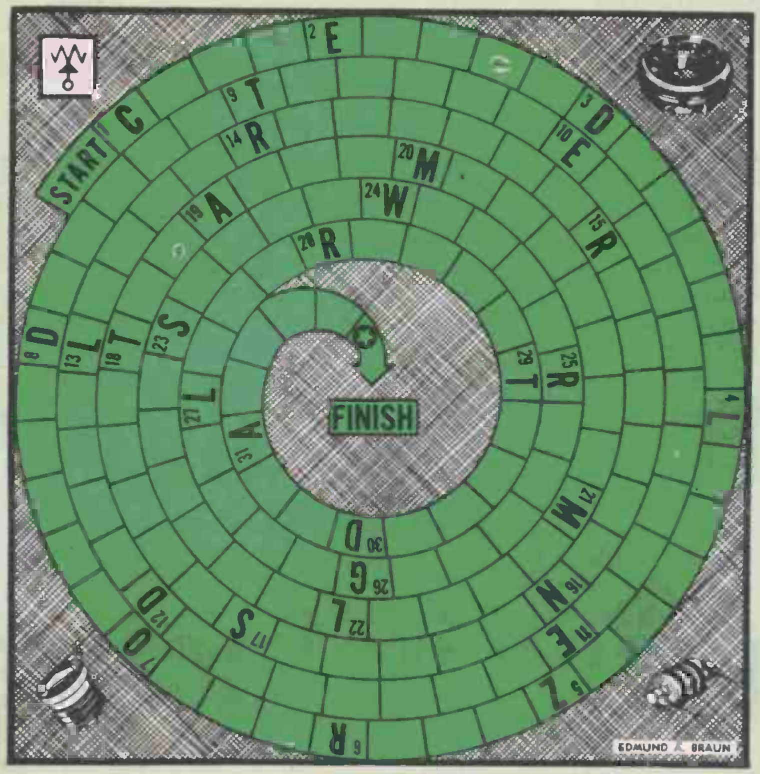
Voltage supplies:
- **Bias:** 0-15 VDC/50 ma low-current supply. Polarity switch.
- **Switching:** 0-20 VDC/100 ma supply. Polarity switch.
- **Supply:** 0-30 VDC/200 ma supply. Polarity switch.
- **Power:** 0-25 VDC/5 amp supply. Polarity switch.

Voltage range switch: 0-15 VDC and 15-25 VDC.
Digital voltmeter: ± 200 VDC accurate to .05%. Indicates polarity.
Five position meter selection switch: Monitors any of the four output voltages or an external voltage.
Six-month limited warranty.

PTS ELECTRONICS, INC.
The Only Name You Need To Know
P.O. BOX 272, BLOOMINGTON, IN 47402

Give this a Whirl!

by Edmund A. Braun



We know you're interested in electronics, but do you enjoy puzzles? Then you'll have fun solving this Pinwheel Puzzle because it's based on electronic terminology. The last letter of each word is the first letter of the next word. Each correct answer is worth 4 points; a perfect score is 124. It should be fairly easy to get a passing grade except perhaps for someone who is sure "annealing" is the posture for praying; or that "genemotors" is an automobile manufacturer! Pencil sharp? Comfortable? Then, GO!

1 Unit for strength of radioactive sources in term of number of disintegrations per second in the source.
2 To spread out part or all of the trace of a cathode-ray display.
3 Pertaining to the class of devices or circuits in which the output varies in discrete steps.
4 Pertaining to the force exerted by an electric field and a magnetic field on a moving electric charge.
5 Pertaining to a breakdown caused in a semiconductor device by field emission of charge carriers in the depletion layer.
6 Fixed relationship in degrees or numbers between two similar things.
7 The CGS unit of magnetic intensity.
8 Device using gas or liquid to retard the moving parts of a circuit breaker, etc.
9 Silicone-carbide ceramic material.
10 A substance in which the conduction of electricity is accompanied by chemical action.
11 Lengthened or stretched out.
12 Measure of sharpness of a recorded facsimile copy or reproduced image.
13 Having an output that varies in direct proportion to the input.
14 The accurate matching of two or more patterns such as the 3 images in color TV.
15 A hot-cathode gas-filled diode that operates at a high pressure.
16 The core of an atom.
17 Pertaining to a pole used in field system of a generator or motor.
18 Prefix for the numerical quantity of 10^{12}. Abbreviated T.
19 Centimeter-gram-second electromagnetic unit of resistance.
20 Compounds of this metal are sometimes used for cathodes.
21 Hand operated; not automatic.
22 Emitting light; glowing.
23 Darkened area caused by a body intercepting light rays.
24 Speaker designed to reproduce bass frequencies.
25 Producing an audible or visible signal at a station or switchboard.
26 In mathematics, the figure 1 followed by 100 zeros.
27 Type of direction finder.
28 Ears used as an indoor antenna.
29 Group of four, especially a group of 4 pulses to express a digit in the scale of 10 or 16.
30 General term to denote any or all facts; numbers, letters, and other information.
31 In an antenna, a group of elements arranged to provide desired directional characteristics.

The solution is on page 53.

Testing solid-state devices in factory gear

By Wayne Lemons

When taking care of industrial electronic equipment, the name of the tune is "Get the unit back on-line—fast!" Successful maintenance technicians develop as many shortcuts as possible. Sometimes you remember which part most frequently causes a particular symptom; or the manufacturer's manual may have suggestions. Other times, you exchange a spare subassembly for the defective one. But, if the symptoms are unfamiliar, or there is no spare, you're on your own.

Pretty soon (you hope) you have isolated the trouble to one specific area in the complex system. All that remains is a circuitful of parts to be tested, to identify the culprit as quickly as possible.

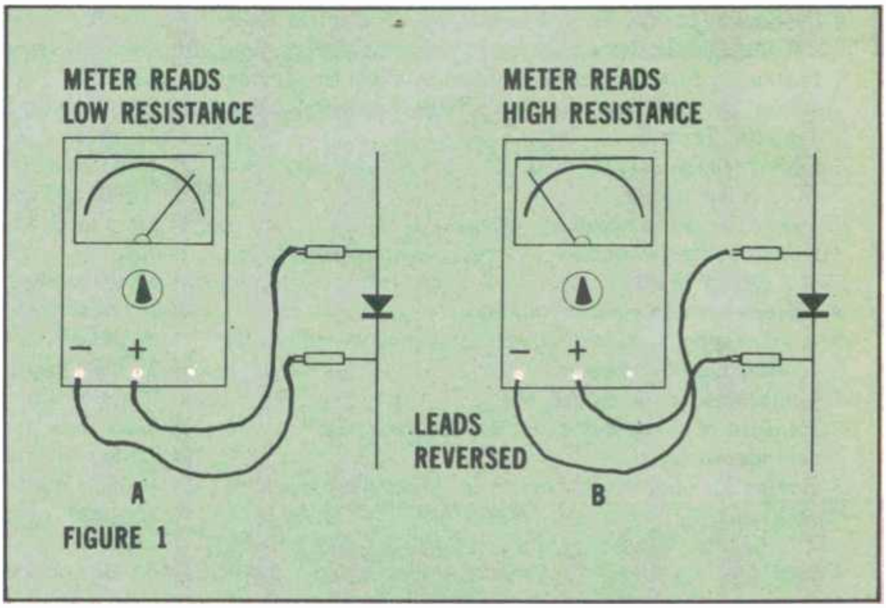


Figure 1 "Diode action" means an ohmmeter shows low forward resistance and high reverse or backward resistance.

Many parts in today's factory controls are solid-state. And even long-experienced technicians occasionally butt up against a time problem when testing solid-state devices. Here are some reminders (nuts-and-bolts ways of testing) in-circuit whenever possible, and with simple equipment. They should help.

Diodes

The most common solid-state component of all is the silicon diode. This simple device forms a one-way street for current, allowing it to flow in one direction but not the other. Diodes appear as rectifiers, as guides for direct current or voltage, as pulse rectifiers and clippers, for bias compensation, as circuit protectors, for blocking reverse current, to suppress arcs and inductive kicks, and in other uses.

With a diode out of the circuit, you can easily check it with a regular ohmmeter, in the manner of Figure 1. This test should exhibit *diode action*, that is, low resistance (20 Ω or so) in one direction and high resistance (more than 1M Ω) in the opposite.

Exact resistances depend on the type of meter and ohmmeter range used to take the measurement. For example, a diode that reads about 20 Ω on the Rx1 scale may indicate 100 Ω or more on Rx10, and as much as 1000 Ω on Rx100. Any diode with a forward reading more than 50 Ω on Rx1 is probably made of silicon rather than germanium.

An ohmmeter cannot reveal that a diode's junction may break down under operating voltage. Nor can it distinguish a regular diode from a fast-recovery type, or a Zener. Still, within limits, ohmmeter checking is valid, quick and extremely convenient.

In-circuit diode tests

Testing diodes in-circuit, even with an ohmmeter, has two advantages over out-of-circuit tests. First, you know (unless someone earlier made an incorrect replacement) that the diode is the right one, and second, that it is connected in the right direction. In other words, you don't have to worry that the diode is, for example, a Zener when it should be a regular diode, or a slow-recovery type when it should be fast.

Diodes, especially silicon diodes in rectifier or other high-current use, normally go bad in one of just two ways. They short, about 85% of the time, or open the other 15%. This makes in-circuit checks with an ohmmeter valid just about always.

First you connect the ohmmeter leads across the diode. A low reading one way and a high reading the other (diode action) tells you the diode is okay. You can move on to the next part. Of course the higher reading may not be over a megohm. There may be shunt resistances in the circuit. You need to be sure only that there is a *difference* between the readings.

If, on the other hand, the diode measures less than 5 Ω or so, in *either* direction, it is suspect immediately. The reason? Only a shorted diode, or one with a really low-resistance shunt, measures less than 10 to 15 Ω on a regular ohmmeter.

Moreover, there are not many circuits in which shunt resistance across a diode is less than 20Ω. In Figure 2, for example, a diode is used to damp out inductive kick from the relay. The coil measures several hundred Ω dc. So you still find *diode action* across the diode. If the coil is 500Ω, the ohmmeter reads 500 Ω in one direction and only the forward resistance of the diode, perhaps about 20 Ω or so, when the leads are reversed. That 25-to-1 ratio certainly indicates normal diode action.

Misleading in-circuit readings

An open diode in either a full-wave or bridge rectifier stage may not be missed. This is because another diode is always in parallel with any open diode, through the secondary winding. If transformer winding resistance is low, the slight discrepancy in measured forward resistance might not be considered significant.

For this reason, if two bridge-rectifier diodes exhibit a few ohms difference in forward reading, it is a good idea to check further.

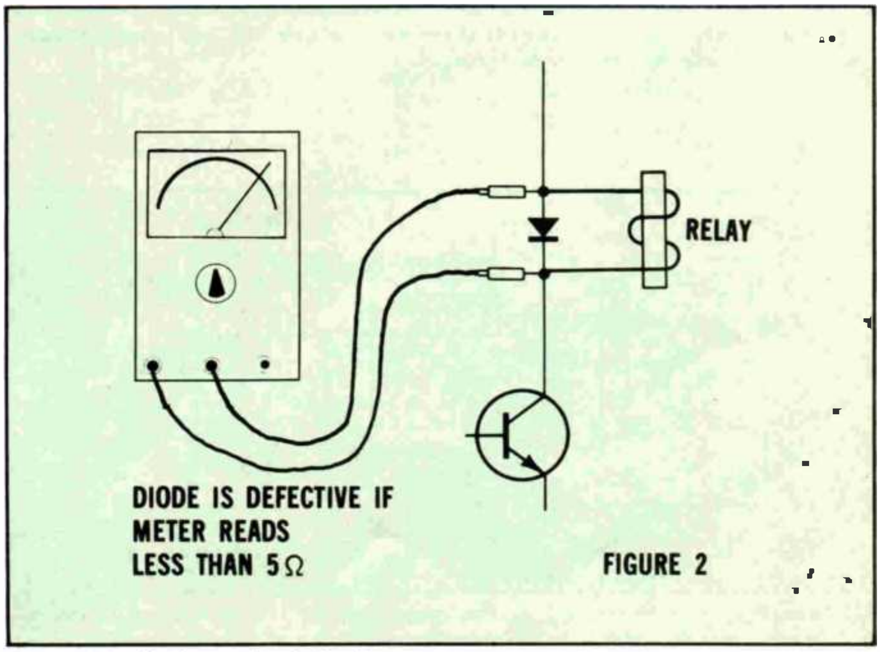


Figure 2 A diode can be judged even when shunted by a coil. Less than 5 Ω both ways means it's shorted.

Disconnect one lead of one diode and test across both diodes again.

An open diode like this often has little effect on the dc output of a full-wave rectifier circuit. In fact, the equipment being supplied power may seem to work normally. Other times it works marginally, making you sense vaguely that something is not up to par, but leaves you not quite sure what it is.

The open diode may change the operation to half-wave, thus cutting ripple frequency in half. But when filtering is ample, this too may go unnoticed. In bridge or full-wave circuits used for other than power supply, an open diode usually brings immediate circuit malfunction.

Leakage

It is rare for leakage in high-current diodes to cause trouble. When leakage does occur, heat inside the diode generally causes it to short or open almost immediately. In low-current and pulse circuits, however, leakage may cause either steady or intermittent troubles. Dependable in-circuit testing for leakage is not possible when there is an inductive, resistive, or forward-conducting solid-state path in parallel with the diode.

Even with the diode out of the circuit, leakage may fail to show up during an ohmmeter test. Sometimes, leakage is avalanche-type, occurring only at some definite reverse voltage and leaving reverse current perfectly normal below this voltage level. Even high-current diodes occasionally show good diode action, yet break down under load. Measurements for this kind of leakage are best done as described later.

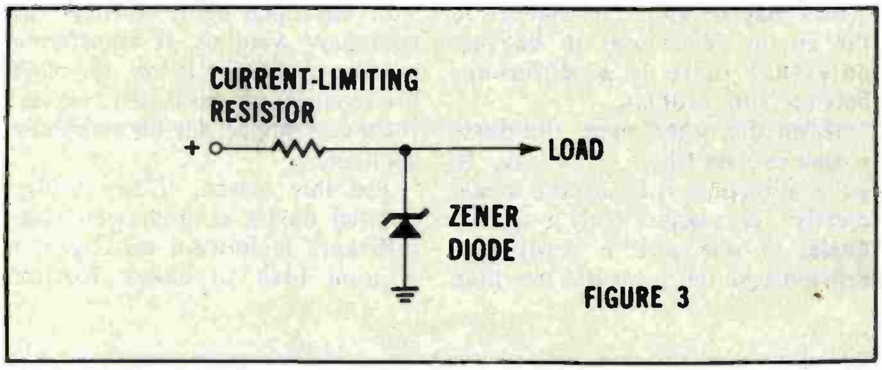


Figure 3 A discolored current-limiting resistor, or one that has changed value, may call attention to a defective Zener.

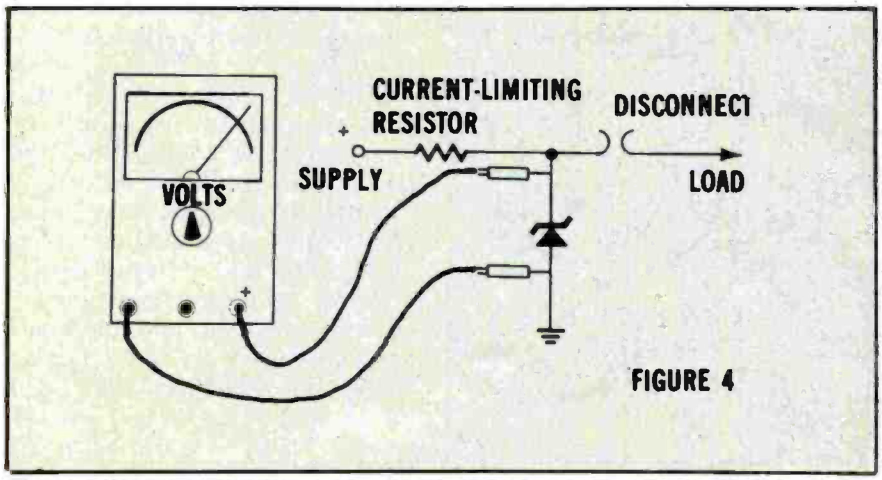


Figure 4 Disconnecting the load will help you decide if a Zener diode is leaky. But first make sure the supply voltage and the current-limiting resistor are okay.

Zener diodes

A Zener or avalanche diode exhibits diode action with an ohmmeter, the same as other diodes. At a certain critical voltage, however, a Zener diode suddenly draws heavy reverse current. Because of this phenomenon, Zeners make good voltage regulators. They can also set a reference voltage for more complex solid-state regulators.

Regular ohmmeter testing proves whether a Zener diode is open or shorted. But an ohmmeter cannot determine at what voltage the Zener avalanches.

Nor, in many cases, will the ohmmeter show if the Zener is leaky—and leaky Zeners are fairly common.

A defective 24V Zener may reduce voltage across itself to 15V or 8V, or whatever. To test this, turn on the equipment (if you can) and see whether or not the rated voltage develops across the Zener (Figure 3). If the voltage measures low, there are four possibilities: the Zener is defective; the load following the Zener is excessive; the voltage feeding the Zener is low; or the series limiting resistor preceding the Zener has changed to a high value. Unless a slightly higher-than-normal output voltage might damage some part of the circuit (and usually it won't) the best quick test for a defective Zener is to disconnect one end and check the output voltage. If voltage rises where the Zener *was* connected, the supply voltage and limiting resistor are okay, and the load is not excessive.

One visible sign of a leaky Zener is a burned or discolored limiting resistor. If the resistor is wirewound rather than carbon, it may become warm enough to discolor the board around it. Sometimes the Zener will itself overheat enough to discolor the board.

Another way to check a Zener in-circuit is diagrammed in Figure 4. You remove the load from the Zener and check to see if the voltage across it stays normal. However, this test can be misleading if the limiting resistor happens to have changed to a high value, or if regulation of the supply voltage is poor.

Replacing diodes

The factory-recommended diode replacement is almost always best. You can expect that it exhibits the correct electrical specifications and that it fits in the niche provided. But there are times when a replacement may not be available immediately, or when modifications need to be made. The following important parameters need to be considered whenever you choose a replacement diode:

- **Peak reverse voltage** (PRV). This refers to how much reverse voltage a diode can withstand without breaking down or *zenering*. For safety, the PRV rating should be about double the peak voltage expected. The extra margin minimizes breakdowns due to voltage transients and surges. Figure 5 charts the amount of PRV you should allow for in different kinds of rectifier circuits.
- **Forward average current** (I_O). Even small silicon diodes may have an I_O rating of 1A or more. Large silicon diodes with heat sinks may be able to carry 200A or more.
- **Repetitive peak forward current** (I_{FRM}). This parameter is important for diodes that are followed by capacitor-input filter circuits. The diodes supply current for considerably less than a half-cycle, restoring the charge in the filter capacitor only on peaks. This may mean that the forward current during each peak may be several times as high as the *average* current required. As a rule of thumb, most silicon diodes can safely handle these peaks if the I_{FRM} is five to ten times the I_O.
- **Intermittent surge current** a diode can withstand also becomes important. The I_{SURGE} or I_{FSM} specifies the amount of current a diode can safely handle for a short period of time—usually one cycle at 60Hz or about 17ms. This rating is especially important when a power supply is first turned on. The input capacitors appear for an instant as a short circuit, and require a heavy surge of current from the rectifier diode.

If you can't find the specification as to surge current for a particular diode, as a general rule figure that a silicon diode can withstand surge current 15 or 20 times the average forward current rating. A few may withstand 50 or more times the I_O rating.

Fast-recovery diodes

For circuits in which a diode must react or switch at a rate higher than a few hundred hertz, a regular silicon rectifier diode cannot turn off quickly enough to stop current flow between cycles.

In low-power, higher-frequency circuits, a slow diode replacing a fast one may result in a circuit malfunction. (An IN914 is a popular fast diode for low-power circuits).

In higher-power circuits, such as one in which pulses are rectified to supply dc power, a slow diode not only causes circuit malfunction but overheats quickly due to heavy reverse current. It can also damage other parts before burning itself out, especially if adequate circuit protection is not provided.

Diodes together

With the advent of inexpensive high-current diodes, designers seldom parallel diodes in rectifier circuits. Yet, you might have occasion to do it yourself. A word about the rules might be in order.

If, for example, a 2A rectifier is needed and only 1A diodes are available, they may be connected in parallel. But because of normal differences in the diodes, even of the same type, one may conduct considerably more current than the other. Early failure of one could occur. To prevent this, you should connect equalizing resistors in series with each diode, as Figure 6

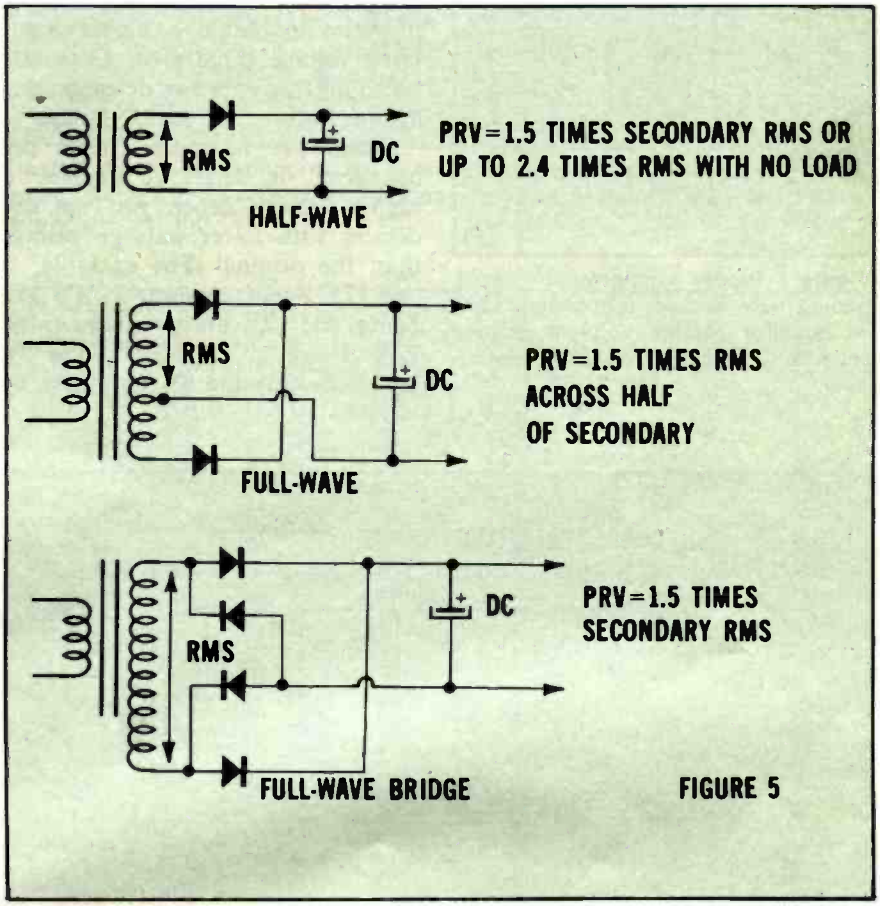


Figure 5 Approximate PRV expected across diodes in sine-wave rectifier circuits. For example, if rms measured across secondary of transformer C is 50V, PRV across any diode is about 75V. Replacement diode should be rated for at least 150V PRV.

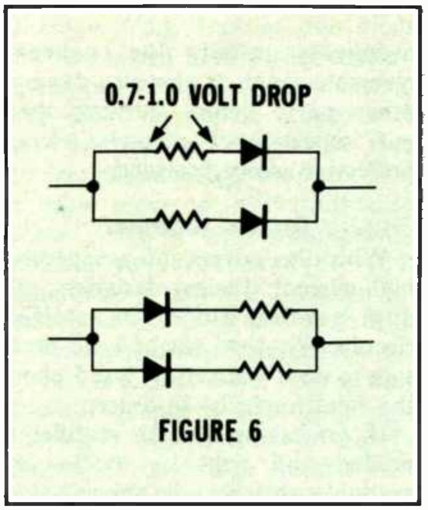


Figure 6 Diodes may be connected in parallel successfully only if resistors are placed in series. Select resistor value so that each resistor drops approximately 0.7 to 1V.

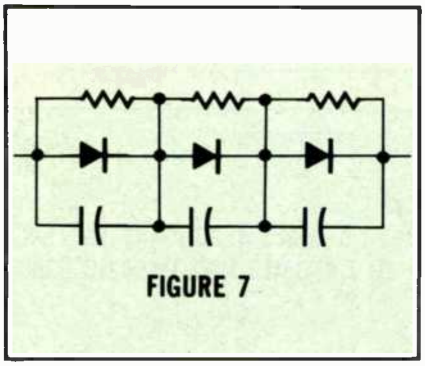


Figure 7 Diodes connected in series should have resistor-capacitor shunts to equalize reverse voltages across them and to suppress cutoff transients.

shows. The resistors should be selected to drop about 0.7 to 1V in normal operation. Be sure they have ample wattage ratings.

It is rather common practice to connect solid-state diodes in series to attain higher PRV ratings. However, equalizing resistors and capacitors are recommended, and Figure 7 illustrates how to connect them. The resistors divide the voltage more equally across the diodes when they are reversed-biased. The capacitors protect any diode that cuts off slightly before a neighbor does.

Resistor values should be roughly 40 times the PRV ratings of the diodes. For example, if a diode is rated at 600 PRV the resistor across it should be about 240,000 (400 x 600).

Equalizing capacitors in 60Hz circuits should be about 0.01μF. Use disc ceramic types, with a voltage rating approximately twice the expected PRV.

Zener diodes may be connected in series to obtain a higher regulated voltage (Figure 8). Generally no equalizing resistors or capacitors are needed.

When two or more Zeners are connected in series to replace a higher voltage Zener, you can use devices with lower wattage ratings than the original. For example, if two 12V Zeners replace a 24V 1W Zener, the 12V units may be rated ½W. However if a 15V and a 9V are used, only the 9V unit may be rated ½W. The 15V unit should be rated at 1W since it will need to dissipate more than half the power consumed in the circuit.

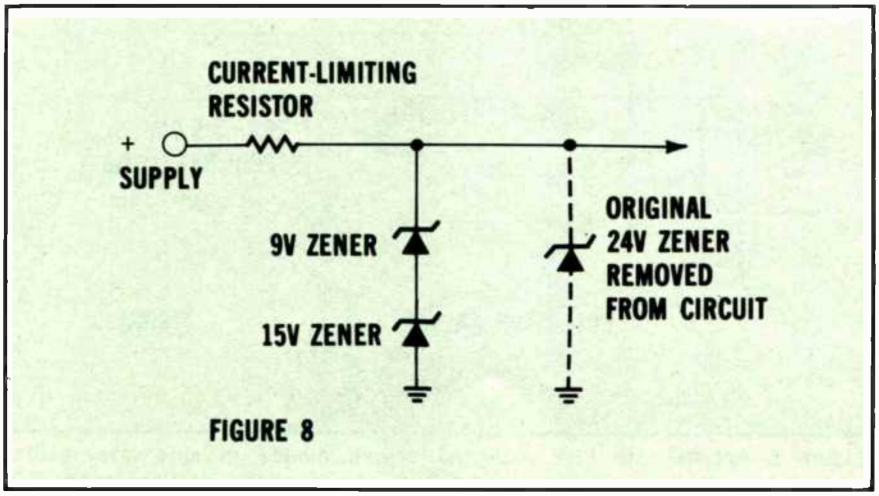


Figure 8 Two (or more) Zener diodes may be connected in series to replace a single higher-voltage Zener. Zeners should *not* be paralleled.

Testing Replacement Diodes

If you have any doubt about a replacement diode, check it before installation. Checking parts you have already replaced can confirm your testing procedures and perhaps relieve your mind that the repair is complete. Moreover, someone may have inadvertently mixed regular diodes and Zener diodes. Unless type markings are legible on the diode, only testing can distinguish which is which.

Both regular and Zener diodes can, of course, be tested with commercial testers. But for the times when a tester isn't available, the method described here works. You need only an unsophisticated variable source (it doesn't even have to be regulated), a limiting resistor, and a voltmeter. The limiting resistor is not critical; generally, a 1000 Ω ½W type is suitable for most testing.

Set the supply to zero or low voltage. Connect the circuit as drawn in Figure 9A. Gradually turn up the voltage while watching the meter. When the diode *zeners*, the voltmeter reading stops rising. Increase the power supply voltage only enough further to make sure the voltage rise has actually ended. You don't want to exceed the wattage rating of the diode.

For a bit of sophistication in this test, add a milliammeter in series with the resistor. The milliammeter will suddenly start indicating current when the diode zeners. Adjust the power supply for a reading of 10mA for small Zener diodes, or up to 100mA for a high-power Zener. The voltage you measure across the Zener diode with this much current flow is the actual avalanche point of the Zener. This should be very close to its voltage rating.

If your dc power supply can furnish high enough voltage, the circuit of Figure 9A can also be used to find the PRV rating of a regular diode. If, for example, a regular diode zeners at 100V, then it should not be used in a circuit where PRV exceeds 50V. For PRV checks, the series limiting resistor should be raised to 10k 1W, to prevent excessive reverse current through the diode if the test voltage is advanced too far. Or, monitor the milliammeter and keep reverse current no more than about 10mA.

A fixed dc supply can also be used for testing Zener diodes as long as its output voltage exceeds the value needed. Figure 9B shows the hookup. The limiting resistor value, as a rule of thumb for almost any diode, can be about 100 Ω for each volt of drop expected across it. For example, if you want to check a 24V Zener with a 50V supply, the resistor value should be in the neighborhood of 2600 Ω (50 - 24 = 26 x 100 = 2600). A 2700 Ω resistor would do because the value is not critical. You may also want to connect a milliameter in series to monitor test current.

Checking transient-protection diodes

Failure of a transient- or surge-protection device may not be immediately apparent. In fact, one may be defective for quite some time before you realize it. One clue is more than a usual amount of failures in other diodes, transistors or ICs.

There are at least two types of transient protection for power lines. The most common is simply a capacitor. The capacitor shows high reactance to the power-line frequency but fairly low reactance to sharp transient-voltage spikes. This causes the spikes to be absorbed—or, more correctly, to be integrated to low levels.

A solid-state device for suppressing voltage spikes compares essentially to two Zener diodes in series (Figure 10). When a voltage spike exceeds the set level, one of the Zeners fires—which one depending on polarity. Its mate, which is forward-biased for that polarity, conducts normally. The spike is therefore clipped at this level and prevented from reaching the remainder of the circuit.

These devices obviously cannot be checked with an ohmmeter. If enough power-supply voltage is available, you can check them by wiring up either circuit of Figure 9, right in the equipment. Use a limiting resistor that reduces current in the Zener to no more than 10mA or so. Reverse the hookup and test the Zener combination for suppression of both positive and negative spikes. Some leeway is permissible between the actual avalanche voltages in the two directions.

Next time, quick testing for many other solid-state devices in factory gear such as SCRs, Triacs and Diacs will be discussed. □

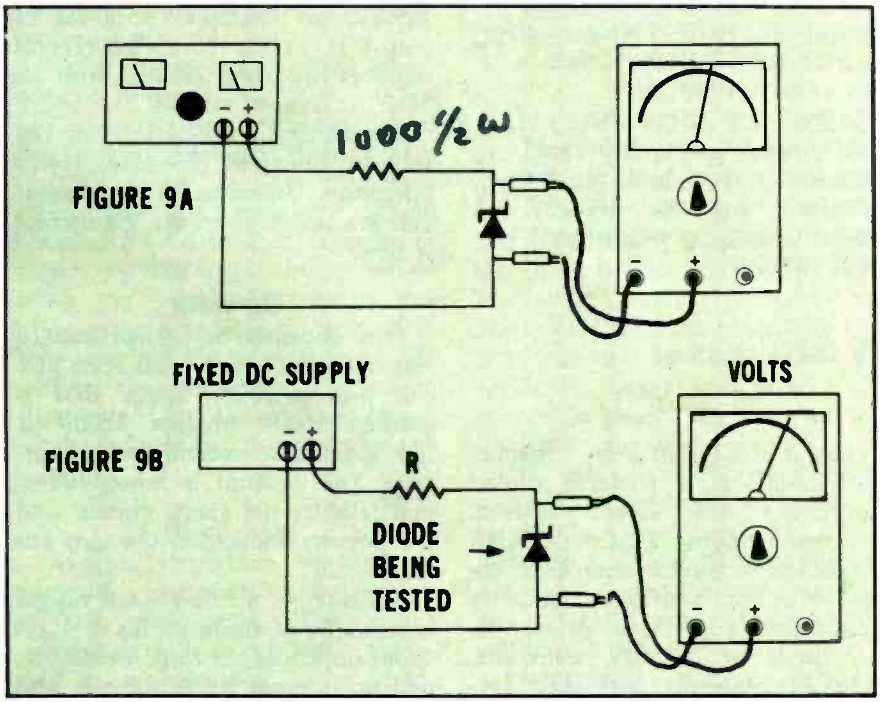


Figure 9 Whether variable or fixed, dc supply can be used to test Zener diodes. Output voltage must exceed rating of any Zener to be tested. Can test PRV of regular diodes, too.

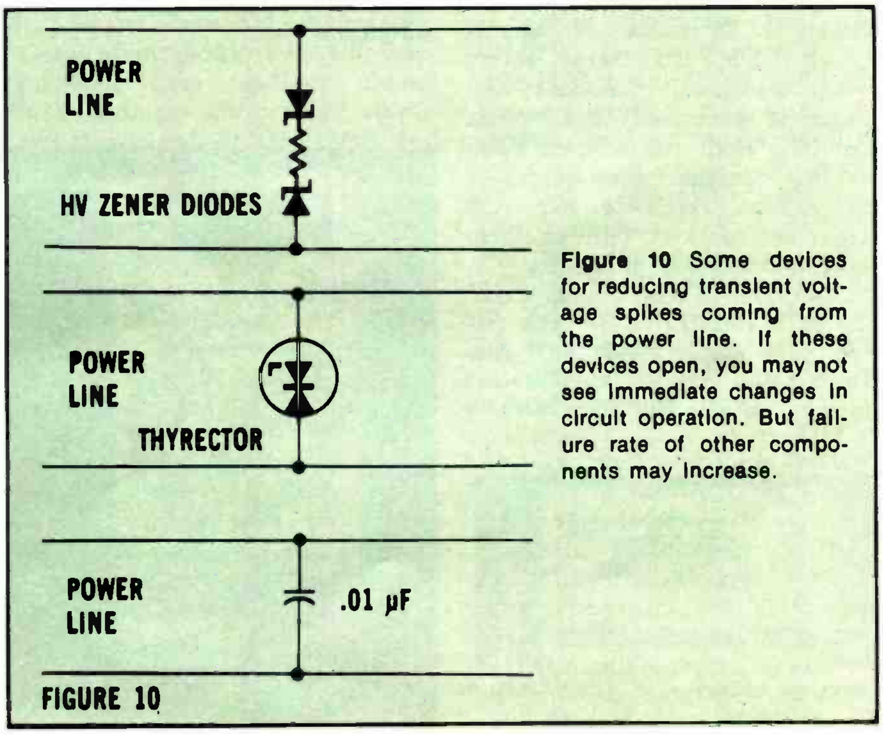


Figure 10 Some devices for reducing transient voltage spikes coming from the power line. If these devices open, you may not see immediate changes in circuit operation. But failure rate of other components may increase.

Reports from the test lab

Each report about an item of electronic test equipment is based on examination and operation of the device in the **ELECTRONIC SERVICING** laboratory. Personal observations about the performance, and details of new and useful features are spotlighted along with tips about using the equipment for best results.

By Carl Babcoke

Model TECH-310 from Beckman Instruments is a portable digital multimeter with several unusual features including 22M Ω dc input resistance, a special semiconductor test, a unique continuity indicator and effective overload protection. Automatic dc polarity, automatic zero, automatically positioned decimal and an overrange that reads "OL" are additional features. The seven measurement functions have 29 ranges.

Digits of the Liquid Crystal Display (LCD) readout are almost ½-inch high. One large rotary switch selects all functions and ranges. It turns easily and indexes positively. Both the selector knob and the function/range markings are recessed. The DCA and ACA areas are darker tan to help separate the various functions.

Low-drain CMOS circuitry and the LCD display allow the 9V battery to supply about 2000 continuous hours with an alkaline battery or slightly less with a zinc-carbon type. When about 20 hours of use remain in the battery, the decimal blinks as a warning.

In a 3½-digit display, the first digit can be blanked out, or it can show a number 1. No other numbers are possible. Therefore, this readout is limited to a maximum count of 1999 (1.999V or 199.9V, for example). If a higher count is called for, the circuit replaces the usual reading with an "OL" overrange symbol.

Accuracy specifications of the various functions are for 1-year operation. Undoubtedly the accuracies are better when the instrument is new.

Dc volts

Five decaded dc-voltage ranges start at 200mV (0.2V) full scale and end with a 2000V range that is marked 1500V because 1500V is the maximum recommended voltage. The decimal is moved automatically by the range switch, and the polarity indication changes automatically.

Accuracy of all dc-voltage ranges is ±0.25% of reading plus 1 digit. Input impedance is rated at 22M Ω, and an internal active filter is said to remove almost all extraneous ac signals above 49Hz. Model 310 gave accurate readings when measuring half-wave rectified dc, and this indicates proper integration of all waveforms.

Ac volts

The 200mV, 2V, 20V and 200V ac ranges are similar to those for dc voltage. However, the highest range (actually 2000V full scale) should not be used to measure ac sine waves of more than 1000V RMS or 1400V peak. The limitation is necessary because peak voltages above 1500V exceed the safety ratings of the instrument.

Internally, the ac circuit is average-responding for sine waves, but is calibrated for RMS. Input impedance is rated at 2.2M Ω.

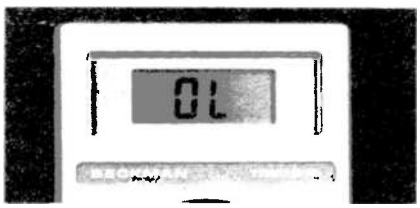
Frequency response was exceptionally good. (Many digital meters are not flat over the audio range.) TECH-310 measured within ±⅓dB between 20Hz and 40kHz, with a small peak at 50kHz and rolled off rapidly above that frequency. This is better than the manufacturer's specifications.

Basic ac voltage accuracy is rated at ±0.75% of reading +3 least-significant digits.

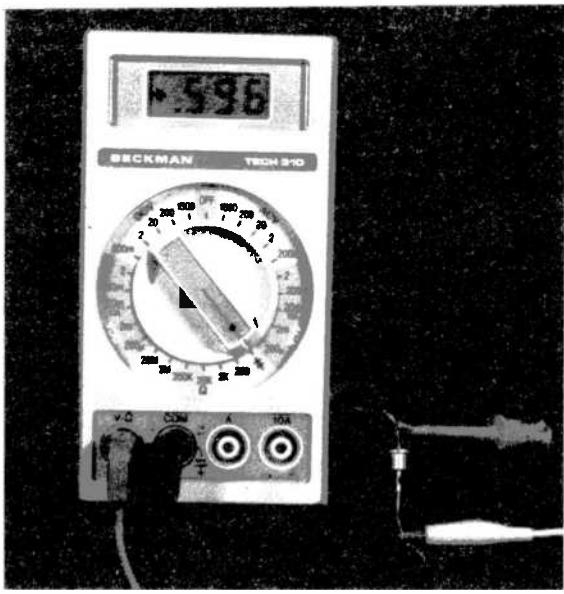
Ac and dc current

Ranges for both dc and ac current are 200µA, 2mA, 20mA, 200mA, 2A and 10A. One test-lead jack is used for all except the 10A range, which has its own jack.

Rated accuracy for dc current except the 10A range is ±0.75% of reading +1 digit (10A is ±1.5% of reading +1 digit). For ac current,



Overrange indication is a non-flashing "OL" as shown.



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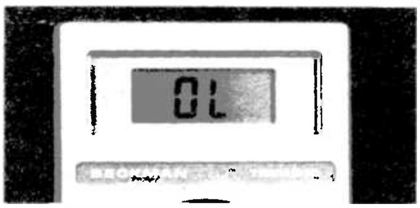

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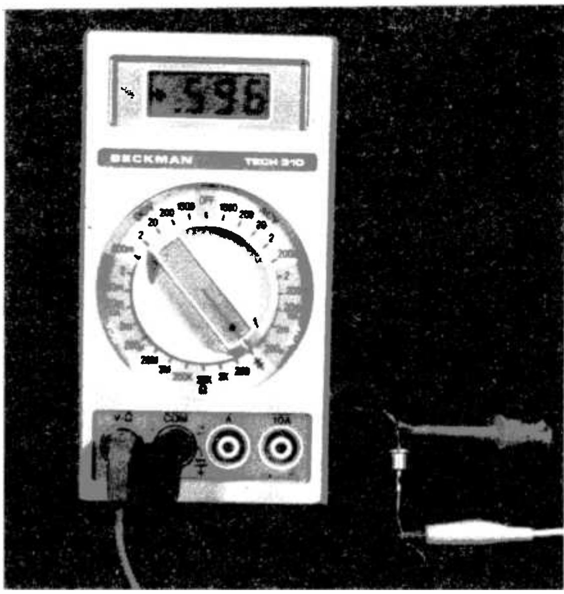


Diodes or transistor junctions are tested by supplying a current of 5mA and reading the dc voltage drop across the external diode.

the rating is ±1.5% of reading +3 digits (10A is ±2% of reading +3 digits).

Polarity indication operates automatically for dc current. Frequency response of ac current is the same as for ac voltage.

Resistance

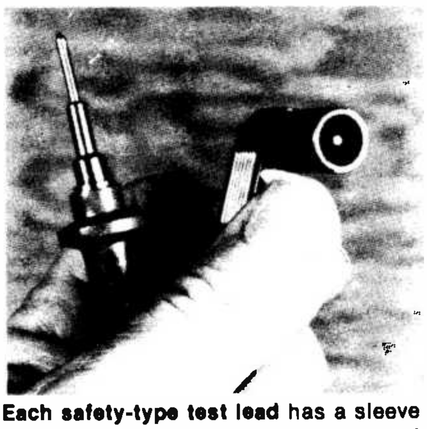
Six resistance ranges measure from 200Ω full scale (resolution of 0.1Ω) to 20M full scale (10KΩ resolution) at an accuracy of ±0.5% of reading +1 digit (±1.5% of reading +1 digit for the 20M range).

Maximum open-circuit voltage across the test leads was about 0.42V and the VΩ probe was positive. When measuring a resistance barely above the overrange point, the dc voltage was about 0.2V. This is not enough to cause silicon diodes or transistor junctions to conduct. Therefore, resistors usually can be checked in-circuit without large errors from solid-state conduction. A separate test is provided for diodes.

Insta-Ohms

One of the minor deficiencies of most digital resistance measurements is that rapid intermittent open or short circuits are not revealed properly because of the time necessary for the meter to count up or down. Beckman in the TECH-310 has solved the problem by adding an ohms symbol to the upper left corner of the display. Any resistance reading between a dead short and about twice the value of the range that is in use causes the ohms symbol to appear long before the digital readout settles down to a stable reading. When the probes are removed from a resistance (or when an intermittent open occurs), the ohms symbol disappears rapidly before the readout returns to zero.

On or off operation of this ohms symbol is rated at 100ms (0.1s), but it seems nearly instantaneous to the eye. For example, starting with the test probes not touching each other and the overrange signal showing on the readout, a series of rapid shorting together and separating the test probes causes the ohms symbol to flash on and off in step with the shorts and opens but without allowing the "OL" signal to disappear from the regular digital readout. Such fast responses can be helpful.



Each safety-type test lead has a sleeve at the plug to insulate the metal contacts, plus a ridge on the test probe to prevent fingers from touching the metal tip.

Diode test

Another important feature that resembles resistance measurements is the *diode* test. The switch position is next to the 200Ω range, and it is identified by a diode symbol. A test current of 5mA is supplied to the diode under evaluation and the meter reads the voltage drop that's across the diode, up to a maximum of 1.999Vdc.

This test can be very informative. Germanium diodes and transistor junctions gave readings around 0.3V, ordinary silicon diode rectifiers showed about 0.6V and two LEDs each measured 1.59V. A damper diode out of an old tube-type color TV evidently had several diodes in series since overrange was obtained. However, a silicon damper diode from a solid-state color receiver measured about 0.6V.

Positive identification can be made of cathodes versus anodes or silicon versus germanium types. LEDs not only show their characteristic voltages (not all require 1.6V) but dim light can be seen. For reverse (or leakage) tests, use the regular resistance ranges.

Accuracy of the diode test is rated at ±0.25% of reading +2 digits.

Many diodes and transistor junctions can be tested sufficiently while in-circuit, providing the paralleling resistances are higher than 200Ω. With one polarity of test leads, the reading should be the correct voltage drop for that kind of diode. After the leads are reversed, the readout should show "OL". If both readings are near zero or overrange, the junction is shorted or open.

Comments

All voltage ranges are protected to 1500V peak by the circuit design, and spark gaps are provided for voltages between 1500V peak and 6kV peak. Resistance ranges are protected to 300Vdc or RMS ac, and the current inputs have a 2A fuse. But these added protections should be used *only* for accidents. Don't knowingly apply voltage in excess of ratings to any solid-state meter.

The Beckman one-year limited warranty is unusual. It agrees to repair or replace the ailing multimeter with a new or reconditioned one for $3 (postage and handling) and send it back by air, usually within one working day.

Performance of the Beckman TECH-310 was excellent in all ways. Features of Insta-Ohms indication and the diode test were found to be dependable and very helpful.

Another advantage not mentioned in the manufacturer's literature is that the digital multimeter has an internal metallic sheath that shields the circuits. Although the meter was not tested in an intense RF field, it should be stable under that condition. The performance was not affected in any way by bringing it almost in contact with the high-voltage section of a color TV receiver. This is a stringent test, and the lack of any problem indicates good shielding.

A similar meter, TECH-300, does not have the Insta-Ohms continuity indicator or the 10A range. Accuracy is slightly lower.

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In summary, the Beckman TECH-310 is a professional-quality digital multimeter that should be a valuable addition to any service operation. □

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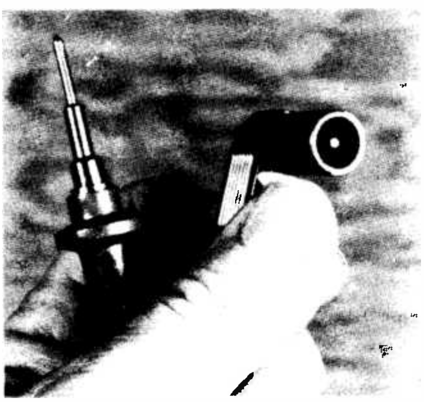

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Testing Sencore VA-48 performance

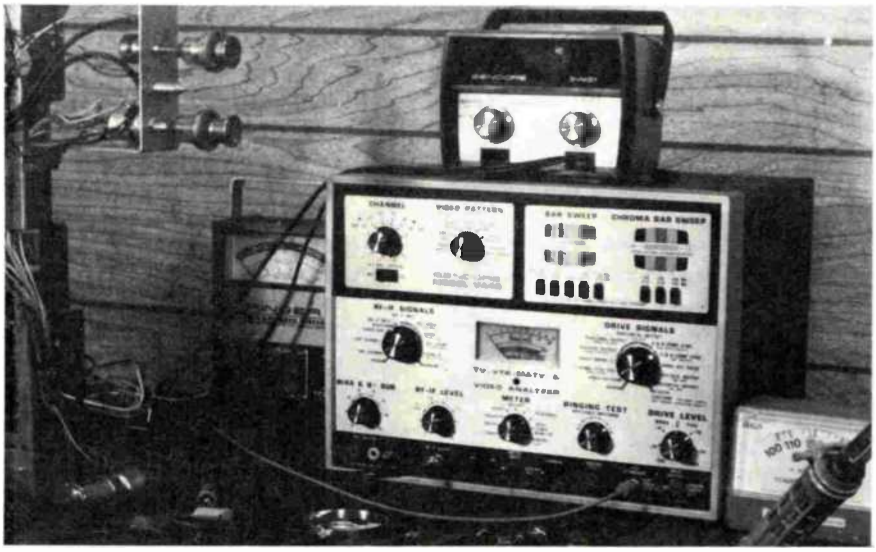
By Gill Grieshaber, CET

Although similar to "Reports from the Test Lab" this feature is longer and more detailed due to the many functions of the VA-48. Results of tests and tips on using the instrument are included.

The phrase "TV-VTR-MATV & Video Analyzer" that appears on the Sencore VA-48 panel does not completely describe this versatile item of test equipment. The following is an incomplete list of signals and functions of the VA-48:

- color-bar generator
- dot-crosshatch generator
- tuner substitute
- alignment generator
- peak-to-peak voltmeter to 1000V
- peak and null dc meter
- variable dc voltage for bias or B+substitute
- Ringer tester of flybacks and yokes
- controlled-amplitude source of all major injection signals for testing color TV receivers
- 5-frequency "Bar Sweep" pattern for measuring response up to 3.56 MHz
- 3-frequency "Chroma Bar Sweep" for chroma response at center and both edge frequencies
- a standard 1VPP (at 75 Ω load) video signal that's properly clamped with zero Vdc at the negative-going sync tips.

Obviously, many explanations are required for the multitude of items listed. But one point not made clear by the list of separate functions and signals is that all output signals are phase locked. For example, an RF carrier with video modulation can be injected at the antenna terminals or in the IFs to provide a raster picture, while at the same time a keying pulse (of same phase) can be used to test an AGC circuit. The value of phase-locked signals will not be appreciated properly until after the feature is used in actual servicing.



Sencore-VA48

"Channels" and "Video Pattern"

In the upper left corner of the front panel is the channel selector knob, which can be turned to any VHF channel (2 through 13) or a choice of six UHF channels (Figure 1). Also, two UHF positions can be retuned by a small screwdriver to any desired local channel. A hole in the panel near the UHF channel-15 mark allows access to the trimmer pot. Another hole near the channel-60 UHF mark permits that channel to be retuned. A "4.5MHz Crystal" switch adds that carrier when needed.

Modulation for the RF carrier selected by the channel switch is determined by the "Video Pattern" switch (Figure 1). Seven patterns are available: a single cross, a single dot, a full cross-hatch, all dots, conventional color bars with black bars between, bar sweep and chroma bar sweep. The two sweeps will be explained later.

So far the description is similar to a deluxe color/bar pattern generator. But the VA-48 has many other features.

Below the channel selector is another switch marked "RF-IF Signals," which has one position for UHF channels and another for VHF channels. Signals from this switch go to the "RF-IF Level" control (Figure 1B) for calibrated attenuation, and then exit at the "RF-IF Output" jack. These signals go to the TV antenna terminals.

RF-IF Signals selector

The "RF-IF Signals" switch also selects one of three kinds of IF signals. First is the "Tuner Sub" position that provides a modulated picture-IF signal having a level of 5mV (this is the same amplitude as the VHF and UHF signals, and it matches calibrations of the level control). The signal can be injected at the UHF jack on the VHF tuner or at the input of the first IF tube or transistor.

Next position of the RF-IF switch is marked "2nd IF Input" that gives the same signal as before except at a 50mV maximum level. The "3rd IF Input" position increases the level to 500mV.

Comments—Signal-injection tests in the picture IF stages can be very helpful when done properly. Usually, the VA-48 is adjusted for the third IF input position of the signals selector and the probe is connected to the input of the third IF stage. (Both the VA-48 and the 300 Ω balun supplied with it have capacitor coupling so additional isolation is not required when connecting to a circuit.) If the video signal is normal (as viewed on picture tube or test scope), the generator is changed to the second IF position and connected to the input of the second IF. After a favorable test result there, the generator is set to the tuner sub position and connected to the input of the first IF stage. During this sequence, the first stage that shows a weak signal (or whatever the original symptom was) is the one with the defect. This identification of the bad stage is a tremendous help during servicing.

Figure 2 shows both the crosshatch pattern on the TV screen during a test of the IF signal injection feature and the video scope waveform when the bar sweep pattern was used. A good sharp crosshatch pattern and strong color bars were obtained when the signal was injected at the input of each IF stage. The level control adjustment was helpful in obtaining the best appearance of the picture.

"Bar-Sweep" and "Chroma Bar Sweep"

These next two waveforms can be selected by the video-pattern switch so one or the other modulates the RF or IF carrier for injection tests. Or either pattern can be selected by the drive-signal switch and appear as adjustable-level video at the drive-output jack (described later) for injection in video or other stages.

Both signals are unique, and they deserve an accurate description. As pictured in Figure 3, the bar-sweep signal has five switches to add or delete specific frequency bursts from the waveform. A drawing above the switches shows the location of each waveform area on a TV picture, along with a drawing of the corresponding scope waveform inserted at the center of the raster. If any of the five switches is moved to the out (or off) position, that burst disappears from the raster or scope.

Figure 3B is a closeup picture of the bar sweep drawing on the

Figure 1 RF and IF signals for signal injection tests of TVs are regulated by these controls.

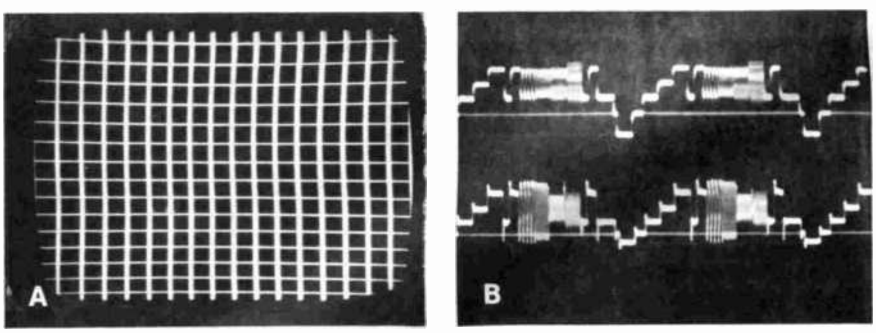


Figure 2 (A) A good quality crosshatch pattern was obtained when injecting the IF test signal at three points in the picture IFs. (B) Top scope trace is the bar sweep pattern taken from the drive-signals circuit. Bottom trace shows the same pattern at the TV video detector after the carrier was injected in the IFs. The uneven frequency response and some overshoot probably are typical of injection that goes through only a part of the IF circuit.

VA-48 panel. The drawing is helpful, but not totally realistic. Examples of real pictures and scope waveforms will be given later.

When a full-bandwidth bar-sweep pattern is viewed on a scope, all five bursts (single bar 0.188MHz, 0.75MHz, 1.51MHz, 3.02MHz and 3.56MHz) should have the same amplitude without any tilt. Less amplitude of any burst indicates a loss of gain at that frequency. Also, the amplitude between each "step" of the black, gray and white bars should be equal. Refer to the instruction book for the significance of this test.

On the picture tube, four frequency bursts should appear to have the same intensity (Figure 4). Most important are the 3.02MHz and 3.56MHz bars. Incidentally, when the bar-sweep pattern is scoped at the video detector of a TV, it would seem logical for the 3.56MHz burst amplitude to be only half of the others, because that frequency usually is at the 50% point of the IF alignment curve. However, Sencore compensated by increasing the amplitude in the generator before modulation so all burst amplitudes should be equal after detection in the receiver. (It is not necessary to compensate the 3.56MHz bar in the VTR standard or video from the drive circuit.)

Testing with bar sweep—Several receivers were tested for IF bandwidth by observing the bar sweep patterns on the picture tubes and scoping the video-detector waveforms.

Evidently, video-amplifier response of the Figure 4 receiver was rolled off more than most, because the video-detector waveform showed excessive level of high frequencies (Figure 4B) but the raster picture was textbook perfect. For that model color TV, those results apparently are normal.

The picture and waveform of Figure 5 were taken from an old tube-type color TV that was badly out of alignment. Both the raster picture and the scoped detector waveform showed poor frequency response.

Figure 6 waveforms show a missing 3.02MHz bar. This can occur if a sound trap is incorrectly

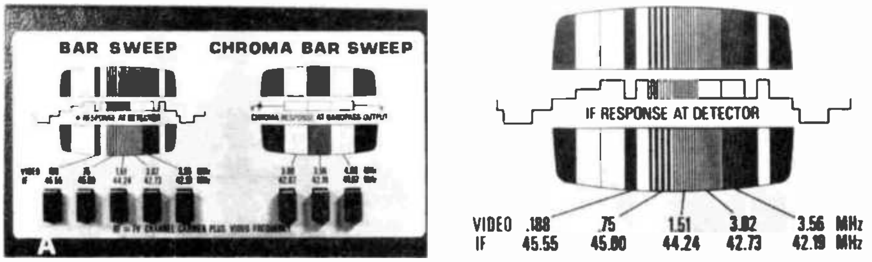


Figure 3 Five burst frequencies of the "Bar Sweep" pattern can be turned on or off by pushbuttons. (A) Drawings on VA-48 panel show the approximate raster picture and scope waveform obtained from the complete bar sweep. The "Chroma Bar Sweep" is treated the same, except only three pushbuttons are required. (B) This closeup of the bar sweep drawing shows the five video frequencies and corresponding five picture—IF frequencies selected by the buttons.

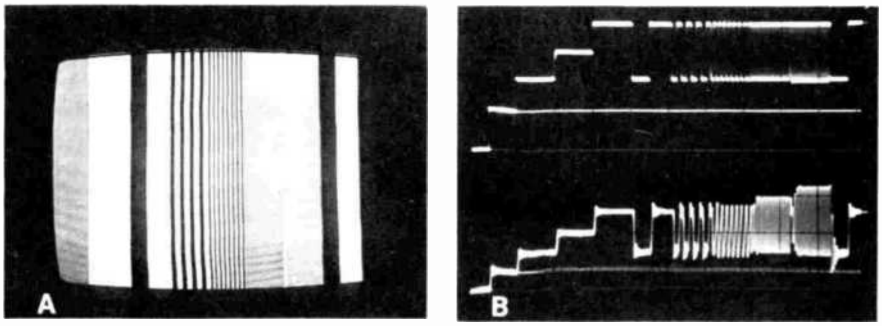


Figure 4 (A) Flat frequency response to 3.56MHz is indicated by this TV picture of the bar-sweep pattern. Consider it as normal response to the pattern when injected at the TV antenna terminals. (B) Scope trace at the top shows the bar-sweep waveform from the "VTR Standard" output. Slightly less than one horizontal line is shown. Bottom scope trace is the bar-sweep pattern obtained at the video detector. This trace was taken from the same normal TV that showed the excellent raster picture in A. Therefore, the IFs evidently were peaked to give higher amplitude at the high frequencies, which then were reduced in the video amplifiers before reaching the picture tube.

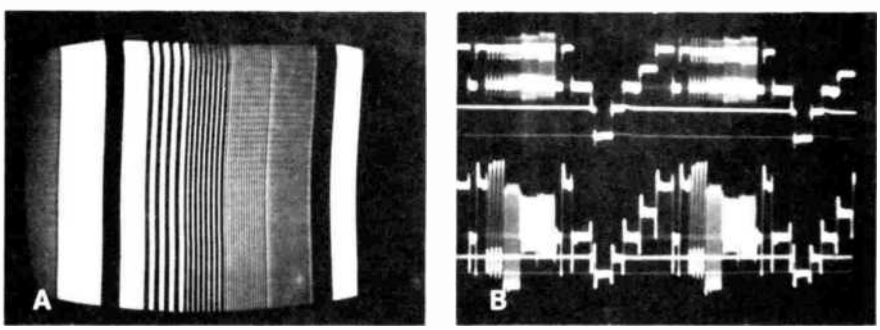


Figure 5 An RF carrier with bar-sweep modulation was injected at the TV antenna terminals. (A) The TV picture had only fair quality with reduced 3.02MHz and 3.56MHz response and some visible ringing. (B) Top scope trace is the original bar-sweep pattern at the drive-signals output. The bottom trace is the same pattern at the video detector of this old receiver that had poor picture-IF alignment.

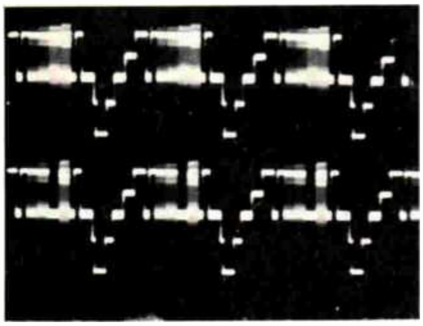


Figure 6 The bottom scope waveform shows the bar-sweep waveform when the 3.02MHz burst was missing or greatly attenuated. Waveform of the bar-sweep pattern taken from the drive-signals circuit is shown above for comparison.

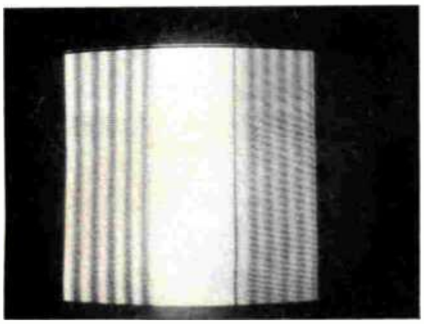


Figure 7 This TV picture shows near-normal response to the "Chroma Bar Sweep" signal. The broad center bar is blue, and the two side bars have audio-modulation lines. These outside bars should have the same brightness, if the overall alignment and response are satisfactory.

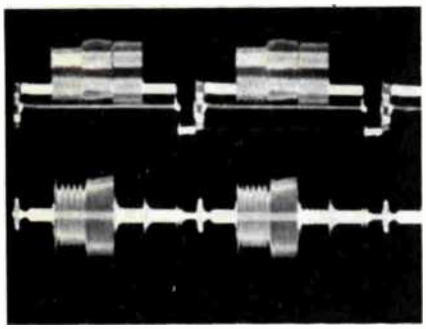


Figure 8 The top scope trace is the chroma-bar sweep signal at the drive-signals output. Below are the poor-quality chroma bars at the demodulator input. Incorrect alignment has reduced the 4.08MHz bar (at the right) to almost zero amplitude.

adjusted. Of course, any or all of the five bursts can be switched in or out as desired. Such flexibility is needed if a receiver defect has distorted the bar sweep pattern.

No color burst is placed on the blanking bars back porch. However, the 3.56MHz bar has the same frequency as that used for color bars. This allows accurate adjustment of the TV color oscillator. First, the color killer is defeated, which brings barber-pole stripes of color in the 3.56MHz bar-sweep bar. Next, the color oscillator is adjusted for zero beat. Afterwards, the killer must be reset.

Testing with chroma bar sweep— Only three broad bars should be seen on the TV screen when the chroma bar sweep is selected by the video-pattern switch. Of course, any or all of the 3.08MHz, 3.56MHz and 4.08MHz color-bar signals can be switched in or out as desired.

These frequencies modulate the picture carrier, and they travel through the receiver IFs and chroma section in the same way as the familiar keyed-rainbow bars. However, only the center bar has a color (blue) in the TV picture, while the other bars have phase-locked sine-wave modulation (see Figure 7 for correct response in a monochrome picture, or the cover of the May 1979 issue of ES for the same chroma bar sweep in color). Both the 3.08MHz chroma bar (at the left) and the 4.08MHz bar at the right should have the same brightness when the chroma alignment is correct.

Figure 8 shows the chroma bar sweep pattern from the generator versus the video detector scope waveform when the color receiver had poor picture IF alignment that greatly attenuated the 4.08MHz bar signal.

Aligning with both bar sweeps— The Sencore operating book for the VA-48 (and other Sencore literature) gives detailed instructions for aligning both the picture IFs and the chroma stages. For trap adjustments, the RF-IF signals switch selected 39.75MHz (adjacent video), 41.24MHz (sound) or 47.25MHz (adjacent sound) crystal-controlled

Solution to:

Give This a Whirl

1 CuriE	17 SalienT
2 ExpandD	18 TerA
3 DigitaL	19 AbohM
4 LorentZ	20 MagnesiuM
5 ZeneR	21 ManuaL
6 RatiO	22 LuminouS
7 OersteD	23 ShadoW
8 DashpoT	24 WoofeR
9 ThyritE	25 RinginG
10 ElectrolytE	26 GoogoL
11 ElongateD	27 LodaR
12 DetaiL	28 RabbiT
13 LineaR	29 TetraD
14 RegisteR	30 DatA
15 RectigoN	31 ArraY
16 NucleuS	

Start with 124 points and deduct 4 points for any part you may not have answered correctly.

Your rating:

60 - 72 Fair but not good.
76 - 88 Good but not excellent.
92 - 96 Very good but still not excellent.
100 - 120 Excellent.
125 PERFECT! You're an electronic whiz!

Errata

Two waveforms were interchanged in the August article "A second look at waveforms." The waveform picture of Figure 4C on page 33 should have been placed in Figure 5 on page 34. And the Figure 5 waveform should have been Figure 4C.

continuous carriers that have audio modulation. Included also is a 4.5MHz sound IF carrier that is frequency modulated by a 1kHz sine wave.

Although no color TVs were available for a complete alignment by these methods, the method seems practical. One strong point is that the picture carrier is operating continuously. Therefore, no clamping of the AGC is required.

Another unique feature is that synchronous video detectors can be adjusted for minimum ringing and best amplitude linearity by interpreting the scoped video waveform. (Synchronous detectors cannot be aligned by the usual sweep-frequency technique.)

Adjustable power supply

At the lower left corner of the front panel and below the RF-IF signals knob are the calibrated knob and banana output jacks for the zero to 35V variable-dc power supply that can be used either as AGC bias or as substitute for a low-voltage B+ source. Neither output jack is grounded (both float), so either positive or negative polarity of voltage can be obtained. The knob and jacks can be seen in Figure 1B.

Rating of the supply is 1A maximum and the regulation measured about 2.5% between zero current and 150mA.

Meter

An analog meter is mounted at the panel's center. It is the readout for five peak-to-peak ac ranges between 10VPP to 1000VPP full scale. Or when the meter selector knob (Figure 9) is turned to the "signal monitor" position, the meter reads the peak-to-peak amplitude of whatever pattern is selected by the drive selector and control (described later). Meter input and common (ground) jacks are below the meter.

Two other positions of the meter switch provide a positive or negative dc voltage peak or null function. A special nonlinear scale places .1V near the left end, 1V at the center 10V at the right of the meter scale. The nonlinear operation eliminates any need to change ranges as the voltage nears zero. Internal resistance is about 20K, therefore, the low resistance might decrease some voltage sources. This is of no consequence when the meter is used only as an indicator of minimum or maximum.

Ringing tests

Last position of the meter switch selects the ringing test, which appears to be similar to that used in the YF-33 Sencore Ringer. This function is designed specifically to test vertical yokes, horizontal yokes and flybacks for shorted turns.

These ringing tests are very easy to make. The coil to be tested is connected to the common and "Ringing Test" jacks. Next, the "Ringing Test" switch (Figure 10A) is rotated through all six positions before being returned to the one that gave the highest meter reading. The number of rings before the decaying waveform (Figure 10B) reaches a predetermined amplitude is read directly on the bottom meter scale. This calibrated scale is helpful for testing or matching any sweep coils of unusual characteristics.

Above the ringing cycles calibration is the bad/good scale, which shows 10 cycles of ringing as the division between good and bad coils.

Tests on flybacks and yokes having known defects proved the ringing tests are dependable and helpful. The only limitations are those of the yokes and flybacks themselves. For example, a perfect transformer would read zero ringing cycles if even one turn was shorted in *any* of several windings. However, the coupling between the turns of most yokes is so slight that a number of shorted turns will reduce the reading to less than 10 cycles, but not to zero. For accurate yoke measurements (by any method), disconnect all resistors and capaci-

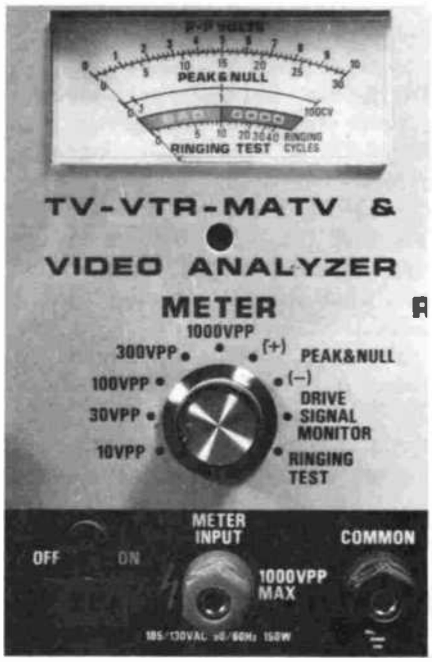


Figure 9 The multipurpose analog meter has these functions: five ranges of peak-to-peak ac voltage; two peak-or-null dc ranges; measures the drive signals PP amplitude; and gives readings of the ringing tests. Peak-to-peak and peak/null functions enter at the "Meter Input" jack.

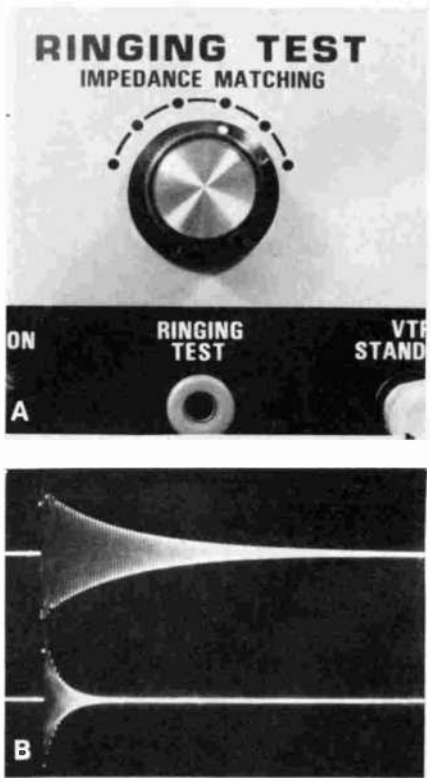


Figure 10 (A) When the ringing test is selected and a yoke or flyback connected to "Common" and "Ringing Test" jacks, the "Ringing Test" knob is rotated to the position giving the highest reading on the meter. Generally, coils giving readings under 10 have shorted turns, and those giving above 10 rings are alright. (B) Top scope trace is the waveform of a flyback with a reading of 37 cycles. When the rectifier-tube filament winding was shorted, the reading dropped to 9 cycles (shown by lower trace).

tors from each pair of horizontal or vertical coils, test each coil separately and then compare the two readings. The one having shorted turns will show a lower reading.

Construction of a flyback determines the amount of coupling between turns. A shorted turn or turns in any of several windings *between* the ringing test leads positively will reduce the reading to zero. However, shorted turns in other separate windings might not lower the reading that much. The high-voltage *doughnut* coil has the least coupling to the primary winding of all flyback windings. In fact, the HV coil should be tested separately for shorted turns.

Solid-state flybacks usually require all transistors, diodes and HV triplers to be disconnected before they will ring. Any questionable readings should be followed by tests of both the suspected flyback and a new one (before it is installed).

Yoke and flyback windings should be more than 3 inches from a metal chassis or a metal bench when tested. Otherwise, the ringing cycle reading will be noticeably lower.

These few precautions apply only to borderline cases. Usually, the ringing test is infallible. It is a valuable addition to the VA-48.

Figure 11 Waveforms for signal substitution in sync, sweep, audio, chroma or video are selected by the "Drive Signals" switch. Signal amplitude and polarity both are adjusted by the "Drive Level" control. Then the selected signal emerges from the "Drive Output" jack.

Drive signals

As mentioned before, one of the best tests is to connect an outside source of signal to various circuits in a TV and watch the picture tube for the result. Whenever a normal picture is obtained, the circuits between the injection point and the picture tube *must* be working alright.

The Sencore VA-48 provides a choice of 11 different waveforms as test signals under control of the "Drive Signals" switch and the "Drive Level" control (Figure 11).

One extra bonus is illustrated in Figure 12: All drive signals (except the 1000Hz audio sine wave) are phase locked to the video signals (such as crosshatch, dots, color bars, bar sweep and chroma bar sweep. Figure 12 shows dual-trace (simultaneous) waveforms of color bars (above) and the tube horizontal drive (bottom trace). The color-bar signal was fed to the TV antenna terminals and the horizontal output tube grid drive was connected to the grid of the output tube. A stable color-bar pattern was shown on the TV screen.

There are only a few precautions. Notice that these drive waveforms have either 30VPP or 300VPP maximum amplitudes. All 300VPP signals are for tube operation. These are the tube composite sync, horizontal keying pulse, vertical output-tube grid and horizontal output-tube grid signals. All others have less than 30VPP, and are intended either for solid-state circuits or for audio and video stages where large signals are not needed.

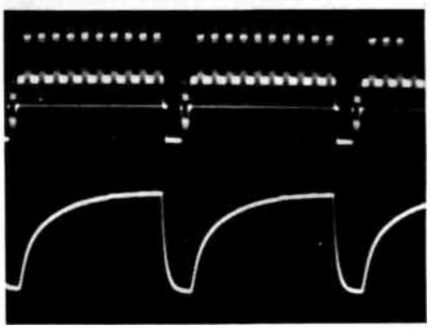


Figure 12 The stable phase lock between all VA-48 signals is illustrated by this simultaneous dual-trace picture.

Do NOT attempt to connect one of the tube-type waveforms to any transistorized circuit. This could ruin the solid-state device.

Calibrations for the continuously variable drive-level control range from -30V when counterclockwise to zero at the center of travel and on to +30VPP at the full clockwise position. These calibrations are approximate but direct reading for all except the four 300VPP waveforms. *For those signals, the calibration must be multiplied by 10.*

Of course, the meter can monitor these drive amplitudes where greater accuracy is required. The meter switch is rotated to "Drive Signal Monitor." For convenience, the circuit automatically changes the peak-to-peak range so the 30VPP waveforms are measured on the 30VPP range and the 300VPP signals are measured on the 300VPP range. However, there is no indication (except for the color-keyed markings around the drive-signals knob) of *which* range is in use. The operator must keep this in mind.

The "Drive Output" jack is supplied with drive signals through a 20μF non-polarized capacitor. A 470K resistor is connected from jack to ground. These components prevent any steady dc voltage from reaching the drive output jack. They also isolate the VA-48 from the receiver circuits under test. In most instances there are no precautions. It is possible to produce a temporary dc voltage of considerable value by rotating the drive level control rapidly when tube-drive signals are present there. No problems were experienced in actual signal substitution tests, but it is strongly advisable to select the type of drive signal, set the level with meter and drive-level control, and then ground the drive-output lead wire for a few seconds to bleed any voltage before connecting to the unit under test. Also, *the output lead should be grounded between tests made on parts of a receiver circuit that have supply voltage and those tests made at tube grid or transistor base.* (This recommendation also holds true for signal-substitution tests made with instruments other than the VA-48.)

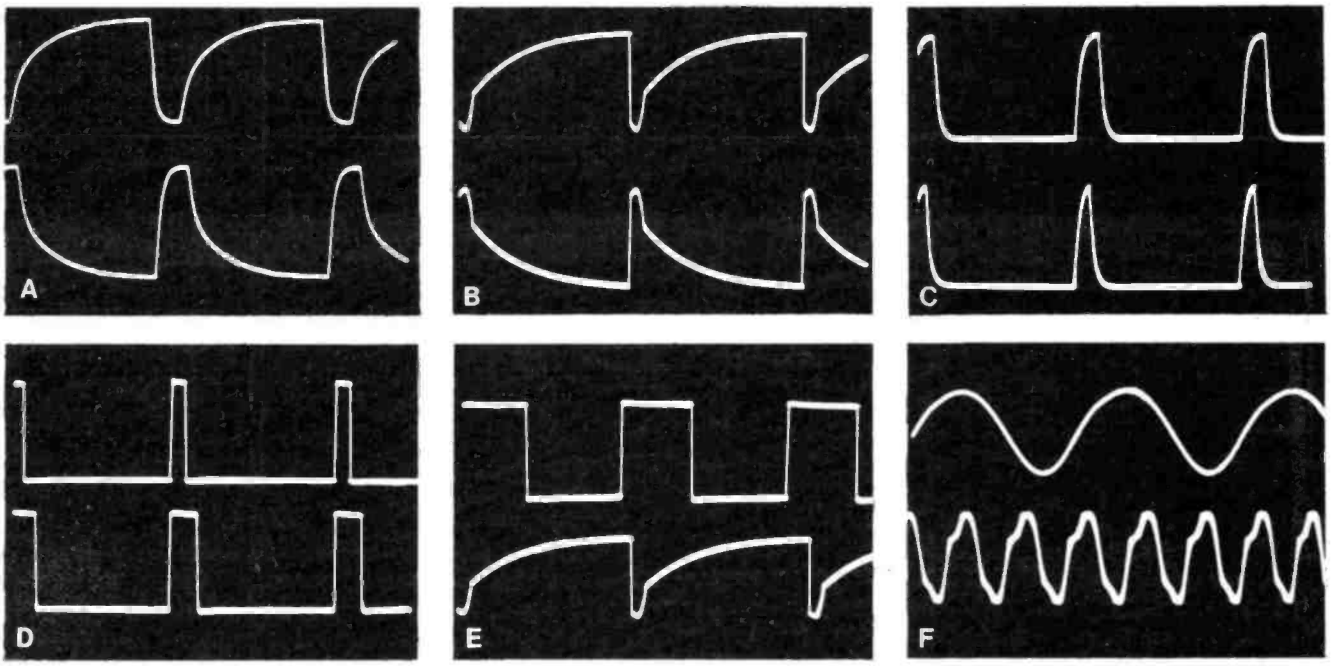


Figure 13 These drive signals were photographed from the VA-48: (A) At top is 260VPP positive-going horizontal-output tube grid waveform. Lower trace is same but negative-going. (B) Top waveform shows 260VPP positive-going vertical-output tube grid waveform. Lower trace is same but negative-going. All following waveforms are positive-going only. (C) Top trace is 260VPP horizontal keying pulse, while 250VPP tube V&H composite sync is shown by the lower trace. (D) Solid-state composite sync of 31VPP is the top trace. Horizontal SCR-gate drive of 31VPP is shown by the bottom trace. (E) At the top is 31VPP horizontal-output transistor base square waves, while the lower trace shows 26VPP vertical-output transistor base drive. (F) Audio sine waves of 27VPP are the top trace, and 28VPP 3.56MHz color carrier is shown by the lower trace. Several video patterns were shown previously.

Drive signal waveforms

Figure 13 shows most of the drive-signal waveforms. Those for horizontal output-tube grid and vertical output-tube grid are shown in both positive (+300VPP) and negative (-300VPP) versions, while all others are pictured in the positive polarity. A few fast-rise waveforms have had the vertical lines touched up to make them visible.

Vertical injection test

The positive vertical output-tube grid waveform was connected to the grid of the output half of the vertical multivibrator oscillator. Because the circuit was not defective, the VA-48 signal and the oscillator signal were interfering with each other and producing an unstable height. When the coupling capacitor between oscillator and output was disconnected and the VA-48 signal injected at the capacitor, almost full height could be obtained. As shown by the pictures and waveforms of Figure 14, the linearity was slightly distorted, but the vertical sweep operated with stability. The lack of good linearity was not important, since the test proved the entire output stage was operating as it should. Similar results were obtained when the VA-48 signal was reduced in amplitude and injected at the oscillator grid.

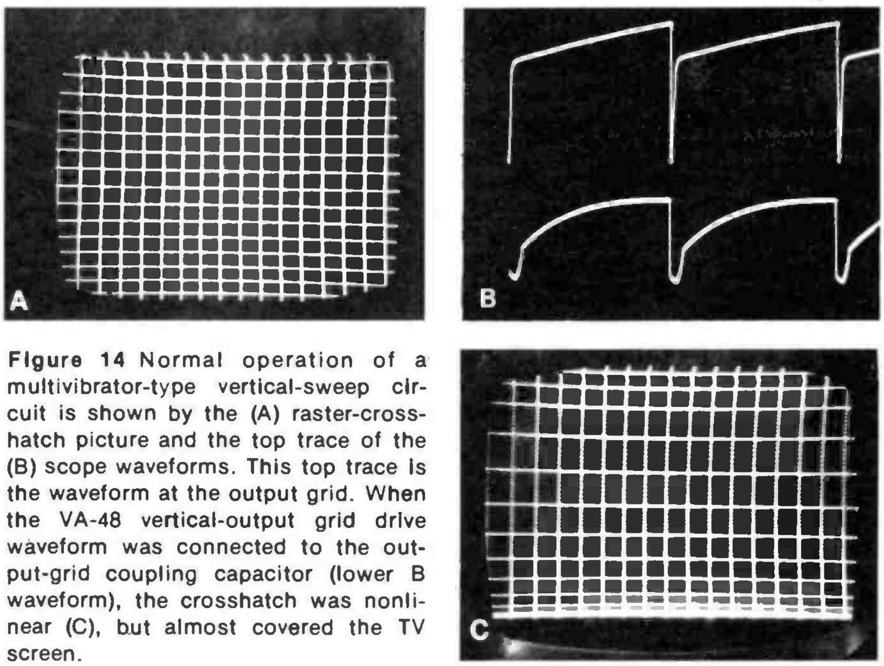
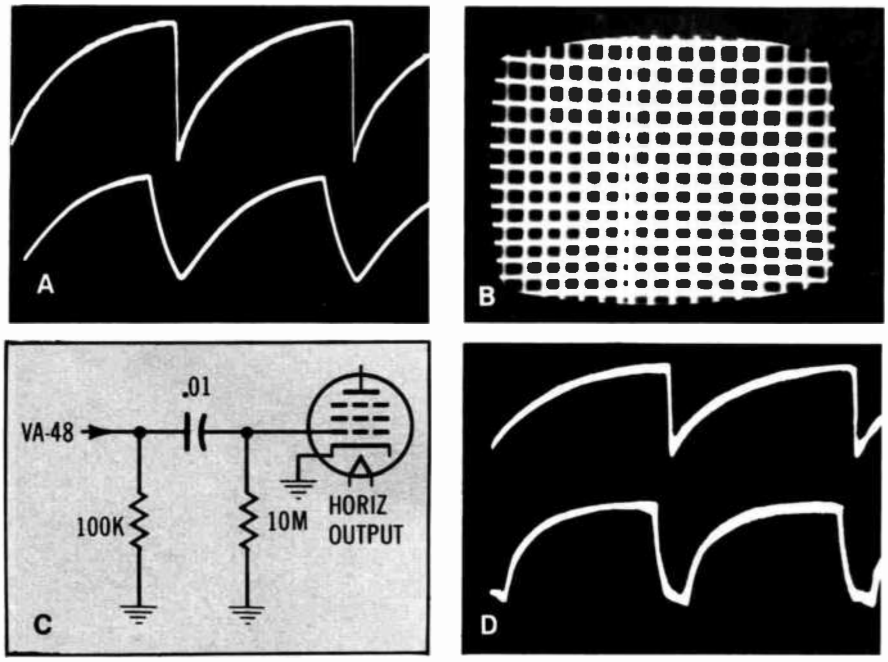


Figure 14 Normal operation of a multivibrator-type vertical-sweep circuit is shown by the (A) raster-crosshatch picture and the top trace of the (B) scope waveforms. This top trace is the waveform at the output grid. When the VA-48 vertical-output grid drive waveform was connected to the output-grid coupling capacitor (lower B waveform), the crosshatch was nonlinear (C), but almost covered the TV screen.



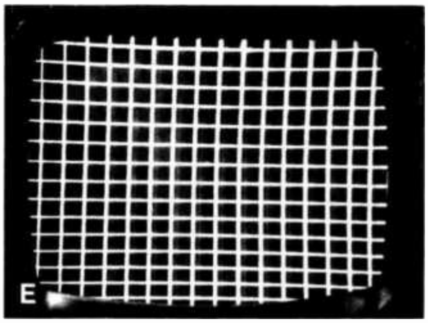


Figure 15 (A) Top scope trace is the normal horizontal-output grid waveform, while the lower trace is the grid waveform when the horizontal output-tube grid VA-48 signal was connected from grid to ground without removal of any components. Circuit capacitances reduced the amplitude and lengthened the retrace time that produced the out-of-focus crosshatch of (B). Disconnecting the oscillator end of the grid coupling capacitor (C) and feeding in the VA-48 signal direct improved the grid waveform (lower trace of D, with normal waveform above), restored the high voltage and gave a perfect crosshatch (E).

Horizontal injection test

First attempt to drive the horizontal-output grid in an old color TV was partially successful. The VA-48 horizontal output-tube grid signal was connected to the grid of the output tube without any circuit changes except to remove the horizontal oscillator tube. As shown in the pictures and waveforms of Figure 15, a careful adjusting of the drive-level control produced an out-of-focus crosshatch pattern with some compression near the center and only about 12kV of high voltage. Of course, this was enough to prove the previous problem was a defective horizontal-oscillator circuit.

The TV model used for the test had two coupling capacitors and two resistors to ground between the oscillator and the output. Therefore, the coupling capacitor (nearest the oscillator) was disconnected from the oscillator and the VA-48 signal was injected there. This time the operation was totally normal, giving full width, 24kV of high voltage and good horizontal linearity.

Video signal substitution

Video patterns from the drive-signals selector switch were injected at various points in the video circuit. Figure 16 shows the successful results of connecting the VA-48 signal to the grid of the first video tube. The frequency response of the bar sweep is not flat because it is normal for the bandwidth to be reduced by video peaking. Whether or not locking is obtained depends on the TV model and where the video signal is injected. Locking was good in this test.

Comments

It was impossible to check all functions of the VA-48 in the available time because there are so many. But all attempted tests performed perfectly.

The VA-48 is said to incorporate tests and functions usually supplied by 10 separate instruments. Many of these signals are unique. These include the bar-sweep patterns and most of the drive signals. The features appear to be very adequate for servicing videocassette recorders, although that application was not explored.

Three general features were most impressive. First is the ability to control the amplitude of these signals as needed. Second in importance is the phase lock between various signals. This is a luxury that a technician probably would not appreciate until after he has attempted to feed in two signals from separate generators. The elimination of extra test leads saves much time and prevents mistakes. Many tests can be peformed with only the RF-IF cable. Others require only a ground lead and one signal lead.

In summary, the VA-48 Sencore is an excellent instrument for MATV, television receiver and videocassette recorder servicing. □

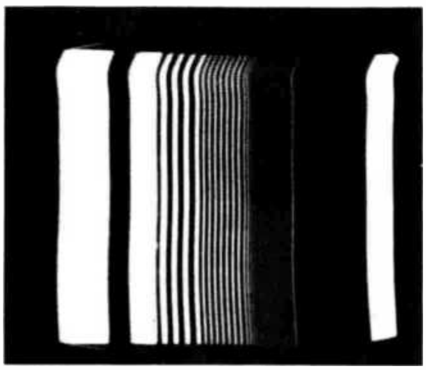


Figure 16 Bar-sweep video from the drive-signals source was connected direct to the video-detector output in an old color TV. The raster picture showed an expected loss of high frequencies, but the contrast was high. This is an excellent way of checking video gain.

This spectacular lightning display silhouetted two Winegard antennas against the clouds of a midwestern storm. MATV systems that do not have proper grounding and protection for the RF transistors often fail during similar storms. *(Photograph by Tom Small, Kankakee, Illinois Daily Journal)*

Lightning protection

Devices and circuits have been developed to protect antenna preamplifiers and MATV line amplifiers from most lightning damage.

By James E. Kluge, technical editor, Winegard Company

When transistorized indoor and mast-mounted preamplifiers became popular several years ago, viewers were pleased by the greatly improved reception of distant or weak TV signals. However, these new preamps sometimes stopped operating for no apparent reason.

Many such preamps were found to have shorted transistors, and investigators discovered that lightning caused the failures. Because of their closeness to antenna and cable, these preamps and MATV line amplifiers were susceptible to damage from lightning. Obviously, some kind of protection was needed.

A direct lightning strike can destroy virtually any or all components, such as transistors, circuit boards, other parts and even the coaxial cable. No known protective system can totally prevent this type of extreme damage.

Instead, the research centered on methods of protecting the input transistor from lightning that produces no visible burned paths, vaporized components, or other obvious destruction.

Although the primary protection today is furnished by a unique diode (Figure 1) at the transistor input, other advances have contributed to the present good dependability.

High-pass filters

Although the principal energy in a bolt of lightning is dc power, each bolt is accompanied by many (perhaps thousands of) random RF pulses that radiate a substantial amount of energy in all directions.

Much of this energy (or the higher harmonics of it) falls within the frequencies occupied by TV signals, and it produces noise streaks across the TV picture.

Some transistor failures can be prevented by including sharp-cutoff high-pass filters that reduce the amplitude of frequencies below 54MHz (where lightning power is greatest) before the combined signal plus noise pulses reach the first transistor.

These noise pulses extend even into the UHF band, but at reduced amplitude. Therefore, UHF amplifiers need only high-pass filters and improved transistors for protection. Amplifiers for VHF (where lightning-caused failures are more likely) require extra protection.

Improved transistors

RF-amplifier transistors have been improved enormously over the years. Gain has been increased while cross-modulation was decreased, noise figures have been reduced and the transistors now can withstand larger input and collector voltages without failures. These enhanced characteristics also have decreased the possibility of failures from lightning discharges.

In general, high-frequency transistors experience a breakdown above 3 to 5V of peak base/emitter reverse voltage. However, transistors of high-voltage ratings typically can withstand up to between 5 and 8V before breakdowns occur.

Translated into actual circuits, this says junction breakdowns probably will result from a negative pulse of greater than 8V between base and emitter. If the junction cannot dissipate the energy fast enough, the resulting heat destroys the junction causing a base/emitter short that ruins the transistor and eliminates all gain. When this happens, the picture disappears into the snow.

Protective diode

Noise pulses of forward-bias polarity produce transistor base-to-emitter conduction that reduces the amplitude below the damage point. However, other protection is required against reverse-bias (negative with NPN transistors) pulses. After extensive lab and field tests, Winegard engineers have produced an effective method of protecting preamps and lineamps at reasonable cost.

A diode having the ability to turn on and off very rapidly is connected between base and emitter of the RF transistor (Figure 2). Notice that the diode polarity is reversed from that of the transistor.

This is a special planar-epitaxial diode that combines the required high-speed operation with low capacitance and high internal power dissipation. Only noise pulses of steep rise times can come through the input filters. Therefore, the protective diode must turn on fast enough to prevent the instantaneous reverse-bias voltage from exceeding the breakdown point. Also, conduction must stop rapidly to prevent loss of the TV signal following the noise pulse. This diode is rated at 2ns recovery time, and the maximum reverse leakage current is only 50μA. Fast switching of the diode prevents the transistor reverse-bias from exceeding about 2V.

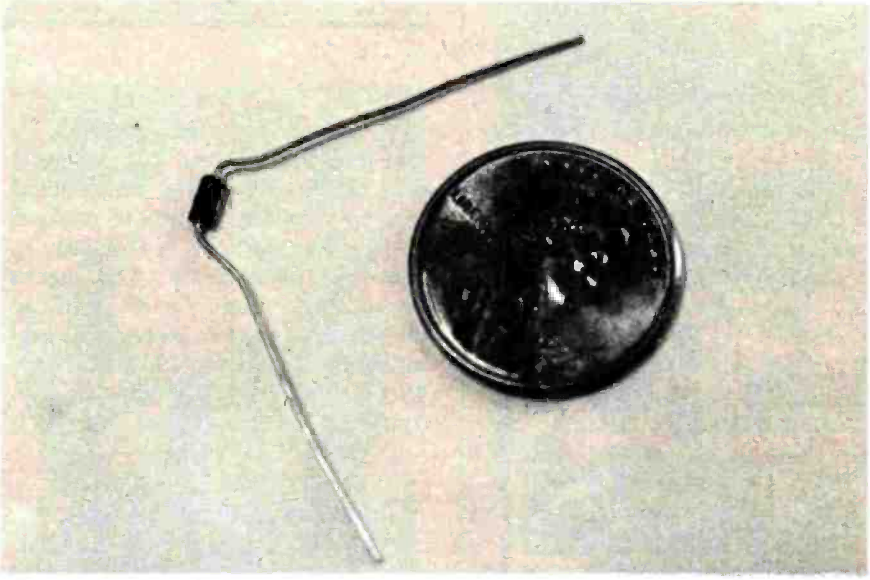


Figure 1 Special diodes used to protect Winegard antenna preamps and MATV line amplifiers are about the size of small power-supply diodes.

Low capacitance is necessary to prevent impedance changes, high VSWR or detuning when the diode is connected. Maximum internal capacitance of this protective diode is 2pF. Also, the protective diode must be capable of dissipating the full pulse power.

Each model of VHF amplifier that is developed in the Winegard engineering laboratory must be able to withstand rapidly repetitive 40kV fast-rise-time pulses without damage. These lab tests indicate that protection has been achieved, and reports from areas having many severe lightning storms seem to confirm this conclusion.

Therefore, unless they receive a direct strike of lightning, properly designed preamps and lineamps *should* operate dependably during electrical storms. □

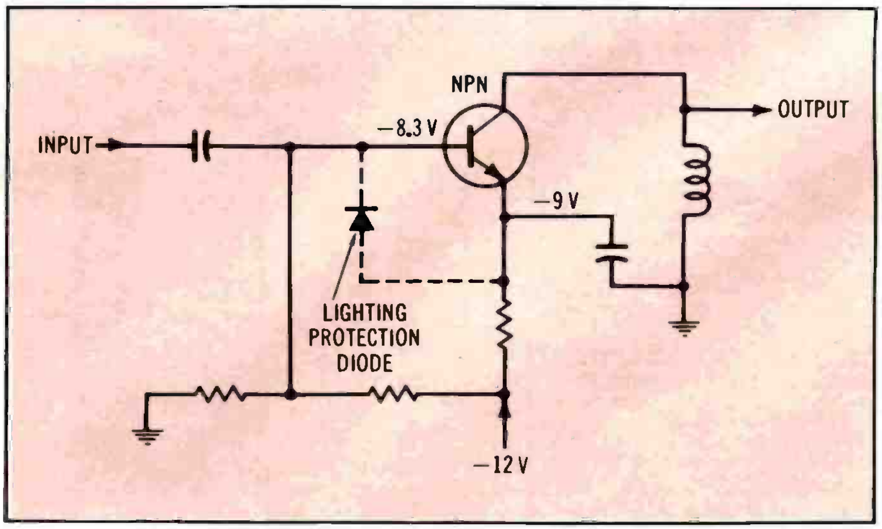


Figure 2 The protective diode is connected between base and emitter of the first RF transistor, as shown in the simplified schematic.

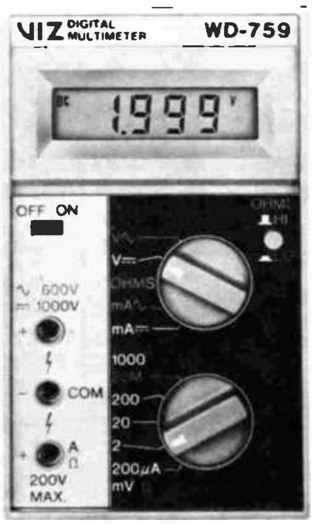
test equipment report

Autoranged digital meter

A fully autoranged digital meter that checks capacitors and inductors for value and ability to perform in-circuit has been introduced by **Sencore.** The Z meter LC53 checks capacitor values from 1pF to 200,000μF to 1% accuracy and inductor values are checked from 1μH to 10H to 2% accuracy. A dynamic capacitor leakage test

measures capacitor current leakage to 10,000μA, with applied voltage in 12 steps from 3V to 600V, detecting leaky capacitors that cannot be found with an ohmmeter. Inductors are checked for quality by a dynamic ringing test that strikes the coil and measures the number of times the coil rings before decaying to 25%. The LC53 markets for $695.

Circle (30) on Reply Card



Two 3½ DMMs

Two 3½ DMMs from **VIZ** provide an accuracy of .1% with an input impedance of 10mΩ according to the company. The LCD model, WD-759, offers visual indication of function in the display window as well as the measurement value. The suggested price is $159. The LED model, WD-758 is identical in electrical performance except that it doesn't provide function indication in the display. Measurement ranges for both are from 100μV to 1000Vdc and up to 600Vac; from .1Ω to 20mΩ and from .1μA to 1A, dc and ac. Price is $149.

Circle (31) on Reply Card

Portable DMM

A portable DMM has just been announced by **B&K-Precision.** Model 2815 is a compact instrument that is shielded against RF interference. It retains accuracy in RF fields so it can be used near 2-way radios or broadcast transmitters up to 450MHz. This new design features high resolution, excellent overload protection and .1% dc accuracy. A major feature is its protection against accidental overloads on all ranges. The ohms range will resist damage from momentary overloads up to 1000V dc or ac peak. Continuous ohms protection is +1000Vdc and -450Vdc or 350VAC.

Circle (32) on Reply Card

productreport

Data cartridge

A data cartridge offering storage for series 9800 desktop computers and 264X-series display terminals has been introduced by **Hewlett-Packard.** Up to 5.4 megabits of unformatted data can be stored on the 98200's 140ft of 0.150-inch tape with a 1600 bit/in recording density on two tracks. Speeds up to 90in/s make short access times and fast transfer rates possible, according to the manufacturer. Acceleration rate up to 2000in/s helps keep start/stop distances to a minimum. The price is $90 a package.

Circle (33) on Reply Card

Static neutralizer

Stat-Free from **Chemtronics** is designed to neutralize static electricity generated by friction and low humidity. According to the manufacturer, it may be used to eliminate static and accompanying dust and dirt on devices such as data

entry terminals, visual display terminals, magnetic tape and disc drives, computer printers and decollators, CRT screens and disc surfaces. Since its coating must be replenished occasionally, 3oz cans are available to MROs for use as leave-behinds.

Circle (34) on Reply Card

Speech processor

The K40 speech processor from **American Antenna** processes speech with a computer circuit. The unit automatically monitors speech and adjusts it in microsecond increments pumping enough dB gain for 400% more power than a standard mic. The electronic storage system recharges while the radio is playing and provides a fresh electrical charge every time the trigger is squeezed. The molded 4-pole internal magnet clamps instantly to any steel surface.

Circle (35) on Reply Card

Power supply

PTS Electronics has designed the MSP-501 fully regulated 5Vdc power supply with an output current capability of up to 5A for microprocessors and other similar electronic devices. Features include a new hybrid regulator and output circuitry for high reliability, noise and ripple of less than 10mv, short-circuit current limiting, and a front panel 4.5 to 6.0Vdc calibration adjustment. The MSP-501 has a $99.95 user net and a 1-year limited warranty.

Circle (36) on Reply Card

catalogs literature

R. F. Gain Ltd's 1979 communications parts catalog features cross references for 2-way systems parts from many major manufacturers. Parts are available off the shelf with 24-hour delivery, according to the manufacturer.

Circle (37) on Reply Card

Philips Test & Measuring Instruments has announced the availability of a comprehensive catalog that contains information, technical specifications and illustrations of all current Philips products marketed by PTMI in the US and Canada.

Circle (38) on Reply Card

Antenna Specialists offers a 6-page brochure, SD-726, that discusses concealed mobile antenna systems. It features the ASP-1000 no-profile, totally concealed UHF antenna and contains information and specifications on the complete A/S line of high and low band VHF and UHF professional disguise antennas, including universal and direct replacement models.

Circle (39) on Reply Card

Littelfuse has introduced a Littelites Selector Guide designed to give buyers and engineers a convenient guide to options available in the Littelites indicator light line. The 4-color foldout chart lists all of the different series in the Littelites line and indicates the types of mountings, terminations, options, and lamps available for each, as well as the UL and CSA status.

Circle (40) on Reply Card

Parker Publishing has announced the availability of a free catalog of new electronics titles. The catalog features books on digital test equipment, reading schematic diagrams, troubleshooting, color TV servicing, home electrical repairs, digital integrated circuits, solar energy, microelectronics and tape recorder servicing.

Circle (41) on Reply Card

Micro Electronic Systems is offering its 1979 DIP insertion, extraction and handling systems catalog. It contains 20 pages of specialty tools.

Circle (42) on Reply Card

the marketplace

Advertising rates in the Classified Section are 35 cents per word, each insertion, and must be accompanied by cash to insure publication.

Each initial or abbreviation counts a full word.

Minimum classified charge $3.00.

For ads on which replies are sent to us for forwarding (blind ads), there is an additional charge of $3.00 per insertion to cover department number, processing of replies, and mailing costs.

Classified columns are not open to advertising of any products regularly produced by manufacturers unless used and no longer owned by the manufacturer or a distributor.

For Sale

AM RADIO reception for interiors of buildings, ships, etc. Catalog. EXTRONIX, 64 Gough, Ivyland, PA 18974. 5-79-6t

REPLACEMENT COLOR YOKES—DEALER ONLY. Zenith 95-2501-2532-2638-2667-S-89633 etc. $19.94, Magnavox 361380-1 $21.95, Sylvania, GE etc. $17.95 to $22.95. Request for price list on your letterhead. David Sims Enterprises, Inc., 665 Jericho Turnpike, Huntington Station, N.Y. 11746, (516) 549-3925. . 5-79-tf

AUTOMOBILE RADIO and tape replacement parts: Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. Laran Electronics, Inc., 3768 Boston Road, Bronx, NY 10469, (212) 881-9600, out of New York State, (800) 223-8314. 5-79-tf

TV & RADIO TUBES, 36 cents EA!! Free color catalog. Cornell, 4221 University, San Diego, California 92104. 8-76-tf

ELECTRONIC SURPLUS: CLOSEOUTS, LIQUIDATIONS! Parts, equipment stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog. ETCO-011, Box 762, Plattsburgh, N.Y. 12901. 6-78-tf

COLOR PICTURE TUBE REBUILDING EQUIPMENT. Semi automatic electronically controlled process. Complete training. Call or write Atoll Television, 6425 W. Irving Park, Chicago, IL 60634. Phone 312-545-6667. 7-79-3t

SATELLITE TELEVISION—Movies, sports, etc. Build or buy your own earth station. Send $3.00 for information. Satellite Television, Box 140, Oxford, N.Y. 13830. 9-79-2t

FOR SALE: TV, stereo, CB test equipment, B&K, Sencore, fairly new, excellent condition. Send for complete price list of available equipment. R.J.P. Electronics, 155 Central Ave., Old Tappan, N.J. 07675. 9-79-1t

REMOTE CONTROL: 2 channel transmitter and receiver module—$14.50. Walnut cabinet—$5.00. Free catalogue. Project Electronics, 1511 Nuuanu Ave #33B, Honolulu, Hawaii 96817. 9-79-2t

SEVEN SOLID STATE INSTRUMENTS, SAMS, parts, more—clean package $1195. Russell Yates, 904 Pershing, College Station, Texas, 77840, (713) 696-7881. 9-79-1t

SAMS PHOTOFACT CB RADIO SERIES, Volume 1 to 65—$150. Cliff Newton, Wathena, KS 66090, 913-989-3461. 9-79-2t

TV SALES & SERVICE—Zenith dealer. Heart of So. Calif. Owner moving. Good business established. Write to: Chuck's Color TV, 662 So. Azusa Ave., Azusa, Calif. 91702, (213) 334-4318. List at $30,000.00. 9-79-1t

SAVE HUNDREDS: American Made quality Head-Ends, V/V, U/V Converters, Camera Modulators. Mid-band available. Factory Prices. Also small CATV System amplifiers. Send $5.00 (or letterhead). Box 809, Boynton Beach, Fla. 33435. 5-79-EOM

Advertising Services

TERRIFIC SWAP OFFERS NATIONWIDE! 7 issues $3.50. "Electronics Trader," Box 73-ES, Folly Beach, SC 29439. 1-79-tf

Wanted

WANTED TO BUY—TV test/repair equipment, supplies, parts, SAM's, carts—whatever is needed for retail TV sales/service operation. Verdi, 6 La Jolla Ct., Ormond Beach, Florida. Call collect (904) 672-8772. 9-79-1t

TUNER TECHNICIAN. 18 months experience or more. Unique opportunity. 40% Commission on labor, 5% on parts, and 40% on additional shipping charges. Send resume to P.O. Box 6456, Oakland Park, Fla. (Fort Lauderdale). 9-79-2t

TV TECHNICIAN AND DEALERS, "INCREASE YOUR INCOME THOUSANDS OF DOLLARS YEARLY," "Rent-Lease-Sell TV's with a guaranteed system," Send stamp for free details, basic plan $15.00, deluxe version $25.00, master plan $40.00...Perry's Rental System, Box 881, Morro Bay, CA 93442. 8-79-3t

Help Wanted

CLOSED CIRCUIT TELEVISION TECHNICIAN: University of Illinois seeking maintenance technician for small format television equipment. Starting $13,270, raises to $17,035 over two years, plus annual increases. Two years electronics study, two years electronic maintenance required. Contact: Don Swift, Personnel Services, University of Ill., Champaign, IL 61820, (217) 333-3109. Affirmative Action, Equal Opportunity Employer. 8-79-3t

TECHNICIANS WANTED: Television-audio-communications. Excellent fringe benefits, salary depends on experience. Miller's Electronics, Highway 24, Goodland, Kansas 67735, 913-899-2386. 8-79-2t

Business Opportunity

MEN/WOMEN FOR FUN! Shaklee Independent Wholesale Distributors earn $200-$5,000 monthly, Bonus, New Car, Etc. Details, Golden, RT2, Box 392ES, Fair Grove, MO 65648 Phone (1-417) 759-2738. 3-79-12t

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Des Plaines, IL 60018
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Helen Hull, P.O. Box 12901
Overland Park, KS 66212
Phone: (913) 888-4664

NEW YORK, NEW YORK
Joe Concert, 4 W. 58th St.
New York, NY 10019
Phone: (212) 888-1977

FT. LAUDERDALE, FLORIDA
Brinker and Brinker
2240 N.E. 53 Street
Ft. Lauderdale, FL 33308
Phone: (305) 771-0064

SAN FRANCISCO, CALIFORNIA
John MacKay, 703 Market St., Room 1109
San Francisco, CA 94103
Phone: (415) 546-1040

LONDON, ENGLAND
John Ashcraft & Co., 12 Bear St.
Leicester Square, London, WC2H 7AS
England, Phone: 930-0525

AMSTERDAM, HOLLAND
John Ashcraft & Co., John J. Lucassen
Sloterweg 303
1171 VC-Badhoevedorp, Holland
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2-29 Toranomon 1-chome, Minato-ku
Tokyo 105, Japan
Phone: 502-0656

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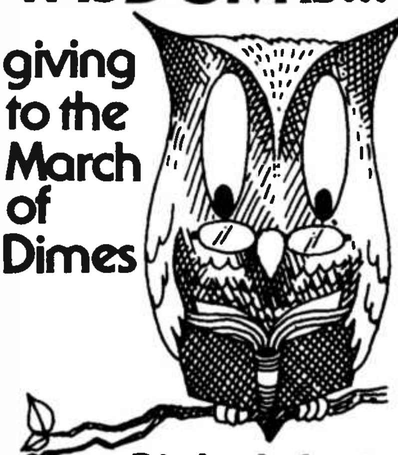

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England, Phone: 930-0525

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TOKYO, JAPAN
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Tokyo 105, Japan
Phone: 502-0656

Take the step up from handheld DMM's

To Fluke's new 8010A and 8012A bench/portable DMM's. You'll find all the features of our popular 8020A handheld DMM plus many more capabilities (some not found in any other DMM) in these two instruments. At prices only a few dollars more than most handhelds.

A sensible package with sensible features. The 8010A and 8012A's bench/portable design is ideal for those who want the best of both worlds. They fit smartly on your bench and use ac power or get right up and go to the job with you. Optional rechargeable batteries are available. Both incorporate the same design goals that made our handheld 8020A DMM so rugged and reliable.

Extensive overload protection (to 6000V) and 0.1% basic dc accuracy make for two DMM's you can really rely on. 20 basic ranges of ac and dc volts and current, six ranges of resistance plus three ranges of conductance prove their measurement versatility.

Conductance = 1/Resistance. It's a unique way to measure high resistance and check leakage in capacitors, pcb's, cables and insulators, and general use above 20 MΩ. A Fluke exclusive found in both the 8010A and 8012A. Ask for our Conductance Measurements Application Note.

To tell the truth. Fluke's hybrid true RMS converter gives you the honest ac answers you demand. You can measure non-sinusoidal waveforms out to 50 kHz without missing any significant distortion components.

Exclusive capabilities for surprising prices. For high current measurement applications, the 8010A boasts an extra 10A range for $239*. The 8012A replaces the current range with another important feature — two low ohms ranges, making it the world's widest range ohmmeter. Its 1 milliohm resolution (on the 2Ω range) is ideal for locating shorts in circuit boards and motor windings. All for only $299.*

Handheld or bench/portable: It's your choice. Whichever best fits your application, you can buy them both from Fluke. With confidence that you'll be owning the finest quality DMM's available. Contact the Fluke stocking distributor, sales office or representative in your area or call:

800-426-0361

If you prefer, just complete and mail the coupon below.

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*U.S. Prices only.

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☐ Please send 8010A/8012A specifications.
☐ Please have a salesman call.
☐ Please send me your Conductance Measurements Application Note.

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ES 9/79