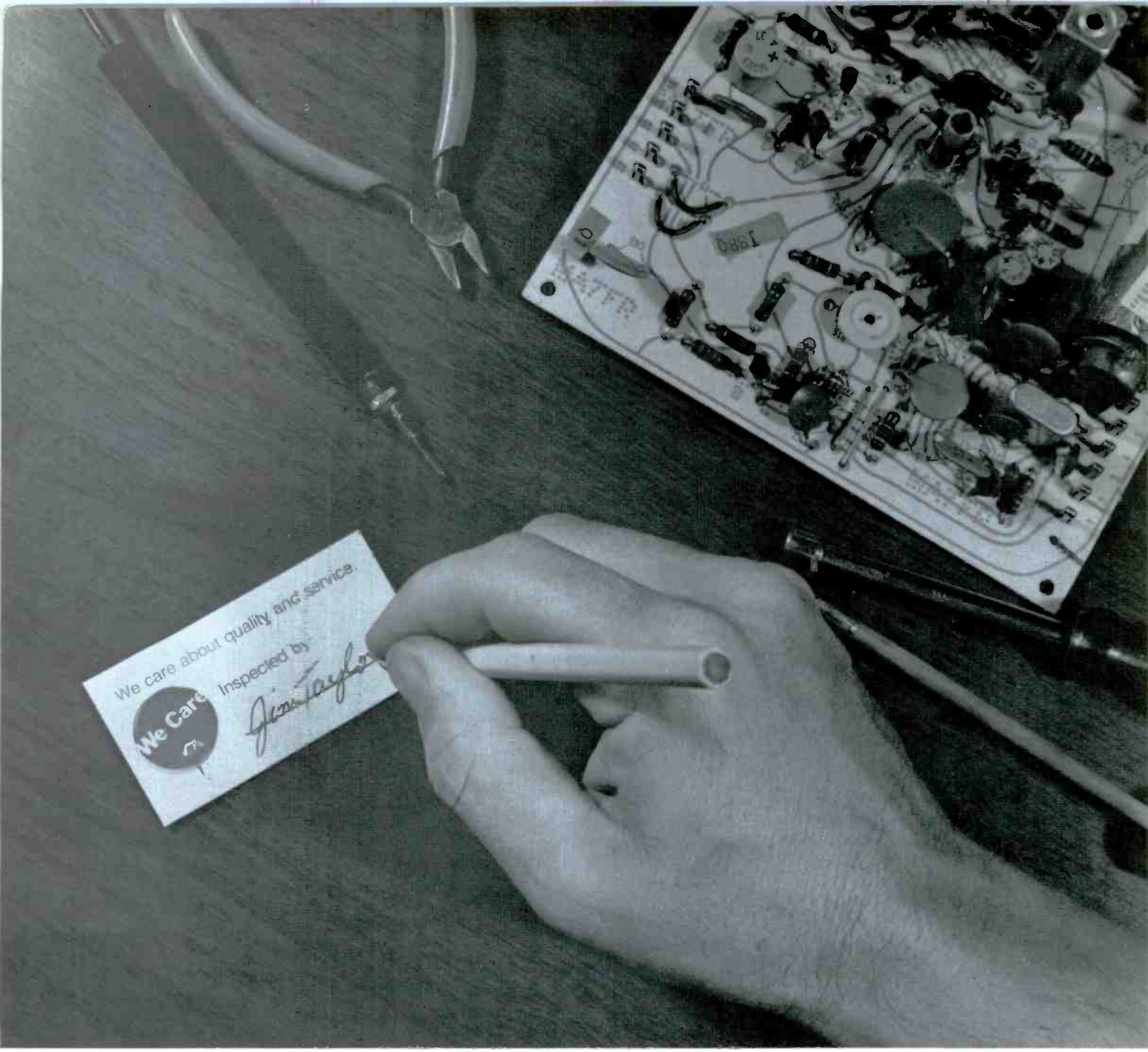
ELECTRONIC™

Servicing & Technology

OCTOBER 1982/$2.25

Is it the TV or is it the cable?

Servicing high-voltage triplers.



Depend on the quality inspection that says "We Care" about your tuners and modules.

At PTS, service is our only business. That's why every tuner and module that comes through for rebuilding gets our "We Care" attention from start to finish.

Each module and tuner is sent through a nine-step rebuilding cycle of which four steps are quality control inspection. Then we back up each quality part with a full year limited warranty.

So, when that final inspection sticker is signed you can be sure of a thorough job.

Only one company has the "We Care" spirit in quality inspection.

Only One.

PTS CORPORATION

For the name of the PTS Distributor or Servicenter nearest you write PTS CORPORATION, P.O. Box 272, Bloomington, IN 47402.

Circle (1) on Reply Card

ELECTRONIC
Servicing & Technology

Editorial, advertising and circulation correspondence should be addressed to: P.O. Box 12901, Overland Park, KS 66212-9981 (a suburb of Kansas City, MO); (913) 888-4664.

Member, Audit Bureau of Circulation

Member, American Business Press

ELECTRONIC SERVICING & TECHNOLOGY (USPS 462-050) (with which is combined Electronic Technician/Dealer) is published monthly by Intertec Publishing Corp., 9221 Quivira Road, P.O. Box 12901, Overland Park, KS 66212-9981. Second Class Postage paid at Shawnee Mission, KS 66201. **Send Form 3579 to P.O. Box 12952, Overland Park, KS 66212-9981.**

ELECTRONIC SERVICING & TECHNOLOGY is the "how-to" magazine of electronics. It is edited for electronic professionals and enthusiasts who are interested in buying, building, installing and repairing home-entertainment electronic equipment (audio, video, microcomputers, electronic games, etc.).

SUBSCRIPTION PRICES: one year $15, two years $26, three years $34 in the USA and its possessions. Foreign countries: one year $20, two years $30, three years $40. Single copy price $2.25; back copies $3.00. Adjustment necessitated by subscription termination to single copy rate. Allow 6 to 8 weeks delivery for change of address. Allow 6 to 8 weeks for new subscriptions.

ISSN 0278-9922

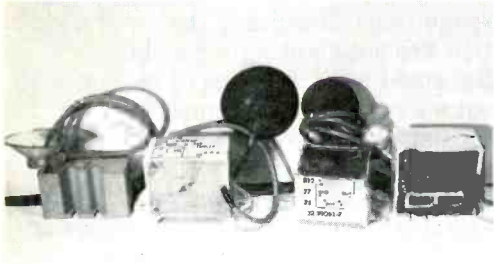
INTERTEC PUBLISHING CORP.

The how-to magazine of electronics...

ELECTRONIC
Servicing & Technology

October 1982
Volume 2, No. 10

The Zenith Video High-Tech Component System is one of the many systems to choose from in the developing field of component television. See story on page 32. *(Photo courtesy of Zenith.)*



Page 26

Page 32

Page 56

Departments

Next month...

Digital building blocks: Clocking is often misunderstood, but if the clock system does not function properly, the entire digital system will malfunction. This article clarifies clocking and puts the pieces together into a comprehensive whole.

Future may bring major changes in television

What might we expect from television in '83? It's not easy to say. There could be some exciting things happening in the near future for U.S. television. They aren't new as far as worldwide broadcasting is concerned, but they are new for the American audience.

Three-dimensional pictures. The 3D Corporation, a West Coast group, has developed a color separation technique to present the third dimension on our home screen, if we wear the special glasses. Perhaps, if they can work out a number of problems in the technique, a majority of viewers will actually see the effect. Contrary to the glowing reports from some PR firms, the films have not been breathtakingly successful.

Improved audio. More and more attention is being expressed to get better television audio. Once the receiver manufacturers begin to catch on to the need for an improved audio system in the home receiver, perhaps we will hear a wider bandwidth of audio frequencies. Then, with some ingenious work being done by the United States – and already in use in Tokyo by NHK Television and in Germany by the ZDF network – we could even receive dual-channel or stereo sound with our pictures. Fine-arts buffs should appreciate a symphony in stereo. Those with international interests will appreciate a chance to hear bilingual broadcasts of news and other program fare.

Second channel displays. Both Japanese and German companies have worked on TV receivers that display two pictures simultaneously. For the sports fans, imagine the pleasure of watching and hearing the big game in color, while being able to keep up with the action (in video) of a not-so-big game being carried on another channel. At the touch of a remote-control button, the two channels may be reversed, allowing the secondary video and audio to be on the primary display – all using only one CRT. Another version uses smaller picture tubes on the side for the second (and even third) channel.

High resolution. The so-called High Definition Television (HDTV) concept will not be introduced to the public in 1983. There are too many problems yet to be solved. The idea, however, should prove interesting when it does come about. Experiments which have been performed with CBS, in cooperation with NHK and other organizations, have shown that an immensely improved picture is possible. New receiver designs are required, as the compatibility with the current NTSC system of transmission is unlikely. Expect the purchase prices to be high.

Information services. Teletext or visual text services may make big news in the near future. In England and Canada, farmers may use their television (and telephone) to receive a myriad of special information sources in specific data areas. Animal husbandry, all-you-ever-wanted-to-know-about topics (asparagus, anchovies and assorted agricultural subjects), entertainment, travel – the list could be unending. Current experiments in the United States involve equipment built into the television that stores data for the viewer to select on a page-by-page basis. Results of the experimentation are not showing what the systems people would hope in terms of viewer acceptance, but viewership is extremely limited – perhaps at most 100 sets involved in any particular test system.

Direct by satellite. Depending upon what finally is decided on geosynchronous satellite spacing and frequency allocations, we may be able to see pictures direct from the satellite through the DBS system. There is a great argument in progress as to how such a system will be used. For the consumer, the outlook is somewhat expensive, because a satellite-receiving dish antenna will be required. Most manufacturers are predicting that the receiving systems *could* be priced in the $5000 range. But as with Low Power Television (LPTV), which already has the go ahead, the question of what we will see to be worth the effort is certainly questioned.

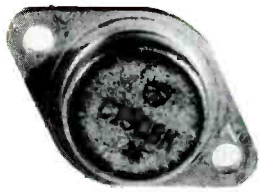
Expanded cable services. By the time the cable TV operators are finished expanding their capabilities, they will still not be able to carry all of the proposed cable services. While there was a prediction of some 200 services via satellite, some are already going under. More will follow, as there is not really a market for umpteen movie services, even if they do offer X-rated movies. Stereo audio is being offered by some, requiring that you have an extra outlet installed (for an extra cost, in most cases) for your FM receiver. Then, assuming that some of the problems of FM by cable are worked out, you will perhaps appreciate simulcast-type audio with your pictures, just as you can get with some of the efforts being made by land-based broadcast stations. Text by television is also a possibility, as is 24-hour news from Turner Broadcast and others. Don't, however, plan on knowing everything about any given subject on the news, as it is played in 20-minute cycles (or thereabouts) and the result is a very hyped-up newscast, much like local TV news. Perhaps someone will discover the PBS news-in-depth concept one day! And, contrary to advertising promotions by cable, expect more and more advertising on the special cable channels. They have to make ends meet one way or another.

Component Television. Perhaps the idea of the TV tuner next to the easy chair is inviting, but

OCTOBER SPECIAL

2SC1308K

Horizontal Output Transistor Equivalent to ECG 238*



V_{CBO} : 1500V
I_C : 7A
P_C : 50W

Also Replaces:

ECG 165*	C1875	D350
C1172B	C1893	D368
C1413A	C1894	D380
C1174	C1922	D627
C1295	C1942	D649
C1309	D200	D663
C1358	D201	D869
C1454	D348	D870

And Many Others Too Numerous To List!

*ECG is a registered Trademark

$2.79 10-99 Pieces

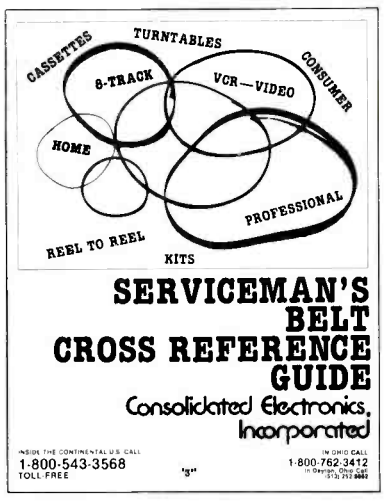
$2.39 100 or More

Minimum Order 10 Pieces
Special Good Thru October 31, 1982.

Call For Our 16 Page October Flyer

The Serviceman's Belt Cross Reference Guide

The most complete belt cross reference guide available.



FREE
With the Purchase of Either BK-1 or BK-2

$3.95

PART NO. CEI 451

8-Track Belt Kit

PART NO. BK-1

Contains one each:
FS 7.0, FS 7.5, FS 8.0, FM 8.4, FM 8.6, FM 8.9, FM 9.1, FM 9.6, FS 10.2, FM 10.6, FM 10.9, FM 11.0, FM 11.3, FM 11.5, FM 11.7, FM 11.9, FM 12.0, FM 12.1, FM 12.2, FM 12.4, FM 12.6, FM 12.8, FM 13.5, FM 13.9, FM 14.4

25 Pieces Total

$19.95 each **2 for $34.50**

Cassette Belt Kit

PART NO. BK-2

Contains one each:
SS 2.6, SS 3.4, SM 4.2, SS 4.6, SS 5.1, SM 6.1, SS 6.2, SM 7.5, SM 8.0, SM 8.5, SS 8.8, SS 8.9, SS 9.1, SM 9.9, SS 10.0, SS 10.5, SS 11.0, SS 11.4, SM 12.1, SM 12.4, SS 13.3, SS 13.6, RS 1.2, RS 3.7, RS 5.0, RS 5.8, RS 5.9, RS 6.1, RS 7.0, RS 7.7, RS 9.3, RS 10.1, RS 10.8, RS 11.7, RS 11.9

35 Pieces Total

$19.95 each **2 for $34.50**

Low Minimum Order, ONLY $10.00

TOLL FREE: CALL TODAY!

NATIONAL
1-800-543-3568

OHIO
1-800-762-3412

CEI

Consolidated Electronics, Incorporated

705 Watervliet Ave. • Dayton, Ohio 45420

Circle (5) on Reply Card

how do you watch it that closely. You don't. Instead the picture tube is mounted in an enclosure and placed on the bookshelf across the room, and the audio is offered from a separate stereo system. While the component concept has been around for some time, an assortment of problems held it back until now. Wiring, to connect the display with the receiver, presents some problems with capacitive and inductive effects, not to mention the safe transfer of the 24,000Vdc potential required for the CRT. The high-voltage system, of course, can be built into the CRT box, to reduce the shock hazard.

Framed picture television. An off-shoot of a component TV system would be to hang the picture on the wall in a convenient place. More than 10 years ago, the idea was discussed in one of the popular magazines, but LEDs for blue were not available and getting them to switch fast enough to work for television was not possible. LEDs still present a problem, but something new is out. Unusual shaped CRTs (still small now, but R&D is under way) and LCD displays (one available in a wristwatch format) with 32,000 picture elements are both on the market. Since 2-way communications from a small, personal-sized unit via satellite was demonstrated in Canada several years ago, it is time to warn Dick Tracy to look out!

What might we expect to see by television in 1983? About what we're seeing now, unfortunately!

Carl a Bentz

Carl Bentz
Technical Consultant

ELECTRONIC SCANNER

Microcomputer interference control hot line opens

Electronic Specialists has opened a toll-free interference-control hot line. The line (1-800-225-4876) is open between 9 a.m. and 4 p.m. Eastern time, Monday thru Friday for persons with microcomputer interference control problems. Experienced staff will analyze the situation and make specific recommendations for control of processor or peripheral interference.

Panasonic to launch new parts distribution system

Panasonic has announced a major project that is expected to cut product parts shipments from overseas to customers by more than two weeks and to substantially reduce the time needed to process parts orders for regional distribution.

The project includes establishment of a new national Parts Distribution Center on the West Coast and the installation of two, computer-controlled, automated parts storage and retrieval systems.

Approximately 86% of the parts for Panasonic products are sent from Japan by sea. Establishment of the Parts Distribution Center will reduce the transportation time from the shipping point in Japan to each of Panasonic's regional warehouses by up to 23 days, according to David Kurpit, General Manager of the Consumer Parts Division.

ASSOCIATION NEWS

ETA elects officers for 1982-1983

The Electronics Technicians Association has announced the election of new officers for 1982-1983. The new chairman is Donald Anker, CET, Marshalltown, IA, of Fisher Control Corp.

Other officers include Vice Chairman Grover Harvey, CET, Indianapolis, Naval Avionics Facility; Secretary Walter Schwartz, Knoxville, TN, NAP Consumer Products; and Treasurer Jesse B. Leach, CET, Lithicum, MD, Lee's TV.

Harvey was also selected as Technician of the Year, ETA's highest award.

Salaries in service department increase

The average national service manager now receives an annual salary of $37,073, according to a survey conducted by Dr. Steven Langer under the sponsorship of the National Association of Service Managers. Similarly, the average salary of regional service managers is now $31,425, of local service managers is $28,773, of field service supervisors is $24,206, of field service engineers is $22,212, of field service representatives is $19,489, and of bench service repairmen is $16,885.

Copies of the 112-page survey report are available for $95 from Abbott, Langer & Associates, P.O. Box 275, Park Forest, IL 60466. More than 260 companies provided salary information on more than 16,000 service department employees in 12 benchmark jobs.

When you need a semiconductor that fits and works, turn to the Master.

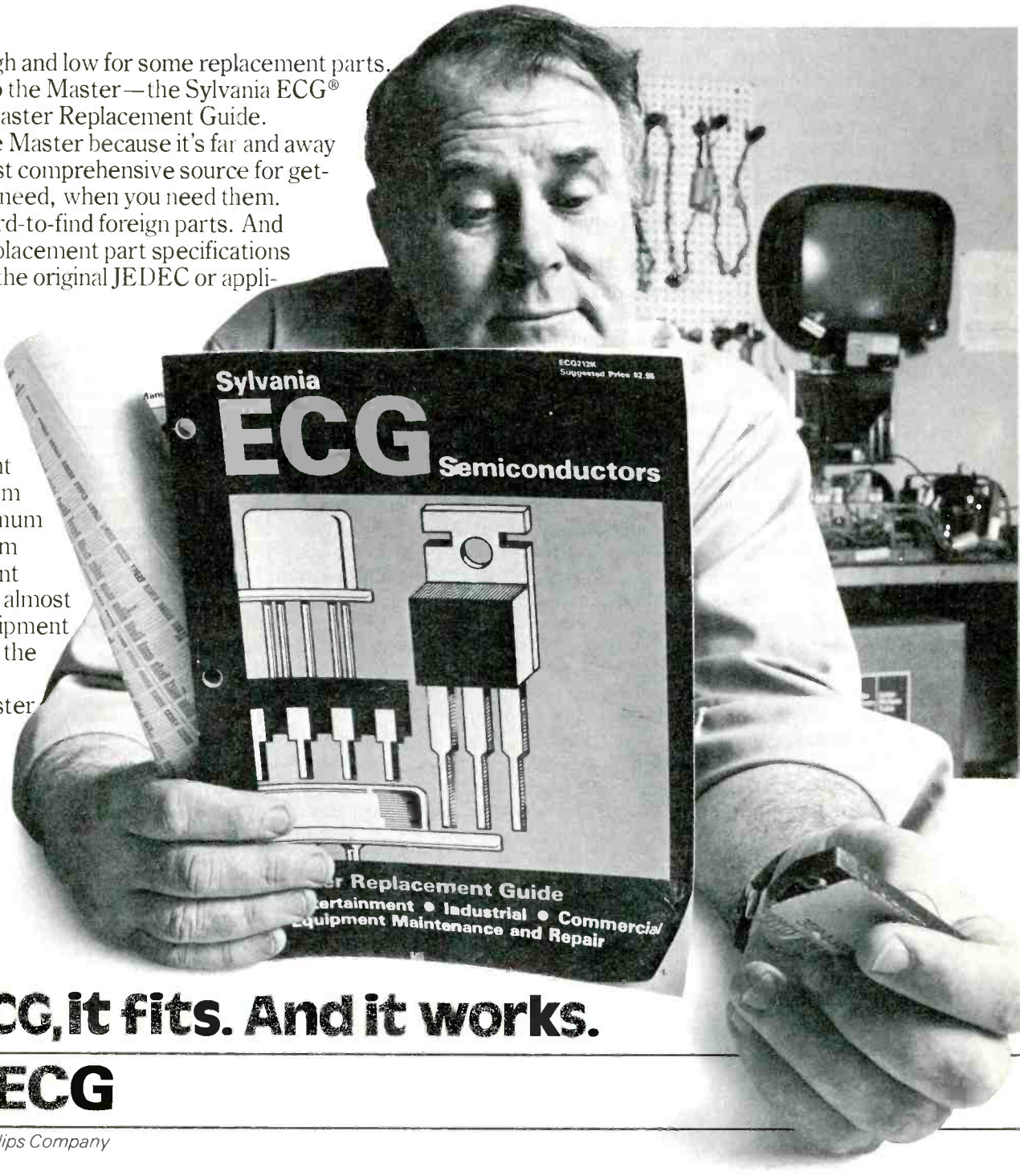
You can search high and low for some replacement parts. Or you can turn to the Master—the Sylvania ECG® Semiconductor Master Replacement Guide.

It's called the Master because it's far and away the industry's most comprehensive source for getting the parts you need, when you need them. Including most hard-to-find foreign parts. And ECG universal replacement part specifications generally exceed the original JEDEC or application specs.

Not surprisingly, the Master comes from the people who first mastered the universal replacement principle—a system that allows a minimum number of premium quality replacement devices to replace almost every original equipment semiconductor on the market.

With the Master working for you, there is no need to turn elsewhere for replacement semiconductors.

For your nearest ECG distributor, call 1-800-225-8326.



If it's ECG, it fits. And it works.

PhilipsECG

A North American Philips Company

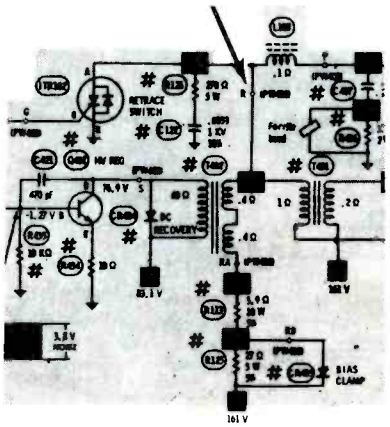
TROUBLE-SHOOTING TIPS

Drifting horizontal frequency
RCA CTC78
(Photofact 1628-2)

The color receiver operated correctly for a time before the picture fell out of horizontal lock, showing the familiar diagonal bars instead of the picture. We installed a MAH001 horizontal module and operated the receiver for about four hours. Performance appeared to be normal, so the customer came for it. The CTC78 receiver operated satisfactorily for four days before the horizontal frequency drifted out of lock again.

This time, a rebuilt MAH001 was installed, but the receiver did not operate at all. Next, we installed a MAH001 module that was known to be good, and gave back the receiver to the customer. The television was returned to us shortly, with a report that it worked for about 30 minutes before losing both picture and sound; *a new symptom.*

A careful visual examination of the horizontal section revealed that another service shop had previously re-soldered many joints in the MAH001 area. Then we remembered several other repairs on similar RCA SCR-sweep chassis that involved bad soldered joints around T401 and T402. Probably the transformer weights contributed to the joint deterioration. Such joints should be re-soldered carefully, making certain the transformer lugs are tinned properly.



We traced the copper wiring on top of MAH001. Between T401 and T402 is lug R, and an erratic connection was found there. After this lug and the transformer lugs were soldered carefully, the intermittent was cured.

Lowell Britt
Gold Star TV Service
Boise, ID

No high voltage, but boost is normal
Admiral 2127P
(Photofact 1392-1)

The Admiral chassis had near-normal boost voltage but no high voltage. Neon-bulb and arc tests showed the flyback high-voltage doughnut had no ac pulses. Therefore, *I concluded that the flyback must be defective,* and that the yoke, damper circuit and horizontal-output circuit were operating normally.

Unfortunately, the installation of a new flyback did not improve the situation. After many futile tests in the flyback area, I decided to check the grid-drive signal of the horizontal-output tube. The dc grid voltage checked about right when measured by a VTVM. However, scope tests of the sawtooth drive signal proved the frequency was out of tolerance about 200%.

Component tests in the horizontal-oscillator circuit located an open in decoupling filter capacitor C10D (between the oscillator coil and its B+ source). A new filter capacitor restored the high voltage and operation was normal.

The normal boost voltage fooled me because I believed the high voltage and boost voltages always increased and decreased in step.

Samuel Martinez
Bayamon, Puerto Rico

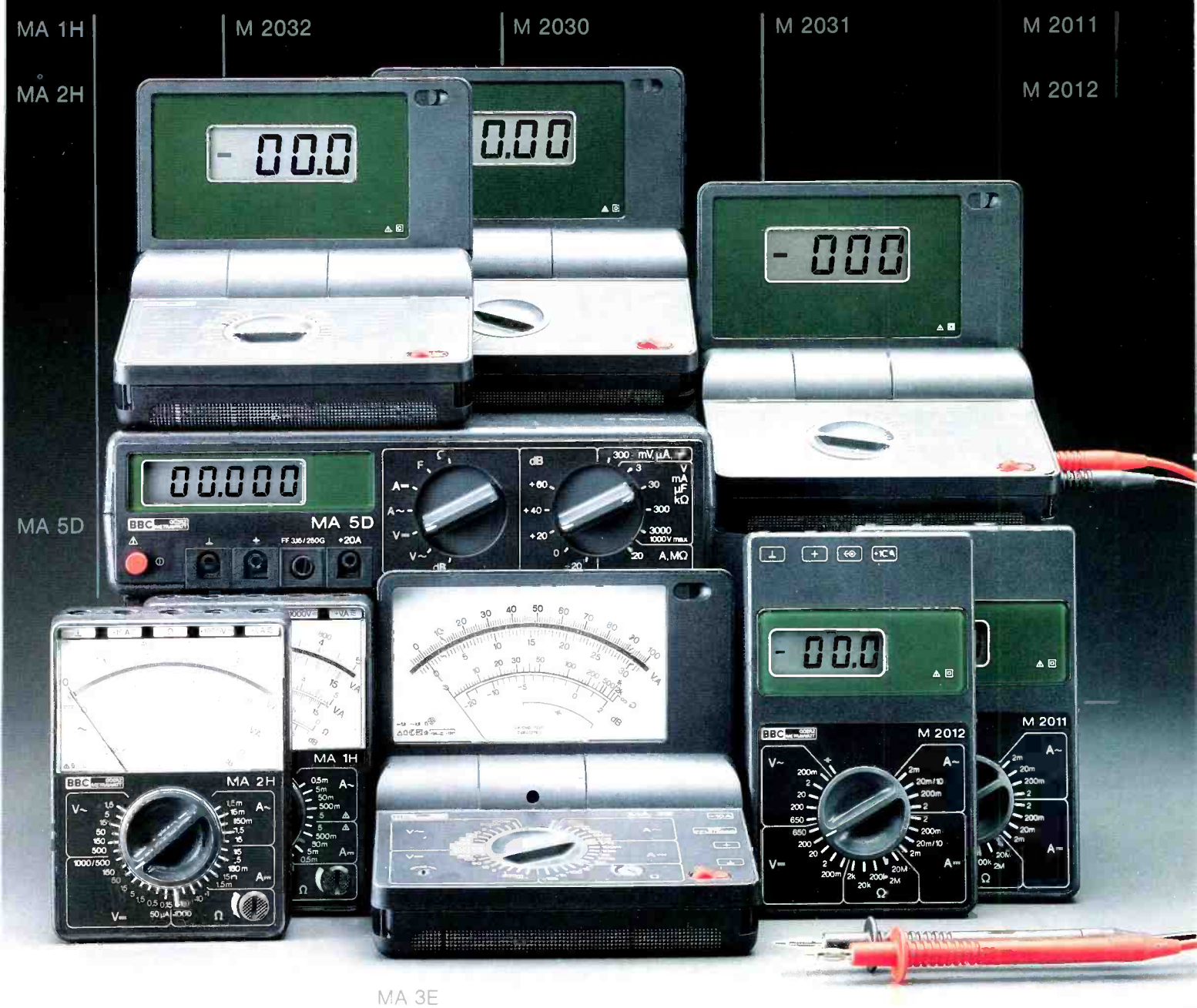
Editor's Note: It is a dangerous oversimplification to think the high voltage and the boost voltage *always* should rise and fall together, although the 6BK4-type high-voltage regulator operation is based on that assumption. The high-voltage rectifier operates on the positive peak of the flyback ringing pulse, and the damper operates on (and completely removes) the negative peak.

BBC BROWN BOVERI GOERZ METRAWATT

MULTIMETERS

The new line of high quality multimeters with analog or digital display.

Outstanding in performance, design and value!



NAME _____

TITLE _____

FACILITY _____

ADDRESS _____

_____ Zip _____

PHONE NO. _____

I would like to receive:

☐ Catalog information only

☐ Representative Call

☐ Name of your nearest Distributor

Model No. _____

Quantity: _____

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL
FIRST CLASS PERMIT NO. 140 EDISON, NJ

POSTAGE WILL BE PAID BY ADDRESSEE

BBC-METRAWATT/GOERZ
165 Fieldcrest Avenue
Edison, New Jersey 08837

BBC BROWN BOVERI GOERZ METRAWATT

USA
BBC-METRAWATT/GOERZ
Raritan Center
165 Fieldcrest Avenue
Edison, NJ 08837
Phone: (201) 225-4414
Telex: 844431

CANADA
RADIONICS LTD.
1240 Ellesmere Rd.
Scarborough, ONT
M1P 2X4
Phone: (416) 292-1575
Telex: 06-963726

Order from your local Distributor, or call BBC-METRAWATT/GOERZ for your nearest dealer.

WARRANTY:

Analog Meters: 1 year

Digital Meters: 2 years

Mod. M 2032: 3 years

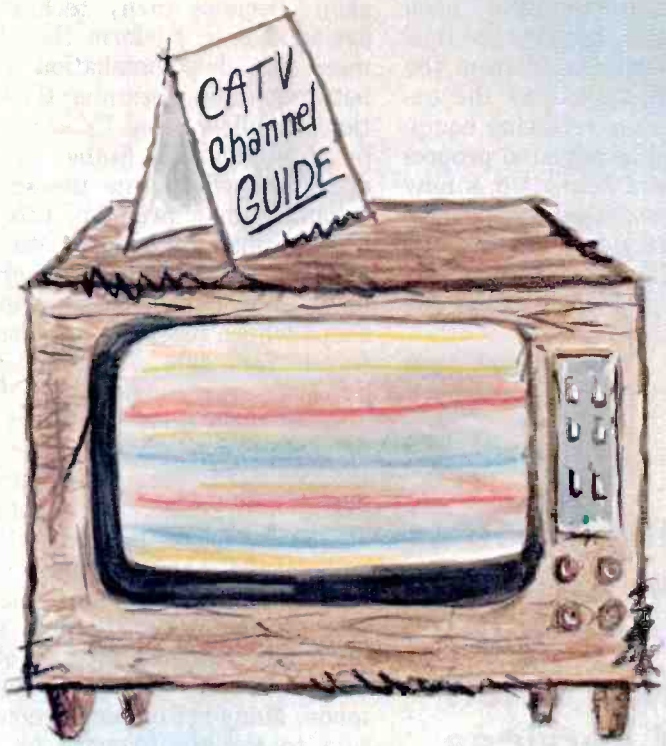
Model	MA 1H	MA 2H	M 2011	M 2012	MA 3E	M 2030	M 2031	M 2032	MA 5D
Readout	analog		digital		analog	digital			
Ranges:									
Voltage	0.15 . . . 1000 V dc/1.5 . . . 500 V ac		200 mV . . . 650 V ac/dc		100 mV . . . 1000 V ac/dc	200 mV . . . 650 V ac/dc			300 mV . . . 1000 V ac/dc
Current	50 µA . . . 5 A dc 0.5 mA . . . 5A ac	50µA . . . 15 A dc 1.5 mA . . . 15 A ac	2 mA . . . 2 A ac/dc	2 mA . . . 10 (20) A ac/dc	10 µA . . . 10 A ac/dc	2 mA . . . 10 (20) A ac/dc			300 µA . . . 20 (30) A ac/dc
Resistance	1 Ω . . . 1 MΩ		2 kΩ . . . 20 MΩ		1 Ω . . . 20 MΩ	2 kΩ . . . 20 MΩ	Lo: 2 kΩ . . . 2 MΩ Hi: 200 Ω . . . 20 MΩ		3 kΩ . . . 20 MΩ
dB Readout	−15 . . . +56 dB		–	–	−40 . . . +62 dB	–	–	–	−60 . . . +80 dB
Capacitance	2 . . . 200,000 µF		–	–	–	–	–	–	300 nF . . . 3000 µF
Temperature			−25 . . . +125°C with temperature probe T 2001						
Input impedance Ri	20 kΩ/V dc, 4 kΩ/V ac		10 MΩ (const.)						
Accuracy analog: class . . . dc digital: basic . . . ac ±(. . . % rdg + . . . digit) Ω	class 5	class 2.5	(0.5% + 1D) (1.5% + 3D) (0.75% + 1D)	(0.25% + 1D) (1.0% + 3D) (0.5% + 1D)	class 1.5 class 2.5 class 1.5	(0.1% + 1D) (0.5% + 3D) (0.35% + 1D)		(0.1% + 1D) (0.75% + 3D) (0.35% + 1D)	(0.05% + 1D) (0.25% + 20D) (0.20% + 2D)
Frequency range	35 . . . 5000 Hz		15 . . . 4000 Hz		15 . . . 5000 Hz				15 . . . 20,000 Hz
Overload protection	meter protection		all ranges up to 250 V ac/dc or higher						
Display	coil-core magnet		3½ Digit, LCD		moving coil	3½ Digit, LCD			4½ Digit, LCD
Scale length: mm/digits	83 mm		1999		101 mm	1999			29.998
Battery	1.5 V size AA		9 V transistor battery						NiCad's/1[illegible]0 V ac
Dimensions	92 x 126 x 45 mm		92 x 154 x 25 mm		146 x 118 x 44 mm				250 x 83 x 2[illegible]0 mm
Special features	Safety terminals and test leads are designed to protect against accidental contact/ Instruments conform with safety standards of VDE and DIN Single dial selector switch for all ranges, oversize display. Mirror scale		extremely compact		adjustable read-off angle, folding design, hands-free operation with neck strap standard, self protection by folding feature		Diode test, Audio continuity test feature True RMS		wire clip terminals, true RMS 30,000 counts
Prices US $ Instruments incl. test leads, battery, manual	49.00*	79.00*	119.00*	139.00*	179.00*	199.00*	219.00*	259.00*	595.00*
Accessories:									
Current probe	WZ 11 / 49.00*								
Temperature probe	–	–	T 2001 / 129.00*						
High frequency probe	–	–	GE 4087 / 249.00*						
High voltage probe, 30kV	GE 4196 / 149.00*								
Safety probes	KS 17 / 7.90*								
Standard probes	KS 19 / 6.90*								
Set of 4 NiCad batteries	–	–	–	–	–	–	–	–	KR 27/50 / 28.00*
Power supply adapter	–	–	NA 2-9/20 / 27.50*						–
Carrying case	F 809 / 10.00*		F 814 / 8.00*		–	–	–	–	F 813 / 39.00*
Protective rubber frame	GH 185 / 12.50*		GH 186 / 12.50*		–	–	–	–	–

*Prices subject to change without notice

Printed in USA, MR-USA 8/82

Is it the TV or is it the cable?

By Carl Bentz



Cable television has made impressive strides in the past several years. Much to the chagrin of broadcasters and TV technicians alike, the old systems continue to grow, new systems develop and new cable services seem to continually mushroom. The arguments, pro and con, have shown little change since the beginning of the fast-growing industry. A discussion of CATV system operation can provide the service technician with a better understanding of the CATV system as well as some ammunition to solve TV receiver problems more quickly.

The most common argument in favor of cable television has always been greater program variety. It is true that a common antenna tower using multiple specially designed antennas for each received channel is economically more practical than if every possible subscriber were to erect a support structure for the same reception possibilities. A single tower, properly installed and guyed, can provide the additional height for antenna mounting locations needed for reception of distant channels. To certain limits, the height will allow acceptable viewing from channels at distances beyond the grade-B contour predictions of the transmitting stations.

Properly designed and maintained equipment at the head-end of the cable system is far more capable of handling lower signal levels from remote channel locations than is the typical receiver tuner, even with an antenna-mounted amplifier. With many services available via satellite transmission, it is also more feasible for a single receiving dish antenna. Over a period of time, the subscriber will certainly pay more for the service than a properly installed antenna system would cost, but at the same time, maintenance expenses for the individual are reduced to zero.

Typically the variety available

easily exceeds what a subscriber would be capable of receiving with a normal antenna installation. Yet, the CATV system is incapable of delivering all the services that have developed in just the past year. The CATV operator offers his subscriber only those services that are economically feasible, whether they are from standard TV broadcast stations or from satellite sources. More than 100 channels are currently being beamed toward the earth from the many satellites in geosynchronous orbit serving the United States alone. Receiving those additional channels, however, requires the purchase, installation and maintenance of TVRO earth-station antenna systems. To most, the costs of a TVRO system are prohibitive, leaving the CATV systems to continue their growth.

A second argument in favor of the CATV installation in the home is connected with the signal received. If the assumption can be made that the CATV system is operated properly, then the signal level received by the subscriber is nearly constant at typically 0 to 10 dBmV (0dBmV = 1mV across a 75Ω load). The AGC system of most TV sets is capable of handling a far greater level range, however. A more constant signal level applied to the receiver may aid in more consistent color quality of the received picture because as the AGC system is required to boost the signal, increased noise will appear in the color information of the signal, producing grainier color. One of the advertising claims of CATV sales people is that installation of cable service will immediately improve the color, but such is not the case.

Color reception is based on two primary factors. First is the quality of the signal. The more consistent signal of greater strength should provide *more consistent operation* of color circuitry. (not necessarily improved color reception). The quality of the color picture viewed on the set will also depend greatly on the condition of the color circuitry. As receiving sets have improved in the recent past with more dependence upon integrated circuits, fewer problems result. Yet, if the color decoding and matrixing within the TV set are improperly adjusted or are malfunctioning, the immediate improvement claimed by the salesman is not realistic. Many CATV installations have been made to no avail, because the trial subscriber disconnected from the service, unwilling to pay the expense to have the receiving equipment repaired or adjusted properly. Perhaps at a later date, a new TV set was purchased and the service was subsequently found to be acceptable. The solution, however, to the color problem was *not* the cable connection.

Adjacent channel rejection syndrome is a common problem when CATV services are connected.

Adjacent channel rejection

Other problems may develop when CATV services are connected. The most common is the adjacent channel rejection syndrome. With great wisdom, the FCC assigned channels to cities with a certain amount of frequency separation between the channels. Even in locations where channels 4 and 5 are used, the two channels are separated by 4MHz of spectrum. Suddenly in systems where all 12 VHF channels are available, the TV is expected to separate adjacently transmitted signals. The inexpensive portables often do not even have the capability of separation of channels even if the adjustments are available. A minor misadjustment is enough to make shadowy figures appear in the background of a viewed program. To most viewers, this is unacceptable, even if they were only willing to pay a minimum amount for the set.

Proper servicing of adjacent channel symptoms requires a sweep generator. Such service is also more efficiently done if (1) it is done in the home or (2) cable service may be wired into the service shop. Because many technicians are unable to perform the alignment, the shop installation is the better solution, assuming the location will allow cable TV service to be brought in. Some system operators will charge the service organization a premium rate for such an installation, because it is expected that the cable service may also be used as a selling aid in shops where receivers are also offered for sale. Negotiations, however, are often possible.

Other difficulties caused by use of cable are relatively minor, but they do exist. Turret-type tuners, using individual tuning channel strips, have been found without some of the channel strips in place or the strips may be defective. The missing or malfunctioning strip precludes reception on that channel until repair or replacement is made. Many set owners are reluctant to pay the expense for one channel. In addition, the balun on the input to the tuner may be defective. Often a receiver used in a city with major stations will receive enough signal to overcome the failure, yet when the limited signal level of the cable transmission is applied, the level is insufficient to jump the gap. The balun is an inexpensive item, but the typical charges to replace it may be more than the owner wishes to invest.

If the cable system is not always operating properly, additional problems will occur. Problems of consistent impedance matching along the lines leading to a home can cause greater multiple ghosting than with a roof-top antenna. Such ghosting is also possible with a badly adjusted or malfunctioning IF amplifier. The technician will need to verify which source causes the difficulty, preferably before charging his client for a massive service call. Theoretically, the CATV service will be called before the service technician is brought in, to determine whether the set or the cable is the culprit, but the CATV personnel are not always aware of system faults or capable of understanding them. The PR problems caused by typical non-technical technicians hired by

SWD-1 VIDEO CONVERTER

FOR CABLE TV

The SWD-1 Video Converter is utilized on cable TV systems to remove the KHz's signal from a distorted video (channel 3 in/out) and also pass thru the normal undistorted/detected audio signal. Rocker switch selects operating mode to remove KHz's distortion from the video or pass all other channels normally. Simple to assemble—less than 30 minutes. Pre-tuned. Input/output Channel 3. Impedance 75 ohms. 117VAC.

SWD-1 Video Converter Kit **$69.95**

VTR ACCESSORIES

SIMPLE SIMON VIDEO STABILIZER

Simple Simon Video Stabilizer, Model VS-125, eliminates the vertical roll and jitter from "copy guard" video tapes when playing through large screen projectors or on another VTR. Simple to use, just adjust the lock control for a stable picture. Once the control is set, the tape will play all the way through without further adjustments. Includes 12V power supply.

VS-125 Video Stabilizer, wired **$54.95**

SIMPLE SIMON VIDEO SWITCHING BOX

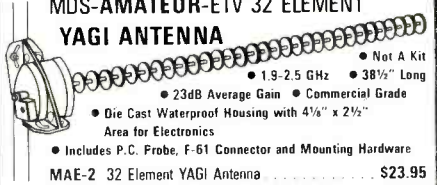
The Affordable Video Control Center

Excellent in isolation and no loss routing system. Simple Simons VSB-300 Video Switching Box enables you to bring a variety of video components together for easy view ng/dubbing. Also you gain the ability to record one channel while viewing another. Unit includes two F-type quick connector ended cables.

VSB-300 Video Switching Box, wired **$19.95**

UHF ANTENNAS and ACCESSORIES

MDS-AMATEUR-ETV 32 ELEMENT YAGI ANTENNA



- Not A Kit
- 1.9-2.5 GHz
- 38½" Long
- 23dB Average Gain
- Commercial Grade
- Die Cast Waterproof Housing with 4⅛" x 2½" Area for Electronics
- Includes P.C. Probe, F-61 Connector and Mounting Hardware

MAE-2 32 Element YAGI Antenna **$23.95**

Kato Sons' Down Converter Kit ★1.9 - 2.5GHz★

Designed for Simple Simon by former Japanese CQ Amateur Magazine's UHF Editor/Engineer. Unit utilizes new ingenious Printed Circuit Probe for maximum gain. Circuit board fits inside MAE-2 antenna housing. Requires 1 hour assembly. IC and capacitors pre-soldered.

Model KSDC-KIT 1.9 - 2.5GHz Down Converter Kit **$34.95**

Kato Sons' Regulated Varible DC Power Supply

For use with KSDC-KIT 1.9 - 2.5GHz Down Converter. Completely assembled with Attractive Cabinet, TV/Converter Mode Switch, Frequency Control and LED Indicator.

Model KSPS-1A Assembled Power Supply **$23.95**

SPECIAL INTRODUCTORY SAVINGS

ORDER ALL THREE ITEMS

MAE-2, KSDC-KIT and KSPS-1A for Only **$74.95**

Regular price if ordered separately $82.85

— CO-AX CABLES ARE NOT INCLUDED —

ZYZZX VHF-UHF Wideband Antenna Amplifier

Revolutionary New HYBRID IC Broadband Amplifiers

50 MHz - 900 MHz

Model ALL-1 12dB Gain
Model ALL-2 35dB Gain

These units are not available anywhere else in the world. Each unit will serve many purposes and is available in Kit or Assembled form. Ideal for outdoor or indoor use. I/O impedance is 75 ohms. Amplifiers include separate co-ax feed power supply. Easily assembled in 25 minutes. No coils, capacitors to tune or adjust.

ALL-1 Complete kit w/power supply $24.95 — **ALL-1** Wired. Tested w/pwr supply $34.95
ALL-2 Complete kit w/power supply 34.95 — **ALL-2** Wired. Tested w/pwr supply 44.95

Our New STVA 14.5dB GAIN, 14 ELEMENT CORNER REFLECTOR YAGI ANTENNA

STVA-3 Yagi Antenna, 14.5dB Gain, Selectable 75 or 300 ohm Channel 60-80 . . . . . **$19.95**

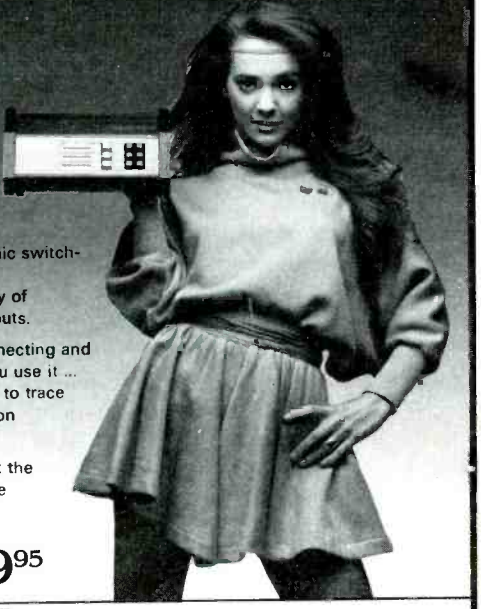
STVA-4 Yagi Antenna, 14.5dB Gain, Selectable 75 or 300 ohm Channel 44-52 . . . . . **$19.95**

RG-59/U 75 ohm Low Loss Coax Cable . . . $.12p/ft. — **F-59** Coax Connector . . . $ .39 ea.
MT-1 Special UHF 75-300 ohm Matching Transformer . . . . . **$1.45 ea.**

Switch to Bambi™!

Electronically

Bambi Electronic Video Switch ... makes switching of your VCR/VTR, Pay TV Decoders, Cable TV, Video Discs, Video Games, Closed Circuit TV, Antennae and Microcomputer as easy as pushing buttons.



The Bambi Electronic Video Switch is an electronic switching network which can accept up to six different sources of video signals and provide the flexibility of directing the inputs to any or all of the three outputs.

Now you can eliminate ... the drudgery of disconnecting and reconnecting your video equipment each time you use it ... the tangled mess of cables which are impossible to trace out ...not being able to use more than one function at a time.

Bambi lets you enjoy using your video equipment the way it should be ... electronically and on line at the push of a button.

Model BEVS-1 Wired **$129.95**

Bambi's front panel was designed with the user in mind. Computer styled construction, with soft-touch keyboard (rated for over 10 million operations), arranged in matrix form allows easy input/output selection without refering to charts. Functions selected through the keyboard are immediately displayed on the 18 LED status indicators.

Check the quality of Bambi against that of much higher priced competition. All solid state electronic switching provides low attenuation (3dB), wide frequency response (40-890 MHz), and excellent isolation between signal sources (each I/O section individually sheilded for 65dB min. isolation).

Bambi's Specifications:

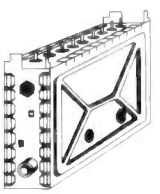
Input/Output Impedance	75 ohm
Signal Loss	3dB ±1dB
Noise	4dB ±1dB
Input Return Loss	12dB min.
Isolation	65dB min.
Power Req.	117VAC 60 Hz, 2W
Dimensions	10¾ W x 6¾ D x 3¼ H
Weight	4½ lbs

7+11 SWD PARTS KITS

MITSUMI VARACTOR UHF TUNER

Model UES-A56F

$24.95



Freq. Range UHF470 - 889MHz
Antenna Input 75 ohms
Channels 14-83 Output Channel 3

KIT NO	PART NO	DESCRIPTION	PRICE
1	VT1-SW	Varactor UHF Tuner, Model UES-A56F	$24.95
2	CB1-SW	Printed Circuit Board, Pre-Drilled	18.95
3	TP7-SW	P.C.B. Potentiometers, 1-20K, 1-1K, and 5-10K ohms, 7-pieces	5.95
4	FR35-SW	Resistor Kit, ¼ Watt, 5% Carbon Film, 32-pieces	4.95
5	PT1-SW	Power Transformer, PRI-117VAC, SEC-24VAC, 250ma	6.95
6	PP2-SW	Panel Mount Potentiometers and Knobs, 1-1KBT and 1-5KAT w/Switch	5.95
7	SS14-SW	IC's 7-pcs, Diodes 4-pcs, Regulators 2-pcs Heat Sink 1-piece	29.95
8	CE9-SW	Electrolytic Capacitor Kit, 9-pieces	5.95
9	CC33-SW	Ceramic Disk Capacitor Kit, 50 W.V., 33-pieces	7.95
10	CT-SW	Varible Ceramic Trimmer Capacitor Kit 5-65pfd, 6-pieces	5.95
11	L4-SW	Coil Kit, 18mhs 2-pieces, .22μhs 1-piece (prewound inductors) and 1 T37-12 Ferrite Torroid Core with 3 ft. of #26 wire	5.00
12	ICS-SW	I.C. Sockets, Tin inlay, 8-pin 5-pieces and 14-pin 2-pieces	1.95
13	SR-SW	Speaker, 4x6" Oval and Prepunched Wood Enclosure	14.95
14	MISC-SW	Misc. Parts Kit Includes Hardware, (6/32, 8/32 Nuts, & Bolts), Hookup Wire, Ant Terms, DPDT Ant. Switch, Fuse, Fuseholder, etc.	9.95
When Ordering All Items, (1 thru 14), Total Price			139.95

7+11 PWD PARTS KITS

INTRODUCING OUR 7+11 PWD PARTS KITS

NEW

Kit No	PART NO	DESCRIPTION	PRICE
1	1VT1-PWD	Varactor UHF Tuner, Model UES-A56F	$24.95
2	2CB1-PWD	Printed Circuit Board, Pre-drilled	18.95
3	3TP11-PWD	PCB Potentiometers 4-20K, 1-.5K, 2-10K, 2-5K, 1-1K, and 1-50k (11 pieces)	8.95
4	4FR-31-PWD	Resistor Kit, ¼W, 5% 29-pcs, ½ W 2-pcs	4.95
5	5PT1-PWD	Power Transformer, PRI-117VAC, SEC-24VAC at 500ma.	9.95
6	6PP2-PWD	Panel Mount Potentiometers and Knobs, 1-1KBT and 1-5KAT with switch	5.95
7	7SS17-PWD	IC's 7-pcs, Diodes 4-pcs, Regulators 2-pcs Transistors 2-pcs, Heat Sinks 2-pcs	29.95
8	8CE14-PWD	Electrolytic Capacitor Kit, 14-pieces	6.95
9	9CC20-PWD	Ceramic Disk Capacitor Kit, 50 WV, 20-pcs.	7.95
10	10CT5-PWD	Varible Ceramic Trimmer Capacitor, 5-65pfd, 5-pieces	4.95
11	11L5-PWD	Coil Kit, 18mhs 3-pcs, .22μhs 1-piece (prewound inductors) and 2 T37-12 Ferrite Toroid cores with 6 ft. #26 wire	6.00
12	12ICS-PWD	IC Sockets, Tin inlay, 8 pin 4-pcs, 14 pin 1-pc and 16 pin 2-pcs	2.95
13	13SR-PWD	Enclosure with PM Speaker and Pre-drilled Backpanel for mounting PCB and Ant. Terms	14.95
14	14MISC-PWD	Misc. Parts Kit, Includes Hardware, (6/32, 8/32 Nuts & Bolts), Hookup Wire, Solder, Ant. Terms DPDT Ant. Switch, Fuse, Fuseholder, etc	9.95
15	15MC16-PWD	Mylar Capacitors, 14-pcs and Silver Mica Capacitors 2-pieces	7.95
When Ordering All Items, (1-15), Total Price			159.95

SIMPLE SIMON ELECTRONIC KITS,™ Inc.

3871 S. Valley View, Suite 12, Dept. E, Las Vegas, NV 89103

NEED 5 OR MORE OF AN ITEM? WRITE FOR QUANTITY DISCOUNTS

In Nevada Call: 702-871-2892

Outside Nevada Call: 1-800-782-3716

Available by Mail Order Only

Send Check* or Money Order. Minimum Order: $16.95. Add 10% Shipping and Handling on orders under $40.00. For orders over $40.00, add 5%. Minimum Shipping and Handling $2.00. Cat. $1.00

— VISA and Mastercard Acceptable —

*Check orders will be held 30 days before shipping.

Circle (13) on Reply Card

CATV operators are great. A mishandled service call by the shop technician can be just as bad.

Power-supply problems

A common system fault is caused by failing or misadjusted power supply modules in the line amplifiers of the CATV system. The cable lines carry ac, which is converted to dc to operate the transistorized amplifiers. If the regulation of the supply is misadjusted, if a component in the module is out of tolerance, or if the ac voltage is outside the range the regulator is capable of handling, *hum bars* may appear. Hum bars are usually dark bands that roll upward through the picture, sometimes causing a weaving from side to side as they pass through. As one darkened area reaches midscreen, a second appears at the bottom. Caused by ripple from the power supply, the effect will disappear if the program being televised is monochrome. The rolling is caused by a beating of the 60Hz power line frequency with the 59.94Hz factor involved in NTSC television. This is typically noticed in summer when air conditioning causes the power line voltage to drop.

Hum bars are easily isolated to the cable system by simply disconnecting the receiver from the cable system and tuning in even a snowy channel. The rolling effect will disappear, unless it is caused by a set power supply problem. The darkness may indicate the amount of the regulation problem, i.e., the darker the bars, the greater the ripple. At the same time, massive ripple or voltage spikes will appear on the screen as brilliant white lines. A violent buzzing will appear in the sound.

Total cable system failures do occur. However, as the reliability of the local power company improves, and as improvements are made in surge protection for the cable amplifier modules with the addition of standby battery-operated equipment, such total system failures decrease. Still, cable outages do occur. During total system failures, most subscribers realize that problems beyond their control have occurred, but some will automatically believe that their TV receivers have failed.

Interference

Cable can also introduce interference that never occurred on a particular receiver until its connection to the CATV system. The illegal CB operator may easily get into the cable channels and appear on one or more channels both as aural and visual disturbances. Because cable systems are always expanding and contracting due to changing temperatures, connections and bends in the cable materials are subject to cracking or loosening. The *leaks* that occur allow ingress of any strong RF signal – CB, HAM, Voice of America, local FM, etc. The ways these outside signals affect reception are almost unpredictable.

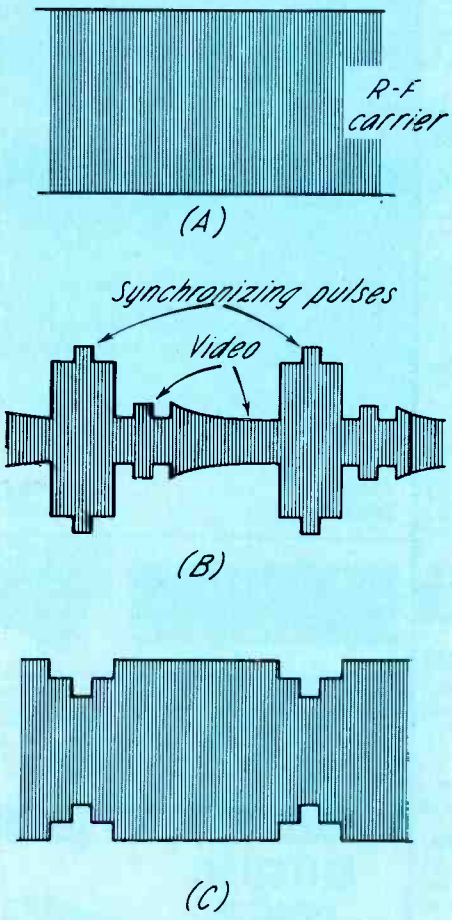


Figure 1. A is an unmodulated CW signal. B is the TV signal (modulated carrier). When A and B are applied simultaneously to a nonlinear device, cross modulation occurs.

(Illustrations courtesy of CREI/McGraw-Hill.)

Another *new* interference that involves use of CATV reception is the adjacent channel rejection syndrome previously mentioned. While typically blamed on the cable operator, the fault is entirely within the receiver if signal levels are within prescribed acceptable bounds of 0 to 10dBmV.

Cross modulation of channels is another common interference caused by improper cable operation (Figure 1). The appearance of cross modulation may appear similar to adjacent channel difficulties. It will normally appear on every channel, however, while adjacent channel rejection failure occurs typically on only a few. In adjacent channel problems, a picture usually will be discernable in the background of the desired channel. With cross modulation, diagonal bars (windshield wipers) will move rapidly across the screen. Such interference is the result of one or more channels operating at a higher level than others. In effect, the cable line amplifiers are being overdriven by some channel

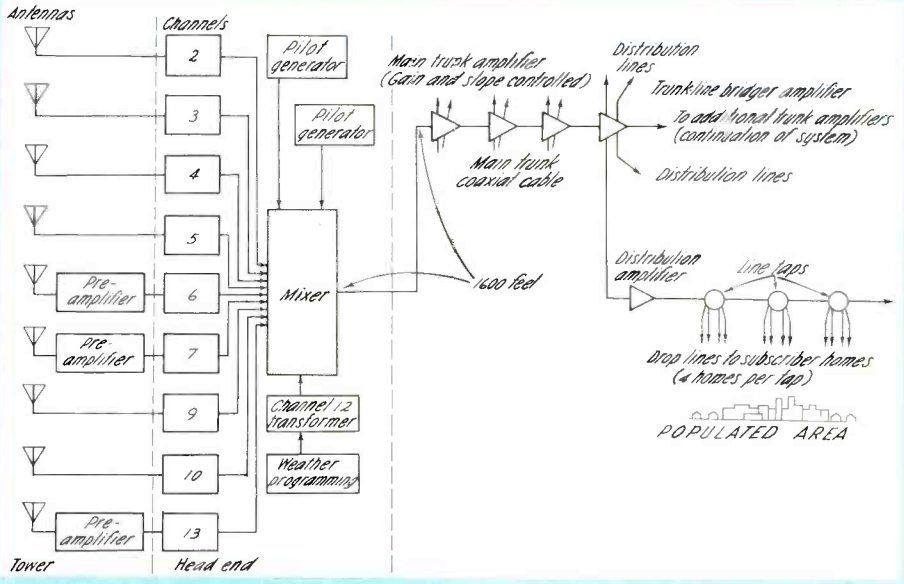


Figure 2. Part of a typical cable TV system.

signals with electronic amplifier distortion resulting. The shop technician will be unable to correct the problem and should report it to the cable operator.

Finally, in cable systems where multiple cables are used, with the constant motion of the cable equipment, co-channel interference is possible as leakage from one cable to another occurs. Just as a distant city Channel 5 may appear behind a local Channel 5 during some weather conditions, leakage between the two cables places two typically non-synchronized pictures on the screen simultaneously, with a definite horizontal-lined texture to the picture.

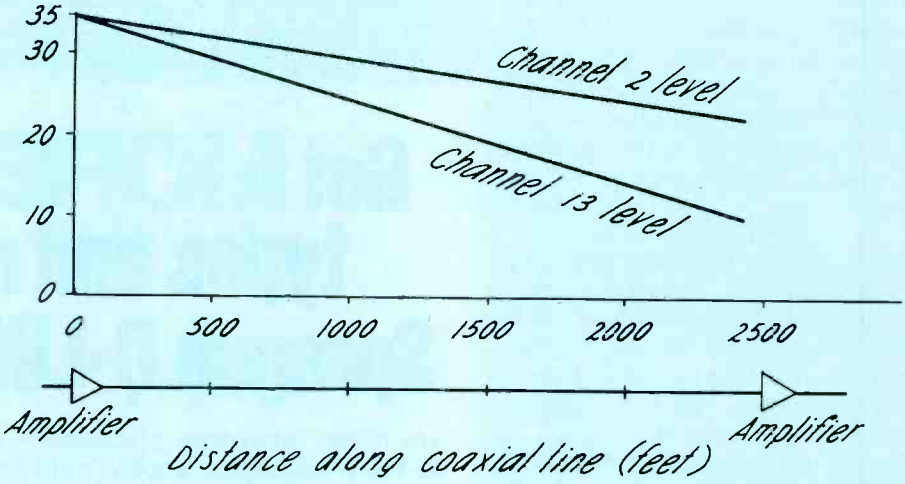
Cable operation

Essentially, the cable is a very simple concept, but there are a number of areas that may cause problems. Cable should be considered as little more than a super antenna that provides greater reception possibilities than a typical antenna installation. The individual antennas used by CATV operators are normally of a special design for each channel. Multiple antennas may be needed for individual channels with special phasing networks in order to reduce unexpected or calculated interference from even more distant stations. Satellite dishes may also be used for the special services desired from the many available today. Other channels may be created by special generation equipment owned by the cable company, for example, weather and news channels using character generators. All signals to be provided to the subscribers are combined in a network called the *head-end* (Figure 2). Channels received as RF are applied to special units, which may change the actual carrier frequencies, depending upon the requirements of the particular system. Such equipment converts the RF signals to IF frequencies before remixing them to the desired new channels. Bandpass filtering may be used on inputs and/or outputs of such equipment to maintain the appropriate vestigial sideband operation required by the FCC. Video channels from the satellite receivers, local origination sources and data channels are applied to modulator units. Crystal control or crystal-based phase-lock loop circuitry is commonly used for carrier generation of all the equipment. Their stabilities are excellent, though tolerances are not as strict as for broadcast stations.

After all the channels are created or converted as necessary, they are applied to a combining network of directional coupler devices along with pilot carriers. Such a network allows all the channels to be combined onto a signal cable without interference. RF output levels are adjusted so that all channels are operating at the same dBmV range, approximately 50dBmV (which by Ohm's law calculates to approximately 1.2W of RF power). The pilot carriers provide a reference for AGC control of cable system amplifiers. The combined channel signals leave the head-end on a single coaxial cable on their way to the distribution system.

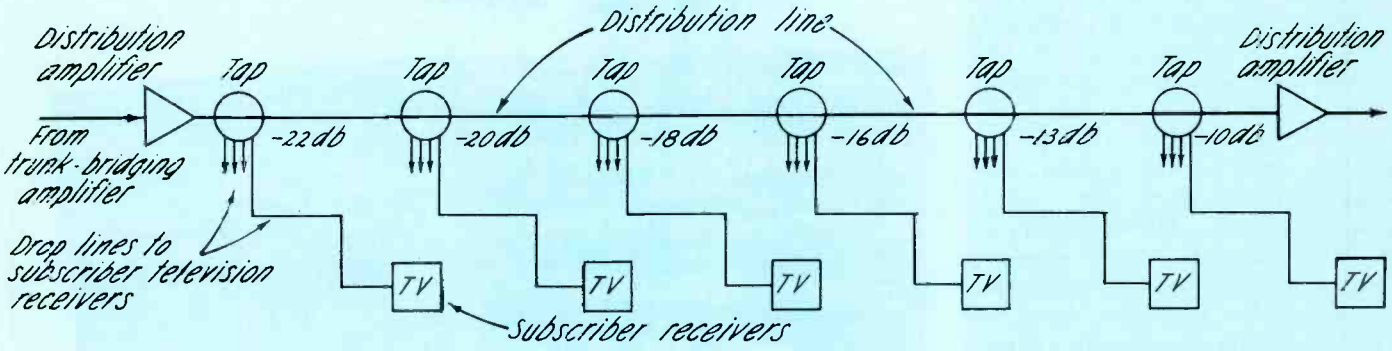
Coaxial cable presents certain attenuation losses to the RF signal that are frequency dependent as well as temperature dependent.

TABLE 4-1			
Cable Loss Versus Temperature			
	5 °F	68 °F	120 °F
Channel 2	11.8 db	12.8 db	13.4 db
Channel 13	23.4 db	25 db	26.5 db

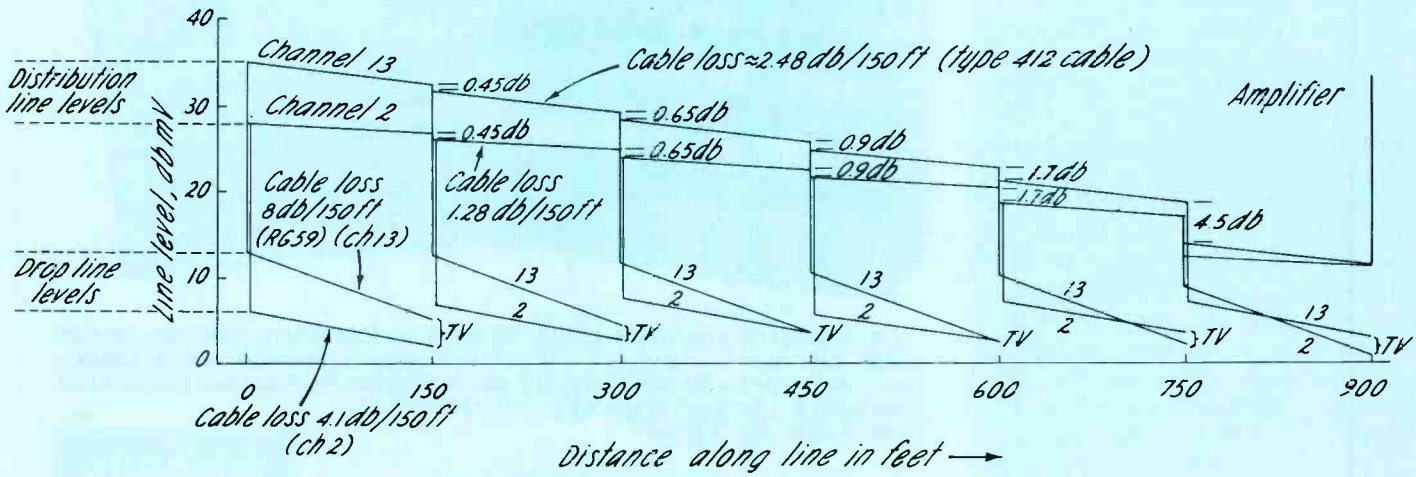


(C)

The TV signal suffers losses along the cable proportional to both ambient temperature and the frequency of the signal. *(Illustrations courtesy of CREI/McGraw Hill.)*



(A)



(B)

The number of amplifiers that may be cascaded in a cable system depends upon the signal-to-noise ratio of the amplifiers.

The losses at Channel 13 are approximately double those at Channel 2. Because RF is involved, conductor skin effect is also important. Generally, the larger the center conductor of the coax material, the less the loss. Major trunk lines leading to the distribution area are usually 1-inch or 0.75-inch outside diameter materials. The "750" cable will allow transmission of the signal to approximately 2000 feet before amplification is required. At that point, a "trunk" amplifier is used to make up the loss from the cable leading to it. At intervals of 2000 feet, additional amplifiers are required, unless either of two splitting devices is used – the RF splitter or the directional coupler. When such splitting of the transmission line is required, short spacing of amplifiers is also required to recover the additional losses involved. A splitter divides the signal by half, or attenuates the signal by 3.5dB. A directional coupler is designed to remove a portion of the signal, attenuated by a specified amount (8, 12 and 16dB are typical), with as little effect to the main line as possible.

As the signal progresses through the distribution system, other types of amplifiers are used. A bridging amplifier still provides a main-line output but also provides multiple lines of distribution with increased amplification. These several lines will be "tapped" with multiple-port outlets, to which individual subscriber installations will be attached. *Taps* are also directional coupler design devices with varying dB attenuation factors that allow the system designer to provide the proper RF level to be applied to the subscriber's set. If a distribution line needs to be "lengthened," the third type of amplifier, a line extender, is used for the needed amplification.

The number of amplifiers allowed within a distribution system is dependent on the signal-to-noise ratio of the amplifier design. In well-established systems, cascades of 35 amplifiers (from the head-end to a subscriber installation) are typical. Many more than that will result in a snowy or grainy quality in the received picture, caused by noise inherently added to the signals by "noisy" components in the amplifiers. The FCC requires constant periodic checking on signal quality by CATV operators.

Signal quality and level measurements at various points within a system are observed and logged. Spectrum analyzers are used to allow observation of comparative signal levels. System design specifications must be met and maintained.

CATV, then, is a large-scale antenna distribution system. It provides additional channels for the subscriber from off-air, satellite or local sources. A more constant signal level and quality is provided when all works properly. However, it cannot improve a poor TV receiver; CATV is not a panacea for all reception evils.

For the service shop technician, CATV can present new headaches. Logic and a little knowledge will provide answers to most of those headaches, and a cooperative attitude toward the cable operators and cable system technicians can improve the possibilities of quick repair solutions. **ES&T**

READERS' EXCHANGE

Needed: Low-priced transistor curve tracer with book; does not have to be in good shape; state price and condition. Also a VTVM or VOM with large meter; any condition, but low priced; state price and condition. *Jack E. Smith Radio Shop, 215 College St., Montezuma, GA 31063.*

Needed: Schematic and selenium rectifier for RCA 400JR 16mm sound movie projector. *Forest Atland Electronics, 972 Washington St., Wooster, OH 44691.*

Needed: B&K V-O-Matic VTVM, model 360. Must be in excellent condition. *Jack Busk, Rt. 2, Box 104, Cottonwood, AZ 86326.*

Needed: Manual or copy for Dynascan picture and pattern generator. Also any slides or transparencies for Sams. *Walter J. Fess, Walt's TV, 1620 W. 33 Ave., Denver, CO 88211.*

Needed: Schematic for Estey model S organ. The sour notes have not been corrected by testing all identifiable tubes. *William B. Rucker, 302 Dillon Ave., Mankato, MN 56001.*

Needed: Operations/service manual for Sanders Data Systems model 321C-002-000 dual cassette drive system. *C. T. Huth, 146 Schonhardt St., Tiffin, OH 44883.*

Needed: Schematic for GE model 12XE 21025. This TV set was bought in 1981. *Roelof P. Feijen, 368 Day St., Leominister, MA 01453.*

Needed: Thermistor, Zenith part #63-5444; focus control, Zenith part #63-5431, 10meg. Color chassis 24NC21/Z. *Joseph J. Mehalko, 324 4th St., Blakely, PA 18447.*

Needed: Oscillator coil for an RCA radio, model RC 1064, 5-tube set. *John G. Lefko, P.O. Box 782, Fairfield, CA 94533.*

Needed: B&K 415 sweepmarker generator. *P. F. Boyer, 2053 Hood Ave., Baton Rouge, LA 70808, 1-504-383-5775.*

Needed: Pioneer model SX-600-T AM/FM stereo

receiver schematic and any other information. *Charles L. Rickard, 3228 Santiago St., San Francisco, CA 94116.*

Needed: Service manual for Fisher AM/FM tuner, model #143 92541600. *Karl Hendricks, 1410 W. 10, McCook, NE 69001.*

Needed: Schematic for Pioneer stereo SX770. Will copy and return. *J. D. Teasley, 7720 Wills Lane, Ft. Washington, MD 20744.*

For Sale: Elenco TV dot/pattern generator, excellent condition, $75; Conar transistor power supply, very good condition, $30; Heathkit cap/res. checker, very good condition, $15. You pay postage. *William Bernstein, 215 Middle Neck Road, Bldg. 7, Great Neck, NY 11021.*

For sale: D66 Telequipment dual trig scope, complete with probes. Sale price $450 less shipping. *Val Obal, 3201 S. 73 St., Omaha, NE 68124, 1-402-393-0459.*

For sale: 154 volumes of Sams Photofacts for CB radio repair; excellent condition, no shipping, lot only, best offer. *P. M. O'Brien, 7 Old Coach Drive, E. Weymouth, MA 02189.*

For sale: B&K 1077B, $250; Vectorscope color bar generator, $100; oscilloscope, $250. All with operating manuals and leads; like new. *Clarence Gillow, P.O. Box 177, Springer, NM 87747.*

For sale: Eico model 10648 battery eliminator and charger, $150; Heathkit model HD15 solid-state dip meter, $75; Okidata Microline-80 printer for TRS-80 microcomputer, $225. All operating manuals are supplied, shipping prepaid. *William Shevtchuk, 1 Lois Ave., Clifton, NJ 07014, 1-201-471-3798.*

For sale: Heathkit IT-5230 CRT checker/rejuvenator. Brand new, completely assembled, fully operational, $120. *Ed L. Williams, 3504 Heritage Valley Road, SW, Atlanta, GA 30331.*

For sale: Sound Technology 1000A stereo generator with 1100A signal conditioner, both like new, $1200; Sencore SC 165 stereo generator, $400; Simpson 467 DVM, new, $200. Manuals and probes. *A&B Electric Company, 1883 E. Main St., Rochester, NY 14609, 1-716-288-1520.*

For sale: B&K 1077B analyst complete with cables and operating instructions. Excellent condition, $300. *Bob Mathews, 50 Vantroba, Glendale Heights, IL 60137, 1-312-682-9249.*

For sale: B&K Dynamic mutual-conductance tube tester, model 707, asking $75; RCA WO-33-A 3-inch scope with probe, asking $95; Heathkit model IG-62 color bar and dot generator, asking $95. All items buyer pickup. *Robert F. Malone, Jr., 11 Bryant Drive, Jackson, NJ 08527, 1-201-367-1431.*

For sale: Sams Photofacts, 100 to 934, best offer. *Bellevue Radio & TV, 109 W. Center St., Bellevue, OH 44811.*

For sale: Sencore tube checker, model MU 150, 1975, perfect condition, $80. *Frank Maas, P.O. Box 949, Homasassa Springs, FL 32647.*

For sale: Heath 1G5228 color bar/dot pattern generator, $125; Heath 1G5257 post marker/sweep generator, $225; Heath 1T5320 CRT checker/rejuvenator, $100. All have been used only one time. *Robert Petry, 1-313-743-5596 after 3 p.m., 3739 Dakota, Flint, MI 48506.*

Readers' Exchange items are listed for free, but may contain only three items. "For sale" items must consist of used equipment, parts, etc., owned by individuals and not new items for sale by companies or manufacturers. If you can help with a request, please write directly to the reader, not to ES&T.

ES&T

PHOTOFACTS™

These Photofacts for TV receivers have been released by Howard W. Sams & Company since the last report in ES&T.

CURTIS MATHES
G379 2097-1
Chassis CMC84-1/2 2101-2

KMC
1311G 2106-1

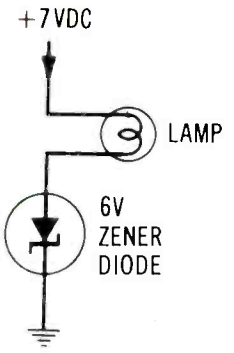
GOLD STAR
CNR-845 2105-1
CR-820U 2109-1

J.C. PENNEY
685-2059F,-00/061,-00,
685-4408F,-00 2096-1
685-2042FC,-10
685-2044FC,-10 2100-1
685-1701F1,-30 2103-1
685-1020F1,-10 2105-2

Quick Quiz

In the circuit shown, what dc voltage should be measured across the lamp?

1. zero volts
2. +1V
3. +6.3V
4. +7V



(answer on page 59)

CompuFix:
Troubleshooting information at the touch of a key

Since the computer was developed little more than 30 years ago, the total storage capacity available has grown greatly year by year. At the same time, the capacity of wire telecommunications such as the telephone has increased tremendously. Although the total capacity of these electronic marvels has grown by leaps and bounds, their cost has decreased correspondingly.

At the same time, the array of consumer products that contain electronic circuits has broadened, and the complexity of those circuits has grown.

A data base

A new service has been instituted that responds to the increased information needs generated by the proliferation of new, electronically based consumer products, and that takes advantage of the existence of the vast computer/communications network. Called CompuFix, this recently formed company offers electronic services a data base that consists of a history of technical problems and repair procedures for many different kinds of consumer electronic products, such as TV sets, stereos, VTRs and more. This information on technical problems, according to CompuFix personnel, is based on the direct experience of several selected, highly qualified, independent servicing organizations.

The data in the computer data base is organized so that anyone using it can quickly and easily arrive at solutions to technical problems by entering the product identification and a description of the symptoms. The response of the CompuFix system is a description of technical procedures to be followed for a specific set of symptoms. Wherever applicable and practicable, the suggested service procedure will refer to specific schematic diagram locations and part numbers.

In addition to the symptom/fix information, the data base will also contain general information regarding product design, performance and principles of operation for consumer electronic products. These data will consist of information supplied by the manufacturers in the form of technical tips, as well as contributions from other qualified servicers and experts in the consumer electronics area. This portion of the systems will be an electronic news journal for users.

A business service, too

In addition to being a symptom/fix data base and a repository of technical tips, CompuFix is intended by its designers to be a business aid to its users. Still under development are the following three business-related applications of the service, which will be offered as separate modules or as an integrated information and business system.

Pricing. This module will consist of general pricing including suggested list prices, cross-referencing of parts and manufacturers, and recommended sources for optimum purchasing. Also included will be pricing for specific technical procedures based on man-hour requirements and mean time to repair. This feature will be offered as an automated cost-estimating system.

Service Contract Processing. This portion of the information service provides storage and retrieval of service and warranty records for each customer entered. In this way, the service record of a unit under extended warranty is available on a national basis to any dealer who subscribed to the network. Also mass mailings for service solicitation can be produced from the database on demand.

General Business Services. General business services can be provided in the form of processing of accounts receivable, accounts payable, inventory, general ledger, payroll, etc.

The system

The idea of CompuFix was developed by several owners of large electronics servicing businesses. The president, Sam Fried, is also president of Master Electronics in Omaha, NE. Vice-president is Jim Robison, former president of Electromatic in Portland, OR, who has left that post to devote full time to this venture.

The computer technical aspect of this service is being handled by Logical Systems. That company, as the technical developer, is charged with continued technical development and integration of the information service, including software development, as well as hardware selection, system integration and database management.

The CompuFix system uses a private packet switched network, which is currently connected to approximately 300 cities across the United States and can be accessed at any of its nodes via a local telephone call.

Using the system

Access to the system will require that the user own or lease a "dumb" computer terminal, personal computer or similar computer interface device, as well as a modem to connect to the telephone lines.

Once the service has been dialed up, the user enters the brand, the chassis and a code that represents the problem that has been encountered. As an example, code 110 covers problems in sound or picture. The terminal screen will then display the repairs that have been made by others when the same problem has been encountered. (See Figure 1.)

As of early June, the data base contained more than 50,000 repairs supplied by a score of TV servicers and is being added to weekly.

The cost of this service is $100 per month, which includes 30 repairs, with an additional $2 per repair for more than 30 repairs.

For more information on Compufix Electronic Database Services, contact their corporate headquarters at 8601 "I" Street, Omaha, NE 68127, or call 1-402-331-1111.

GS&T

Servicing HV triplers

By Homer L. Davidson

Most color TV receivers that have solid-state horizontal sweep also use either a tripler or a quadrupler to rectify sweep pulses and provide a multiplied dc high voltage.
Because these rectifier units are sealed and the individual components are not available for testing, conventional diode tests cannot be performed.
Instead, other troubleshooting methods, as outlined here, are necessary.

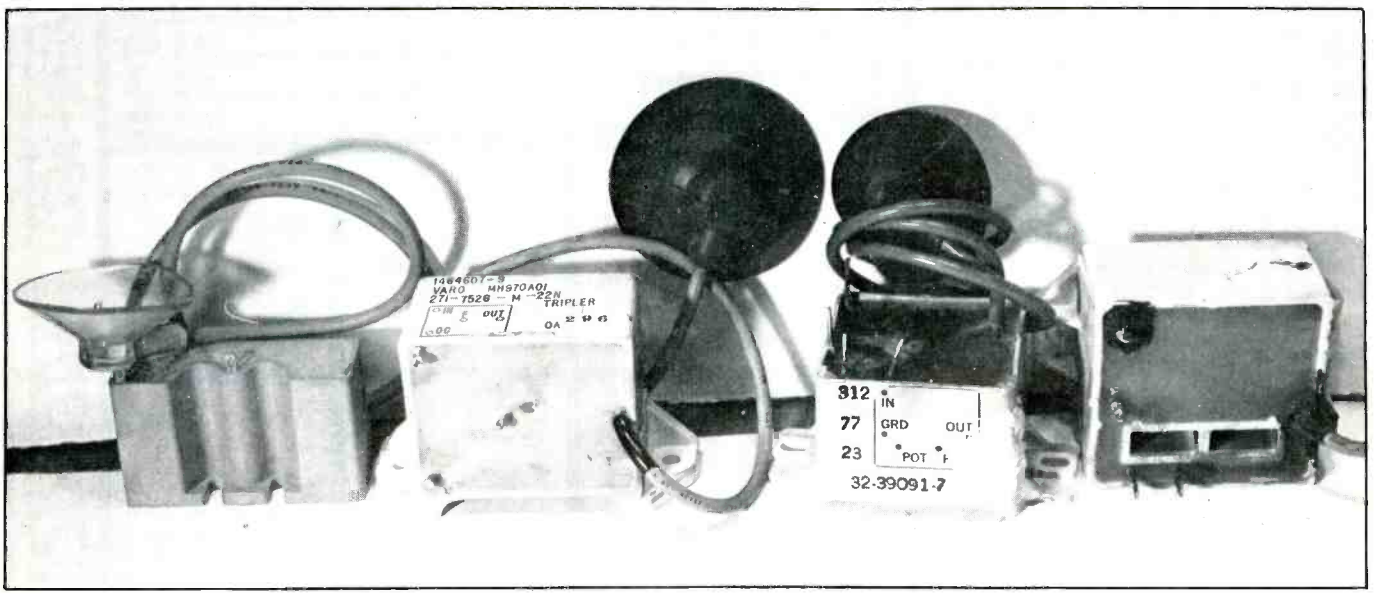


Figure 1 Four original triplers are pictured. From the left, the first is from an Admiral color receiver, the second is from an RCA, the third was taken from a Sylvania (it shows an attempt to stop an arc) and the fourth is from a Zenith television. Dimensions and mountings vary according to models.

A tripler unit in a color TV receiver is a specialized type of rectifier. When horizontal pulses are rectified by a single diode of proper polarity, the dc-voltage output is about equal to the peak amplitude. When cascaded, two of these become a doubler. The first diode develops a dc voltage, then this dc voltage and the input ac pulse is applied to the second rectifier stage.

The dc voltages from both stages are in series to produce twice the voltage of a single stage. Triplers have three diodes and three filter capacitors that generate three times the dc voltage obtained from one diode and its capacitor Quadruplers have four stages and four times the dc-voltage output.

Triplers are used in the majority of solid-state color receivers. Of course, a quadrupler should not be used to replace a tripler, nor should a tripler be a replacement for a quadrupler. When obtaining a tripler or quadrupler, make certain the specifications match the receiver exactly.

Because of the dc voltage multiplication in these components, arcing is more likely to occur in them than in or around the flyback. Many cases of arcing can be seen as white dots, white lines or other flashes superimposed on the picture. Figure 1 shows the appearance of four typical triplers.

Sometimes arcing can be heard inside a tripler or quadrupler. Of course, use care to avoid shocks. A dry section of garden hose can be used as a stethoscope during these audible tests.

Some tripler defects can reduce the high voltage and blur the picture without disturbing the horizontal-sweep voltages or ruining any horizontal components. Other defects produce serious overloads of the horizontal-output stage, perhaps blowing fuses, tripping breakers or ruining output transistors.

Unfortunately any problems from defective triplers or quadruplers can be intermittent, increasing the difficulties of identifying the problem.

The following case histories have been selected to show several types of defects and how to troubleshoot them. They can serve as examples for similar circuits.

Blows fuses

After the F800 1½A fuse blew twice in succession in a Montgomery Ward GA1-12982B (Photofact 1431-3), a 100W bulb was connected across the fuse holder. The bulb showed high brightness until the horizontal-output transistor was removed. Then the bulb became dark, showing that the current had been too high in the horizontal-sweep or high-voltage circuits.

Installation of a new horizontal-output transistor did not solve the problem; the test bulb remained too bright.

Next, all major sweep-circuit loads were disconnected and tested one at a time by applying ac power and observing the brightness of the test lamp. (Line power was removed while these temporary changes were made.) The chief remaining suspect was the tripler, which was disconnected at the input terminal marked *in.* Many of these tripler terminals are covered by silicone material that insulates them. The silicone must be removed before any unsoldering can be done.

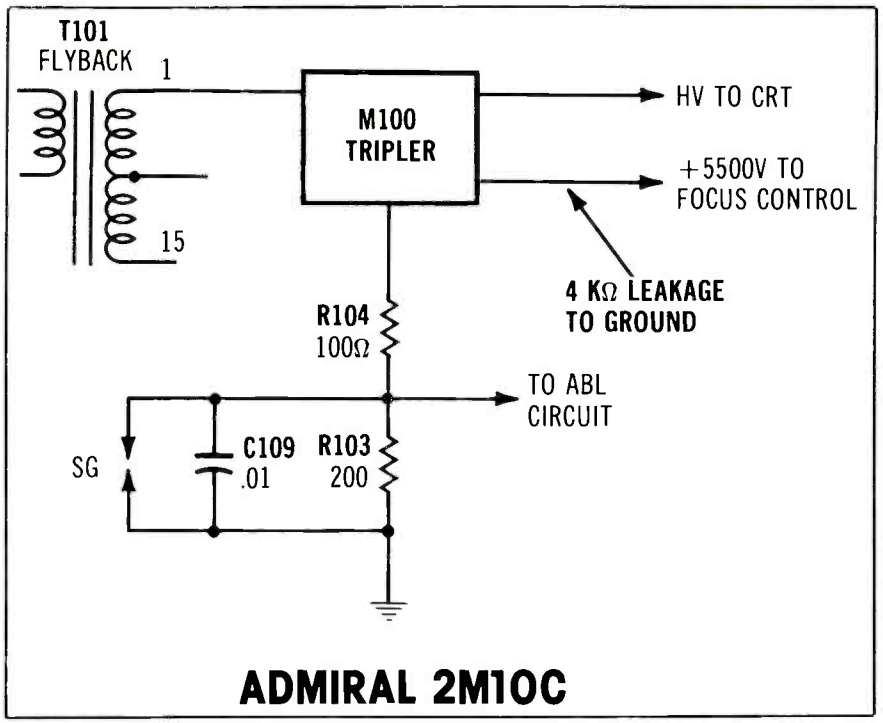


Figure 2 Internal leakage (probably carbonization) in an Admiral tripler removed the focus voltage and overloaded the horizontal-sweep system. Similar leakages often produce hot spots on the tripler case.

After the input wire was removed from the tripler, the test lamp became dark. Installation of a GE-538 universal tripler stopped the fuse blowing and the overload, bringing back good operation.

Fuse opens after 40 seconds

The Admiral 2M10C chassis (Photofact 1522-1) had sound but no raster. Usually, when the sound is normal (without buzz), the horizontal circuit is working, but within a few minutes F102 (1A) blew. A 100W light bulb was connected across the F102 fuse holder. Abnormally low dc high voltage was measured and the test bulb was too bright.

With power off, the horizontal-output transistor was tested by a digital multimeter that has a constant-current diode or transistor-junction voltage-drop test. Both junctions had the proper voltage drop. Reversed test probes applied to the damper diode again showed correct drop. Also no excessive leakage between the output-transistor collector and ground was measured.

However, when the tripler input wire was disconnected, the test-lamp brightness dropped to normal. A new M100 tripler (universal GE-537) was installed and connected. Now, the test lamp glowed with proper dimness. After the test-lamp leads were removed and a new fuse plugged in, the screen lit up with a normal picture.

To clarify the procedure, removal of any components for tests must be done only after the power plug is removed from ac power. After the tests (or after some suspected component is disconnected), the power is restored while brightness of the test lamp is monitored. Normally, the test bulb lights brightly (during charging of the filter capacitors) and then dims down to a moderate glow. Full or half brightness indicates excessive load of some sort, and it must be identified and corrected before the test lamp is disconnected and a fuse installed.

All wires and terminals on the defective tripler were measured to the tripler common ground. A 4KΩ reading was obtained from focus wire to ground (Figure 2). Of

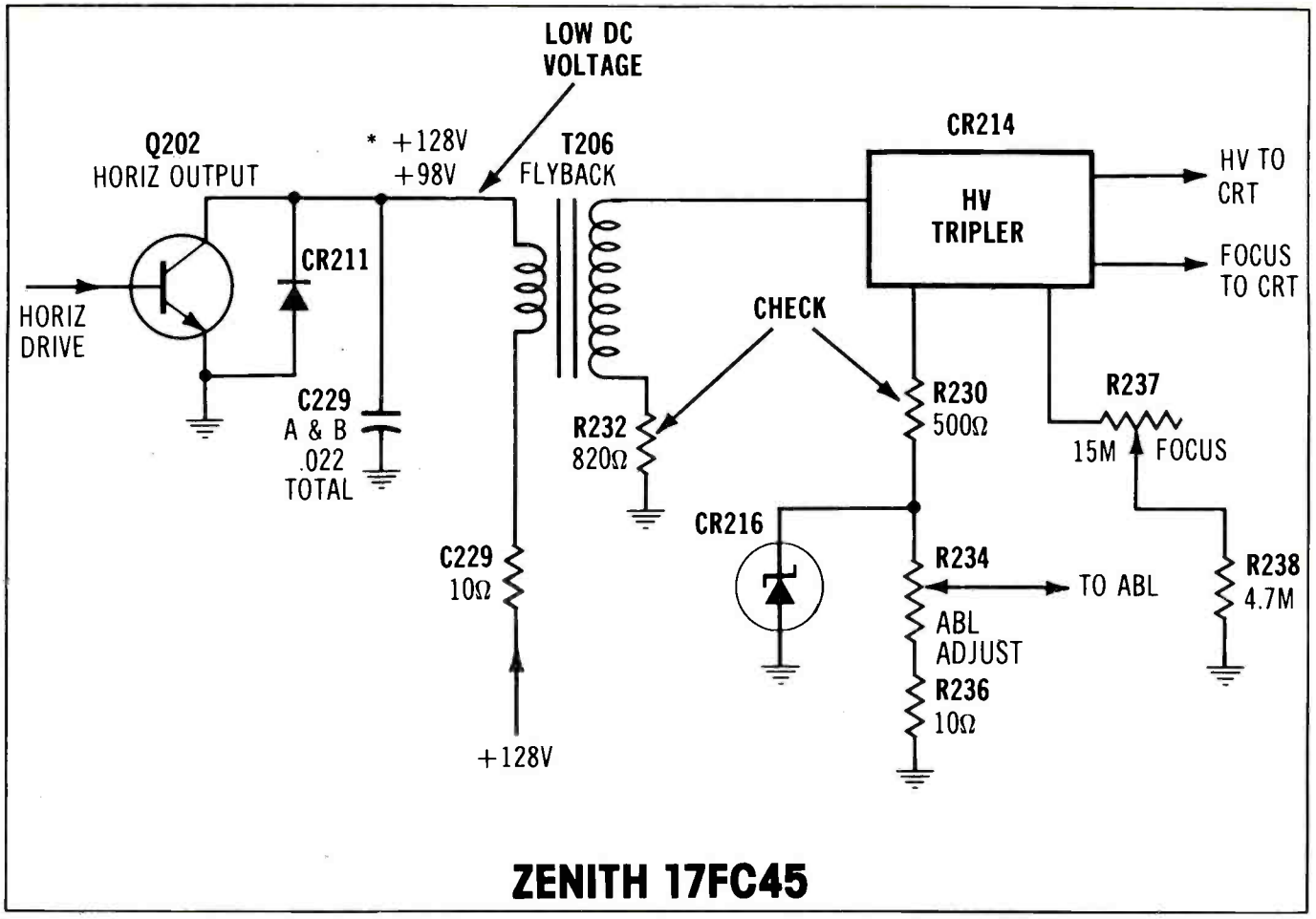


Figure 3 A defective CR214 tripler in a 17FC45-chassis Zenith reduced the high voltage and the Q202 collector voltage. Resistors R232 and R230 should have their resistances tested following any tripler or high-voltage overloads.

course, this proves that leakage or carbonization internally has ruined the tripler.

Insufficient high voltage

Instead of the normal 27.5kV, only 8kV of high voltage was measured in a Zenith 17FC45 chassis (Photofact 1466-3). Sound quality was normal, but there was no raster. Collector voltage of Q202, the horizontal-output transistor, measured only +98V, although normal voltage is +128V. The Q202 base drive appeared to be within tolerance.

Although the Q202 junctions checked out in-circuit, the transistor was replaced to eliminate nagging doubts about its condition. Unfortunately the symptoms were unchanged.

When the black wire from the horizontal flyback was unsoldered from the tripler, the Q202 collector voltage rose to normal. This proved the tripler was loading down the sweep circuit and reducing the voltages. Installation of the proper replacement tripler restored normal performance.

After an overload of this type, resistors R232 and R230 (Figure 3)

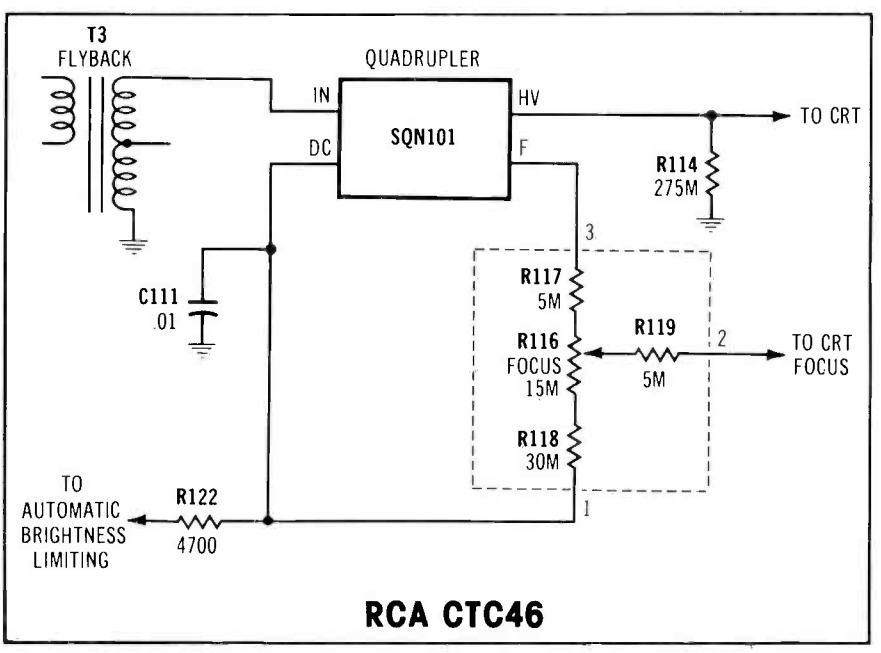


Figure 4 Internal arcing was found in the quadrupler of an RCA CTC46A chassis. Check the Photofact listings to be certain a proper rectifier unit is ordered for replacement. Triplers and quadruplers have the same outward appearance.

should be checked to determine whether or not the overload current has changed their ohmic values.

Low HV with arcing

Sounds of arcing could be heard near the flyback in the RCA CTC46A chassis (Photofact 1278-3) and flashing arcs were noticed in the socket end of the picture tube. When the high-voltage lead was removed from the CRT anode, the circuit breaker tripped.

However, after the flyback lead was disconnected from the quadrupler (Figure 4), the breaker held and a normal 3/8-inch arc could be drawn from the flyback lead. These tests indicated that a defective quadrupler was loading down the sweep.

As you may have guessed already, replacement of the quadrupler with an RCA exact part restored normal high voltage and produced a good picture.

Because there is no easy way to determine whether a dc-voltage multipler unit is a tripler or a quadrupler, you should always check the original part number or specifications. And when the original component is not available, make certain the universal replacement has the desired characteristics.

Arc lines in the picture

Arc lines in the picture can originate either in the flyback or the tripler. This arcing can be heard sometimes and the sound provides a clue about the origin. However, careful listening often is required because the two components are near each other.

Another good test of a bad tripler or quadrupler unit is to operate the television for several minutes, pull the power plug from the wall outlet and then feel the plastic case of the rectifier unit. Normal triplers operate at room temperature, while shorted ones often feel warm to the touch.

Many *flybacks* in new models have three diodes inside and these flybacks are more prone to internal arcs.

Arcs can be caused also by a defective or poorly seated CRT anode lead or by a focus control (Figure 5). Sometimes arcs can been seen after the room lights are turned out, or the flyback/tripler area is darkened.

Loading the horizontal sweep

Low collector voltage of the horizontal-output transistor can be produced by a leaky output transistor or insufficient drive to the output base. Therefore, a low collector-voltage measurement

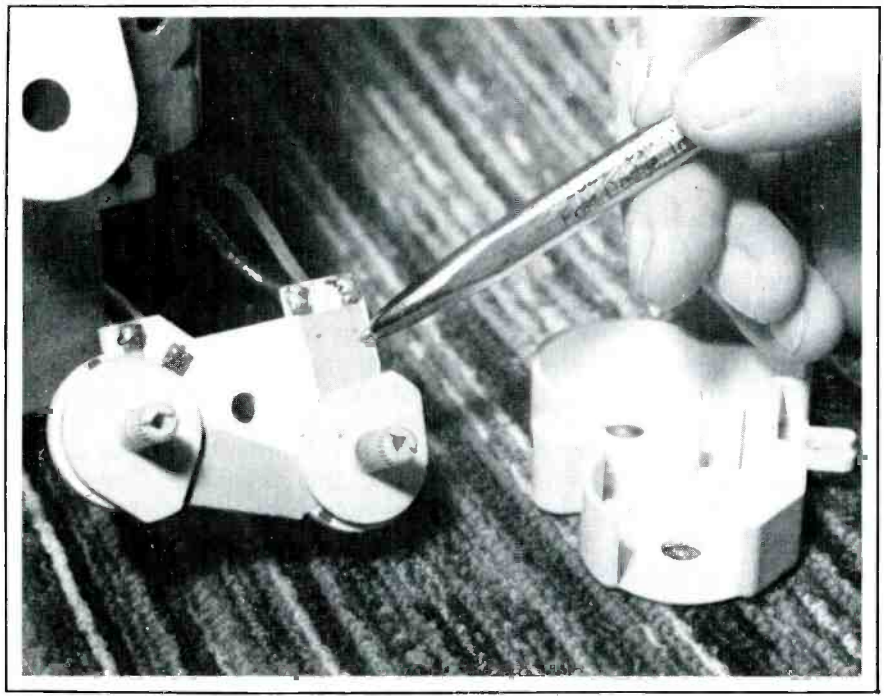


Figure 5 Spots and lines in the picture, caused by receiver arcing, can originate from the anode lead or the focus control. This thick-film, focus-control wiring (from a CTC46 RCA) generated picture interference from arcs.

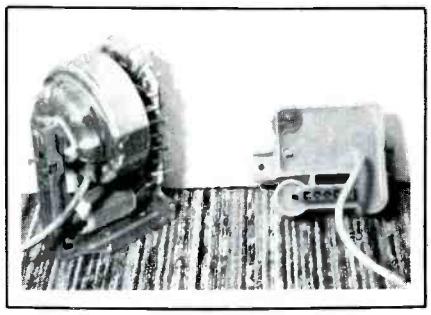


Figure 6 These components were removed from color receivers because they arced. At the left is an RCA flyback that has internal diodes which replace a tripler. The tripler (at right) shows carbonization from arcs on one side.

should be followed by scoping the base signal. If the waveform and amplitude are adequate, the output transistor should be checked for leakage. Sometimes an ohmmeter reading taken from collector to circuit ground can prove leakage. If so, the transistor should be removed for more accurate out-of-circuit tests.

The low-collector-voltage symptom was present in a Magnavox T995 chassis. Only +87V was measured at the collector, but it returned to the proper +114V when the tripler unit was replaced.

Erratic breaker tripping

In another RCA CTC46 chassis, the circuit breaker would trip after anywhere from 15 minutes to a full week of operation. After the breaker was disconnected, a 100W test bulb was connected in place of the breaker and the receiver was placed on a heat run awaiting a brightening of the test bulb.

After it appeared certain that the overload was in the horizontal-sweep circuit, the SCRs, flyback and quadrupler were replaced on suspicion, but without stopping the erratic tripping of the breaker.

Finally, operation with a higher line voltage produced arcing of the focus-control assembly (Figure 4). Replacement of the focus assembly permanently stopped the breaker tripping. Although the quadrupler itself was not the problem, the arcing focus control overloaded the quadrupler, which overloaded the breaker, causing it to trip.

A warm tripler

Always replace any tripler that has audible arcing sounds internally or that feels warm after several minutes of operation. In an RCA

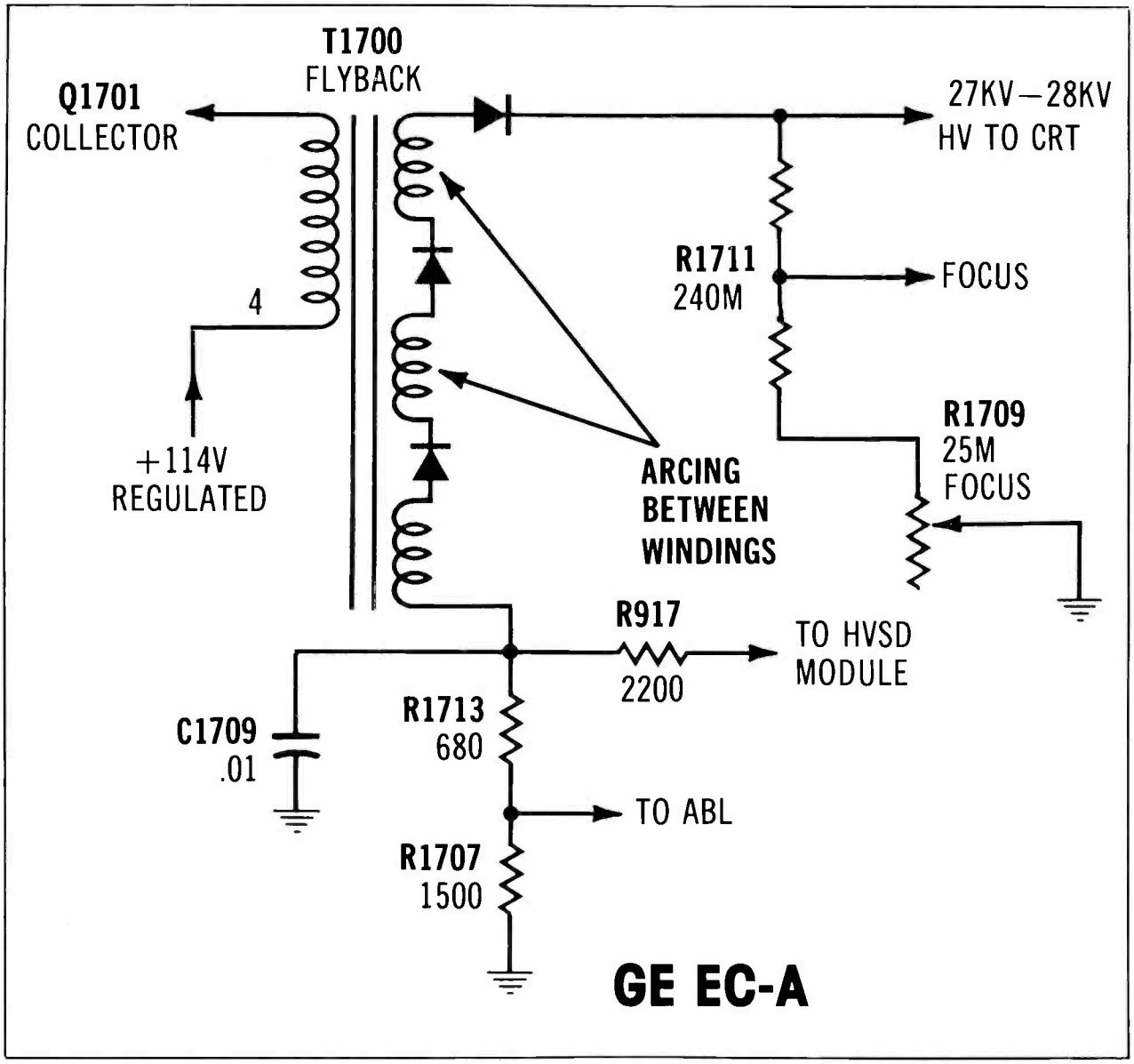


Figure 7 Flybacks that have internal rectifiers seem to have more arcing problems than those without rectifiers. One General Electric EC-A chassis had visible arcing between one winding and the metal framework. Others have failed by developing arcs from one winding to another.

CTC74 chassis, the dc voltage at pin 3 of ITR401 trace SCR/diode measured about +28V, instead of the usual +70V. No high voltage or raster was obtained.

After several minutes of operation, the tripler was warm to the touch – an excellent indication of a bad tripler. To be certain, we unsoldered the wire from the tripler *in* terminal and found the ITR voltage had risen to normal. A new tripler brought back the former good operation, and another repair was finished without elaborate testing.

Constant arcing

Almost constant arcing could be seen and heard around the tripler component in a Montgomery Ward M25 chassis. After the tripler was pulled up away from the chassis to stop the arcing, the picture was normal. It is sometimes necessary to lift the tripler before the source of the arcing can be seen.

Do not attempt a patch job by application of an anti-arc coating. There are uses for anti-arc, but not here. Instead, *replace* the defective tripler with an appropriate new one. This television was repaired by installation of a universal GE-521. Universals sometimes require a different mounting, so there must be sufficient room for all leads without producing other arcs.

Two components that were removed because of arcing are pictured in Figure 6. One is a flyback with internal diodes and the other is a tripler.

Many late-model color receivers (such as the General Electric EC-A chassis) have three high-voltage diodes inside the flyback. In other words, the tripler is built into the flyback. One EC-A developed an arc between one winding and the internal metal framework. Others have arced between two or more internal windings (Figure 7). Of course, replacement is the only remedy.

Sensory tests for arcing in these combination flyback/triplers are about the same as for separate triplers: the molded covering may

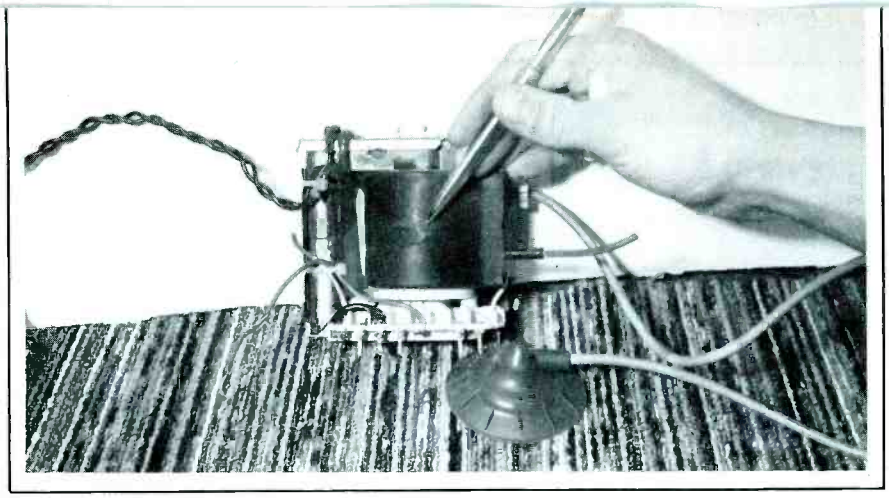


Figure 8 This RCA flyback was replaced after arcing sounds were heard coming from it. After the flyback was removed, a cracked area could be seen in the plastic covering of the high-voltage winding. Evidently the internal arcing had damaged the plastic.

feel warm to the touch and internal arcing may be heard in suspected flybacks.

Shutdown

A significant number of new models have safety circuits that disable the horizontal sweep when excessive high-voltage or HV-current is sensed. An RCA CTC86U chassis produced a short burst of sound before all sound stopped. Also, ticking was heard from the horizontal-sweep section, although there was no high voltage or raster.

After the tripler's input lead was disconnected, a proper small arc could be drawn from the flyback lead, indicating the tripler was loading down the horizontal sweep. Figure 8 pictures leakage evidence in another RCA flyback.

Installing a new tripler solved all problems.

An unusual problem

In a Coronado TV2-6634A chassis (Photofact 1157-1), arcing was noted in many places, such as around the tripler and the picture tube. A high-voltage measurement revealed excessive 40kV high voltage. A new tripler was installed, without any change of symptoms. After some reflection, this replacement seemed inappropriate, because nothing inside a tripler can *increase* the high voltage.

All horizontal voltages and waveforms were normal, and the flyback resistances checked within tolerance. Finally, C910, (a 0.0025μF 10kV capacitor enclosed in a ceramic sleeve) was suspected of being open. Replacement of C910 brought the high voltage down to 26kV. I advise using a replacement capacitor from the manufacturer.

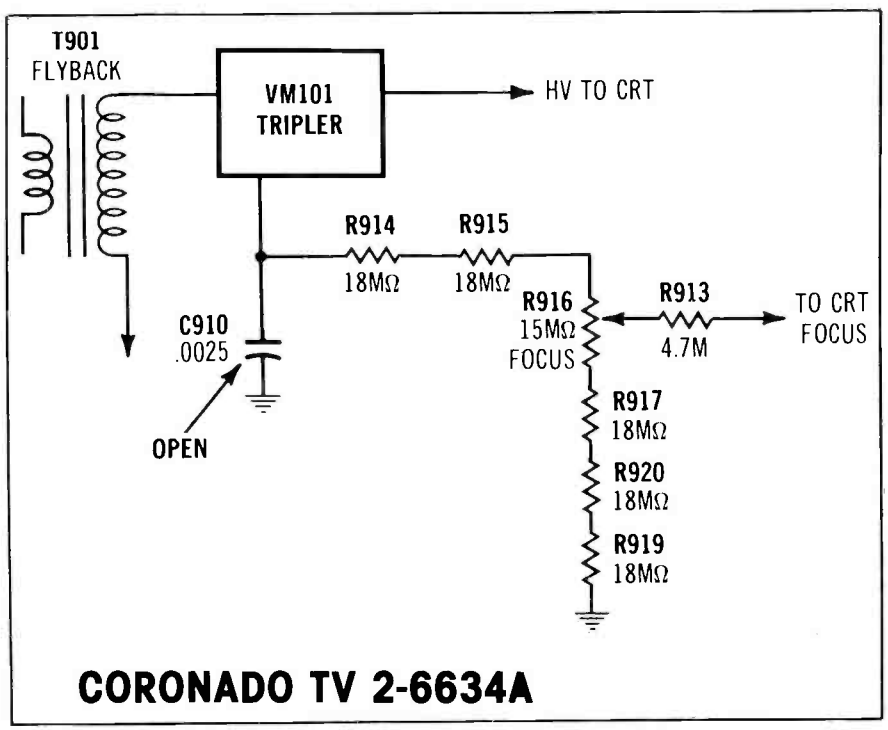


Figure 9 An open capacitor C910 evidently was responsible for excessive high voltage in this Coronado color receiver.

Universal triplers

The majority of triplers can be replaced with a universal type, without difficulties or special problems. In some cases, longer wires and different mounting hardware might be needed to properly mount the tripler.

Use extra care with older chassis that might be equipped with quadruplers. The appearance and mounting of quadruplers and triplers might be similar. However, using a tripler to replace a quadrupler will produce insufficient high voltage. Even worse, using a quadrupler to replace a tripler produces *excessive* high voltage, which can cause arcs, X radiation and other problems. Check Howard W. Sams Photofacts for the correct universal replacement.

Tips

After the correct replacement tripler or quadrupler has been mounted, carefully check each wire to be certain it is connected to the correct terminal. When the wiring is not crystal clear, a simple diagram showing the color of leads or the destination should be made before the original defective component is removed. This will minimize errors when the new tripler is wired, which might be days or weeks later.

After normal soldering of each terminal to accomplish proper tinning, a ball of solder should be constructed so no sharp points of wire or solder remain. Finally, place a covering of silicone cement over each connection. These few precautions will minimize arcs or coronas. ES&T

Some proponents of component TV

By Rhonda Wickham, managing editor

This month when we set to the task of pinpointing one most prominent trend in TV development for the coming year, we discovered that there was no one area that we could single out. It seems that the manufacturers are pursuing several technologies. Besides continuing in their never-ending quest for compact chassis, sharper pictures, higher definition, unexcelled color and contemporary designs, manufacturers are increasing the size of the screen or shrinking the complete unit, developing systems that simulate stereo output from mono input, and projecting from in back of, as well as from in front of a screen.

In the late 1940s and early 1950s as audio electronic equipment advanced rapidly in sophistication and the availability of program sources increased, audio equipment was broken down into its components so that the audiophile could build a high-fidelity sound system precisely tailored to both his ear and his budget.

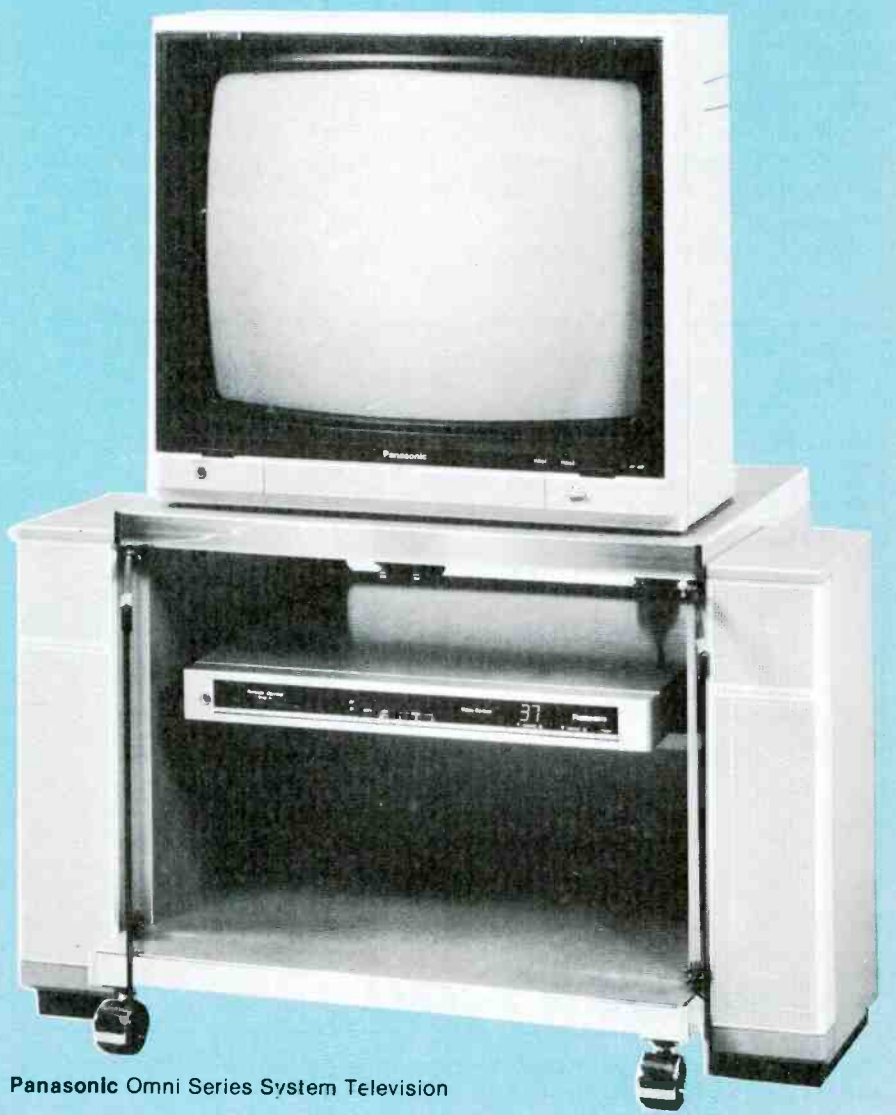
It appears that video is now poised on the threshold of that same step. Advances in video circuitry have made high-quality, high-definition video displays possible. Videotape, videodisc, cable and TVRO have dramatically increased the availability of programming, and more is on the way. Much of this new programming is capable of high-fidelity stereophonic sound. In fact, one aspect of the swing to component video is the first steps toward integration of video and audio into a single high-quality sound-and-picture entertainment center within the home.

Panasonic

Panasonic Company is entering the component television race with their Omni Series System Television. It consists of a color monitor, a video control with synthesizer tuner and a matched speaker system.

CompuFocus picture tubes are featured in the 19-inch (diagonally) monitor component (model CT-9072M). The CompuFocus Video System combines the CompuFocus picture tube with a wide lens for sharp pictures, a tinted glass envelope for better image contrast and use of either a saw filter or a comb filter in the electronic circuitry.

The saw filter used in the system



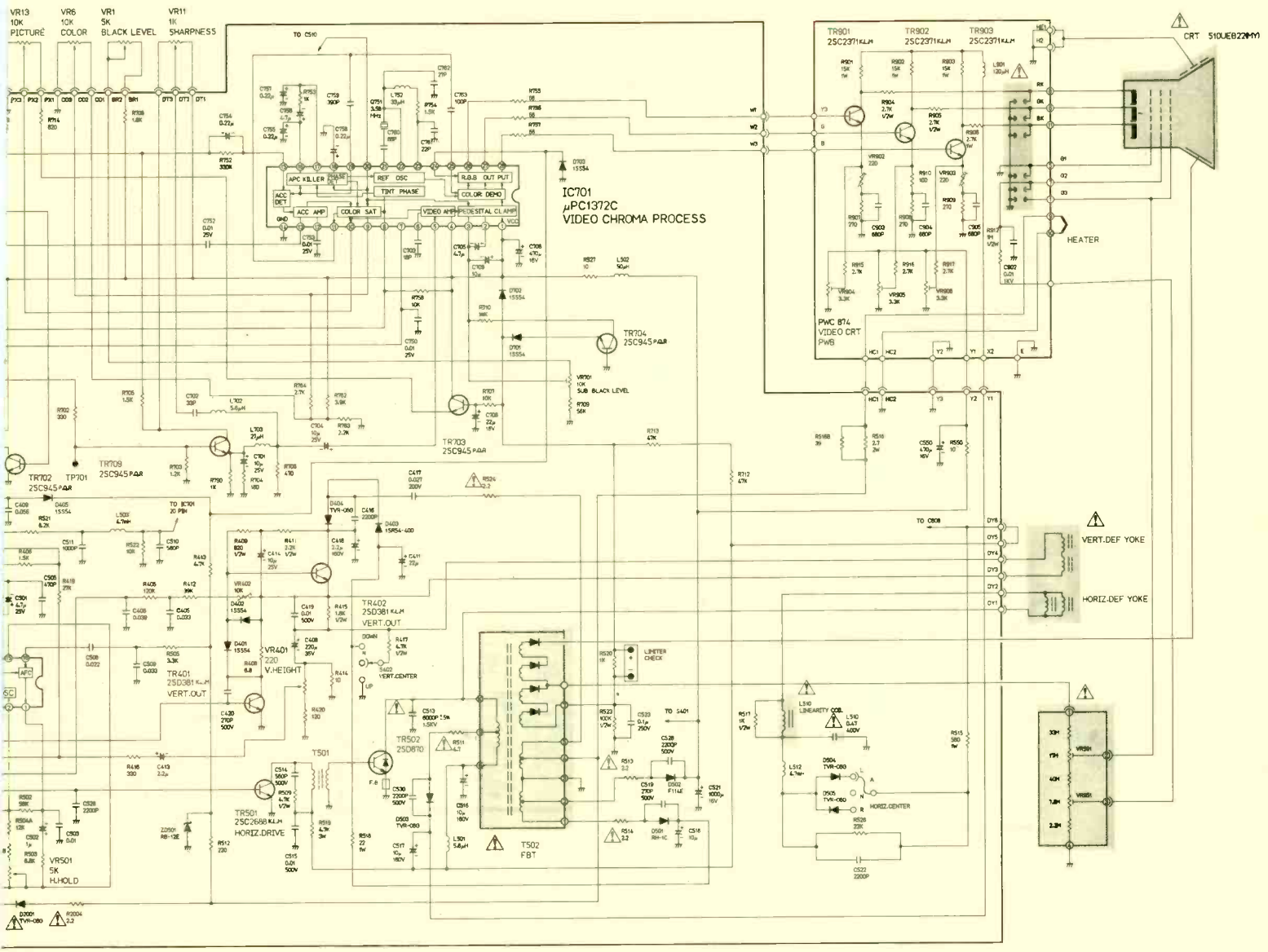
Panasonic Omni Series System Television

ES&T Manufacturers' schematics **PROFAX**

2000

NEC
Color video monitor
Chassis Z7A

OCTOBER 1982



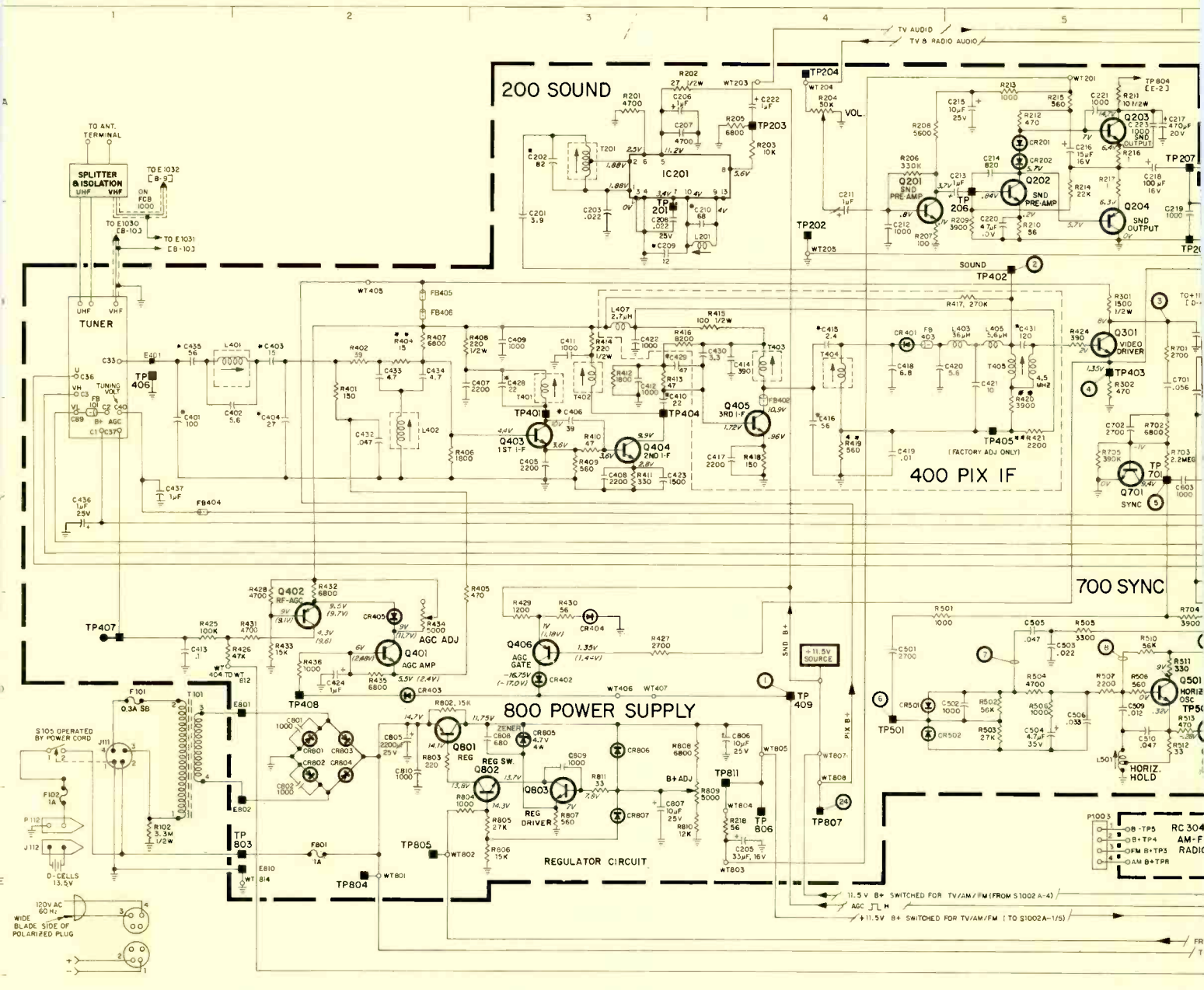
NOTES

1. RESISTOR VALUES ARE IN Ω 10HM Ω K=1,000Ω M=1,000,000Ω
2. ALL RESISTORS ARE ¼WATT EXCEPT WHERE OTHERWISE INDICATED.
3. CAPACITOR VALUES ARE IN μF UNLESS OTHERWISE INDICATED. P=PF
4. ALL CAPACITORS ARE 50VOLTS EXCEPT WHERE OTHERWISE INDICATED.
5. VOLTAGES AND WAVEFORMS MEASURED UNDER AVERAGE COLOR SIGNAL INPUT AND CONTRAST. BRIGHTNESS CONTROL AT MAXIMAM. ALL OTHER CONTROLS SET FOR NORMAL OPERATION.
6. Ⓗ---- HORIZONTAL RATE. Ⓥ---- VERTICAL RATE.

WARNING

REPLACEMENT PARTS WHICH HAVE SPECIAL SAFETY CHARACTERISTICS ARE IDENTIFIED BY ⚠ SHADING ON THE SCHEMATICS. REPLACE THESE CRITICAL COMPONENTS WITH RECOMMENDED REPLACEMENT PARTS.
DON'T DEGRADE THE SAFETY OF THE SET THROUGH IMPROPER SERVICING.

ogy, P.O. Box 12901, Overland Park, KS 66212



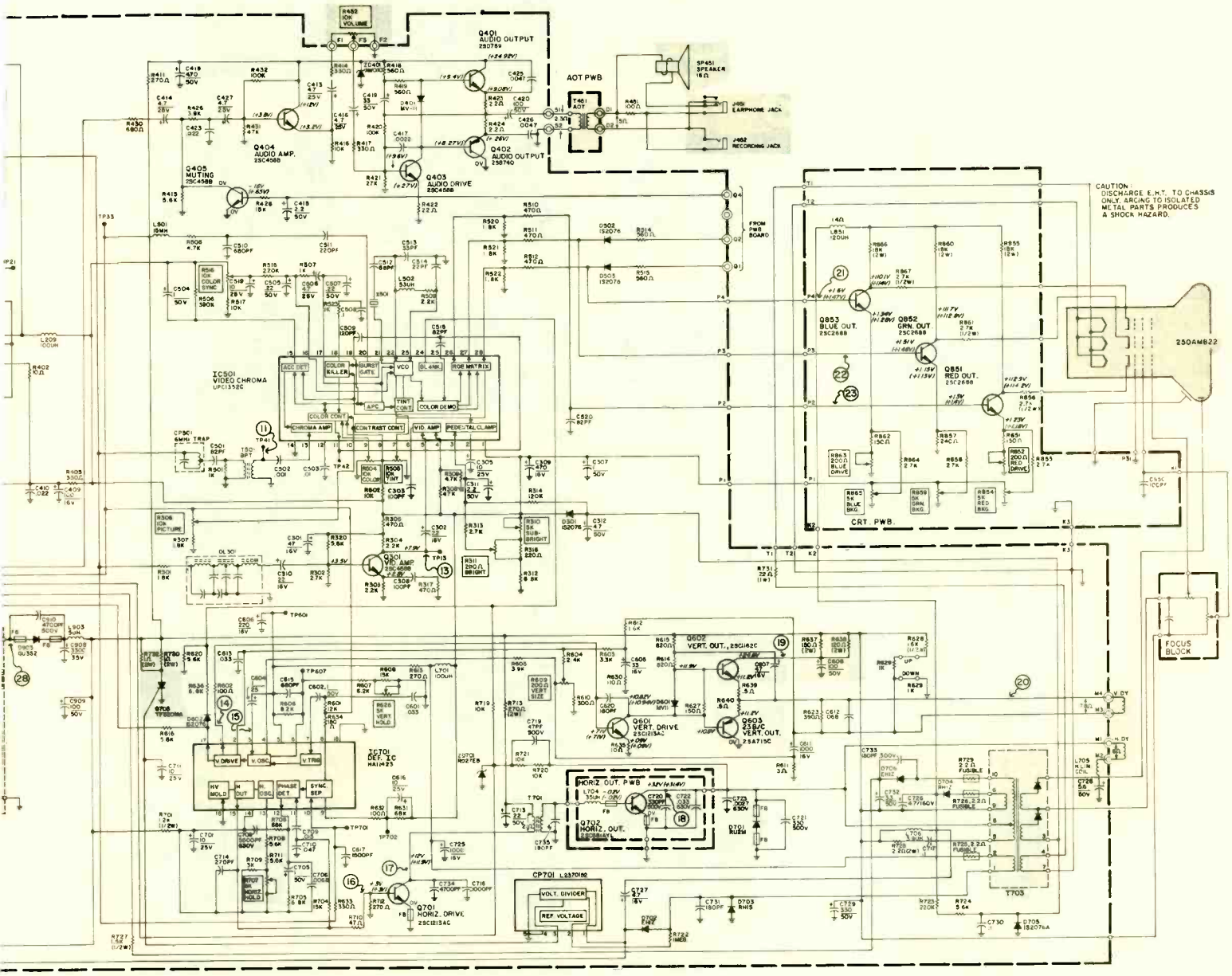
This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

ES&T Manufacturers' schematics **PROFAX**

2002

NAP
Color TV
Chassis 09C201 CQ4X

OCTOBER 1982



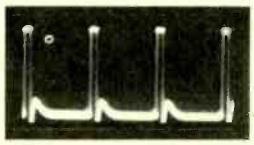
ogy, P.O. Box 12901, Overland Park, KS 66212

WAVEFORMS

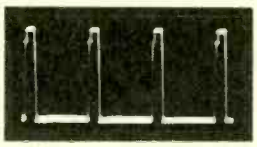
WAVEFORM MEASUREMENT CONDITIONS

1. Maintain line at 122V. AC, 60 Hz.
2. Switch AFT off.
3. Picture, Bright controls at center of rotation.
4. Tint, Color adjusted for proper colors and color saturation.
5. Receiver tuned to standard color bar (Gated Rainbow) generator.

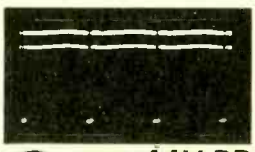
1 5.2V PP Vert.



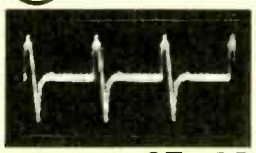
2 10V PP Horiz.



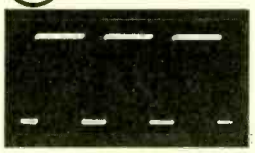
3 27V PP Horiz.



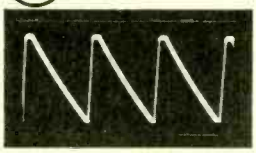
4 .44V PP Horiz.



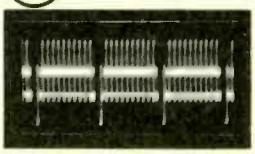
5 .07V PP Horiz.



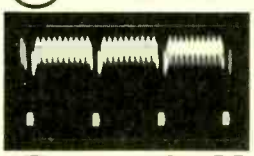
6 9V PP Horiz.



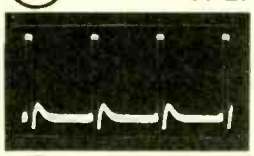
7 4.2V PP Horiz.



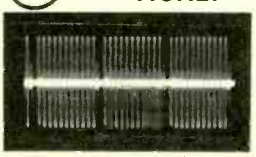
8 .32V PP Vert.



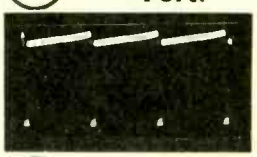
9 .9V PP Horiz.



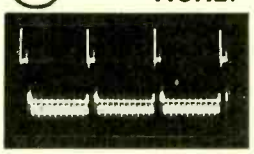
10 10V PP Horiz.



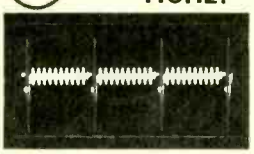
11 .44V PP Horiz.



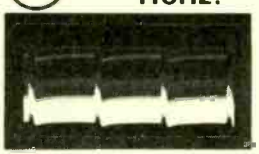
12 .7V PP Horiz.



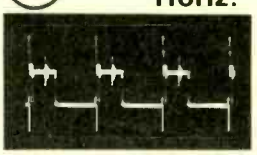
13 .45V PP Horiz.



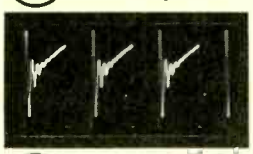
14 .95V PP Vert.



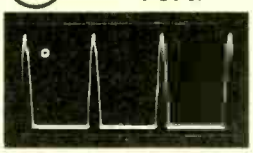
15 .7V PP Vert.



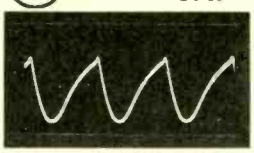
16 2.5V PP Horiz.



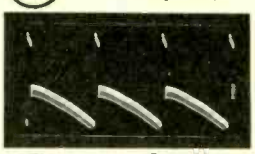
17 32V PP Horiz.



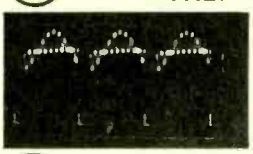
18 280V PP Horiz.



19 10V PP Vert.

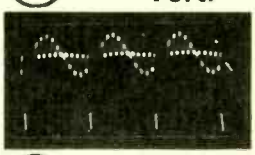


20 30V PP Vert.

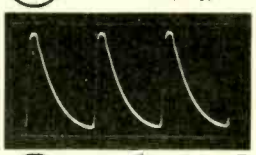


21 2.8V PP Horiz.

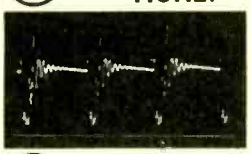
22 1.9V PP Horiz.



23 2.8V PP Horiz.

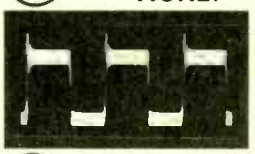


24 7.3V PP Horiz.

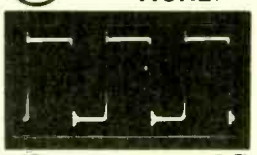


25 .36V PP Horiz.

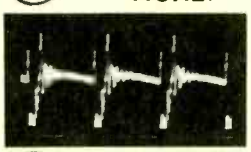
26 7V PP Horiz.



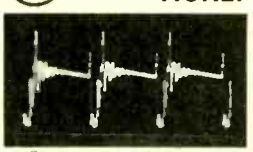
27 450V PP Horiz.



28 95V PP Horiz.



29 .28V PP Horiz.



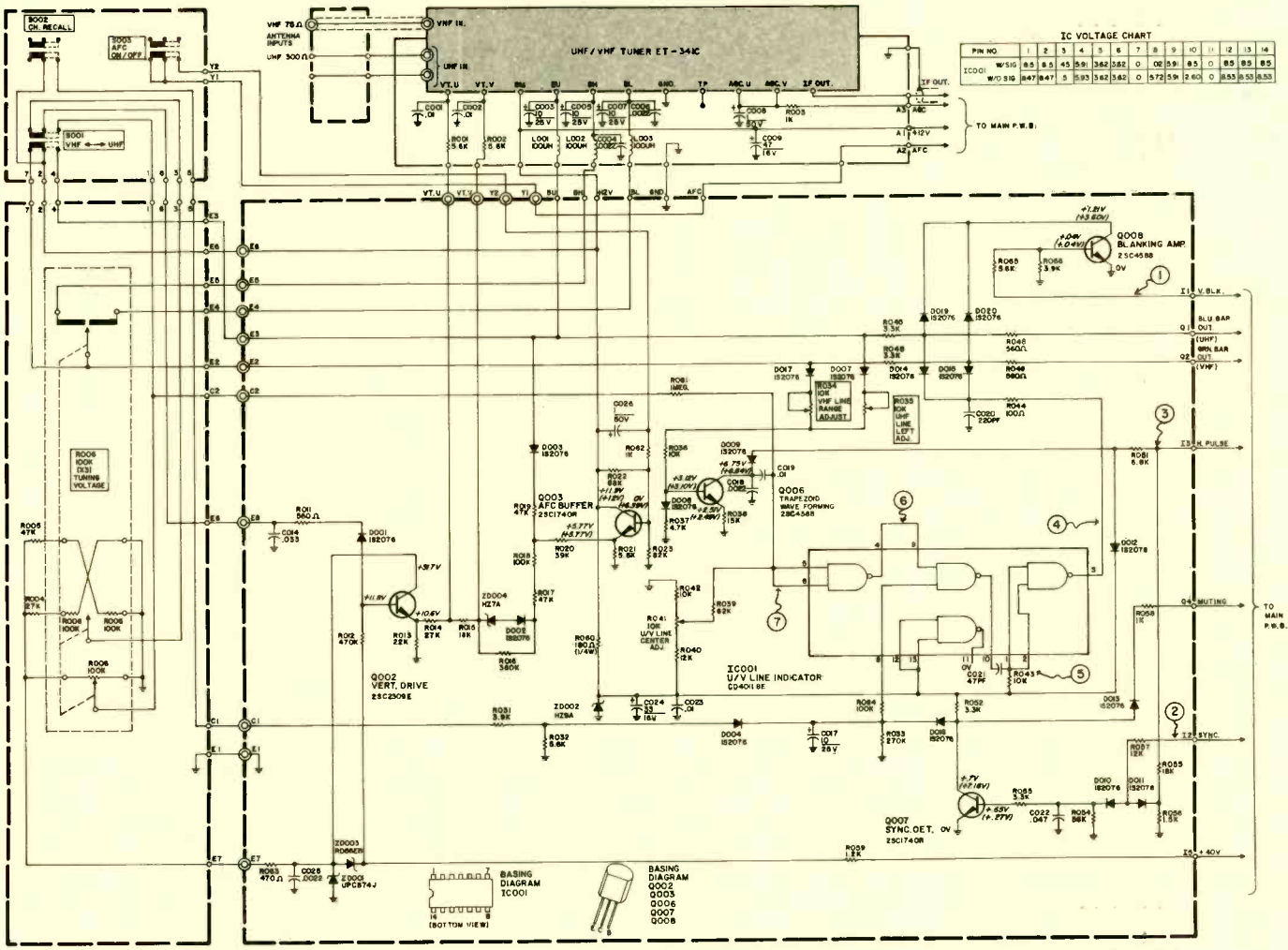
30 .26V PP Horiz.

ES&T Manufacturers' schematics PROFAX

2002

NAP
Color TV
Chassis 09C201 CQ4X

OCTOBER 1982



This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

WARNING

For continued safety of this product, parts identified with an (S) preceding the replacement part number should be used as replacements for those identified in the shaded areas of the schematic diagrams of this service manual. Use of substitute replacement parts which do not have the same safety characteristics as specified, may create shock, or fire hazards.

For maximum reliability and performance, all other parts should be replaced by those having identical specifications.

Under no circumstances should the original design be modified or altered without written permission from the N.A.P. Consumer Electronics Corp. NAPCEC assumes no liability, express or implied, arising out of any unauthorized modification of design.

Reprinted courtesy of N.A.P. Consumer Electronics Corporation.

gy, P.O. Box 12901, Overland Park, KS 66212

SCHEMATIC DIAGRAM — MAIN CHASSIS

WARNING

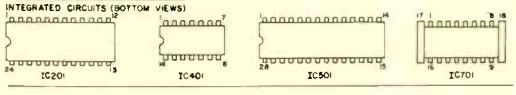
For continued safety of this product, parts identified with an Ⓢ preceding the replacement part number should be used as replacements for those identified in the shaded areas of the schematic diagrams of this service manual. Use of substitute replacement parts which do not have the same safety characteristics as specified, may create shock, or fire hazards.

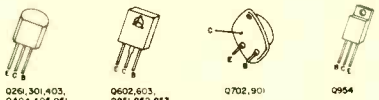
For maximum reliability and performance, all other parts should be replaced by those having identical specifications.

Under no circumstances should the original design be modified or altered without written permission from the N.A.P. Consumer Electronics Corp. NAPCEC assumes no liability, express or implied, arising out of any unauthorized modification of design.

BASING DIAGRAMS

INTEGRATED CIRCUITS (BOTTOM VIEWS)

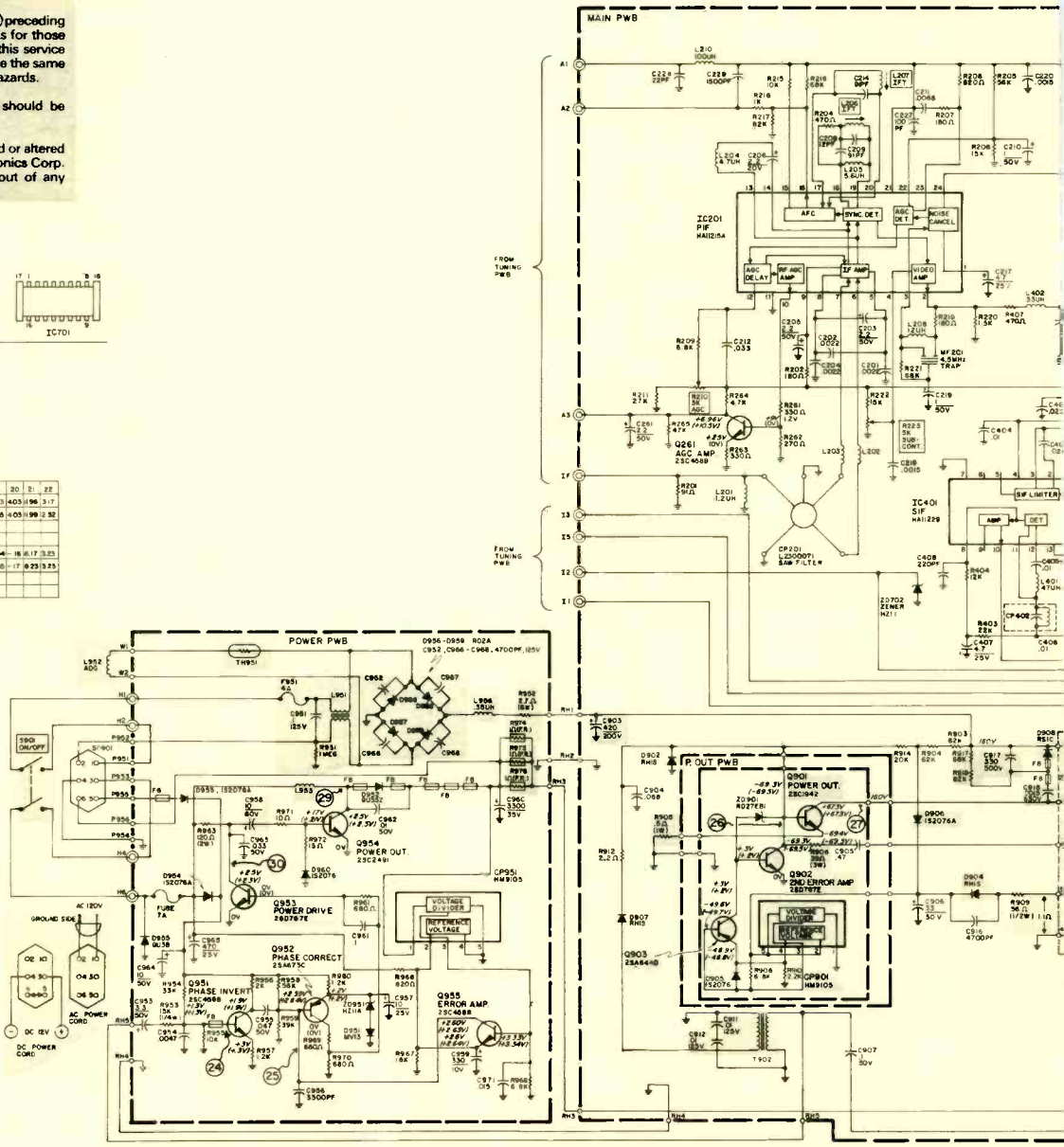




IC VOLTAGE CHART

PIN NO		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
IC201	W/SIG	5.02	0	4.46	4.45	96	4.74	3.58	3.30	4.74	5.48	2.06	0	8.63	4.75	4.75	93	37	4.02	8.63	5.63	4.03	11.96	3.17
	W/O SIG	5.62	5.87	4.34	5.35	96	4.71	4.34	4.30	4.37	7.18	0	0	3.04	4.73	4.73	93	.03	8.24	0	8.62	8.86	4.05	11.99	2.52
IC401	W/SIG	3.99	3.87	0	3.88	5.96	8.54	0	0	3.57	0	2.89	3.87	5.00	0	3.99									
	W/O SIG	0	0	3.67	3.88	8.54	0	0	3.61	0	3.32	0	3.00	0	3.99										
IC501	W/SIG	12.00	8.62	8.58	3.97	3.33	2.65	1.87	3.78	12.09	12.0	38.56	1.98	.28	.08	9.00	8.88	8.74	10.13	4.34	-.16	16.17	3.25
	W/O SIG	12.11	8.73	8.68	6.00	3.34	2.67	1.88	3.81	2.10	12.10	8.36	1.98	.28	.08	9.12	7.93	7.63	6.83	4.36	-.17	9.25	3.25
IC701	W/SIG	.71	3.86	6.81	3.32	10.0	5.47	5.44	1.44	8.40	8.05	3.56	6.73	6.69	12.66	.47	0	5.5	0						
	W/O SIG	.70	3.91	8.68	3.36	10.13	5.53	5.50	.81	9.34	8.87	3.58	6.89	6.71	12.66	.47	0	5.5	0						

PIN NO		23	24	25	26	27	28
IC201	W/SIG	11.89	8.03				
	W/O SIG	11.98	8.04				
IC501	W/SIG	3.22	.68	2.86	.51	1.48	.81
	W/O SIG	3.24	.68	2.87	1.53	1.52	1.57



NOTE: Numbers in circles refer to waveforms. See reverse side.

Reprinted courtesy of N.A.P. Consumer Electronics Corporation.

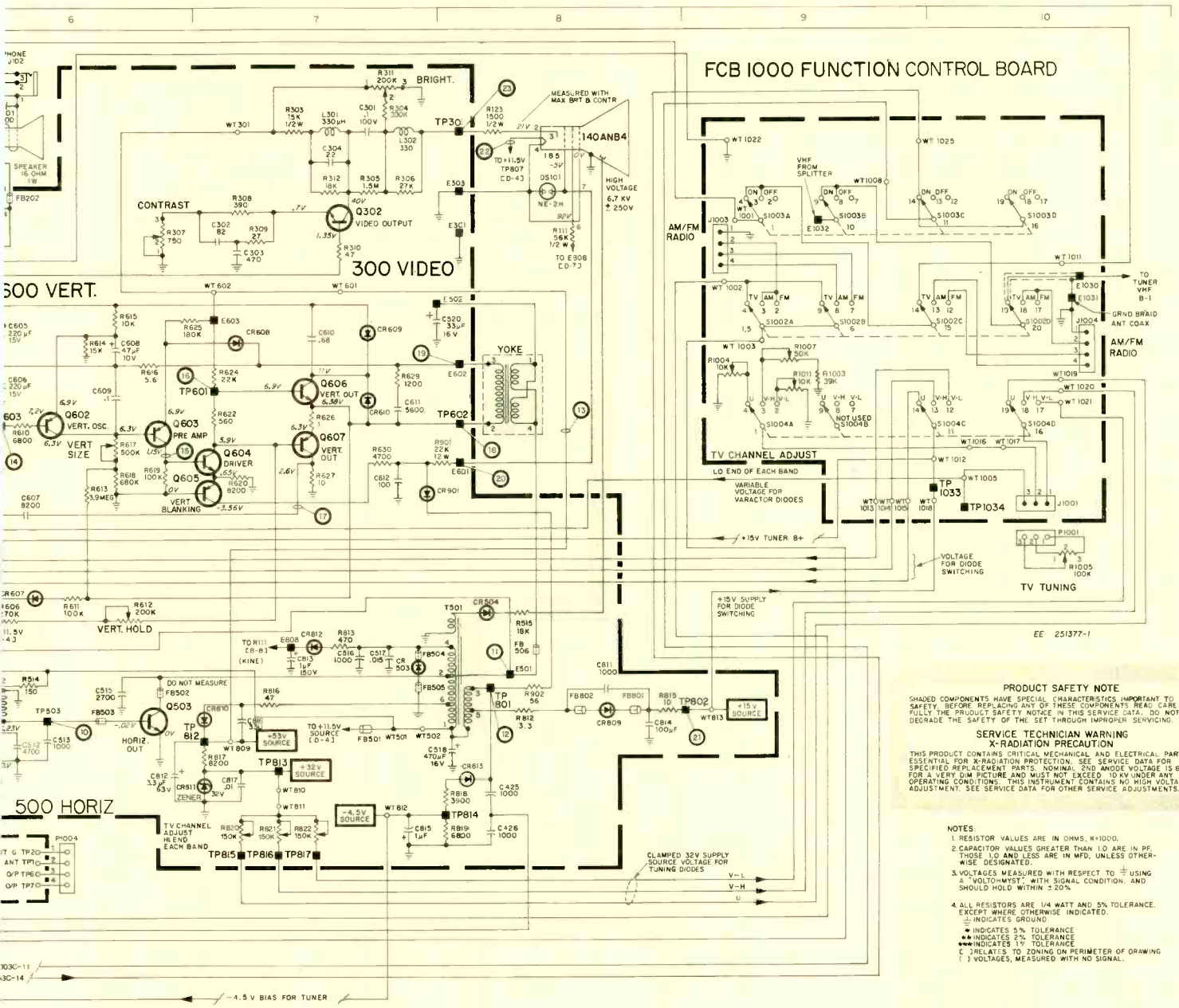
This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

ESⅅT Manufacturers' schematics PROFAX

2001

RCA
B&W TV
Chassis KCS 207B

OCTOBER 1982



PRODUCT SAFETY NOTE

SHADED COMPONENTS HAVE SPECIAL CHARACTERISTICS IMPORTANT TO SAFETY. BEFORE REPLACING ANY OF THESE COMPONENTS READ CAREFULLY THE PRODUCT SAFETY NOTICE IN THIS SERVICE DATA. DO NOT DEGRADE THE SAFETY OF THE SET THROUGH IMPROPER SERVICING.

SERVICE TECHNICIAN WARNING
X-RADIATION PRECAUTION

THIS PRODUCT CONTAINS CRITICAL MECHANICAL AND ELECTRICAL PARTS ESSENTIAL FOR X-RADIATION PROTECTION. SEE SERVICE DATA FOR SPECIFIED REPLACEMENT PARTS. NOMINAL 2ND ANODE VOLTAGE IS 6.7KV FOR A VERY DIM PICTURE AND MUST NOT EXCEED 10 KV UNDER ANY OPERATING CONDITIONS. THIS INSTRUMENT CONTAINS NO HIGH VOLTAGE ADJUSTMENT. SEE SERVICE DATA FOR OTHER SERVICE ADJUSTMENTS.

NOTES:
1. RESISTOR VALUES ARE IN OHMS, K=1000.
2. CAPACITOR VALUES GREATER THAN 1.0 ARE IN PF. THOSE 1.0 AND LESS ARE IN MFD. UNLESS OTHERWISE DESIGNATED.
3. VOLTAGES MEASURED WITH RESPECT TO ⏚ USING A "VOLTOHMYST", WITH SIGNAL CONDITION, AND SHOULD HOLD WITHIN ± 20%
4. ALL RESISTORS ARE 1/4 WATT AND 5% TOLERANCE, EXCEPT WHERE OTHERWISE INDICATED.
⏚ INDICATES GROUND.
* INDICATES 5% TOLERANCE
** INDICATES 2% TOLERANCE
*** INDICATES 1% TOLERANCE
C ; RELATIVE TO ZONING ON PERIMETER OF DRAWING
( ) VOLTAGES, MEASURED WITH NO SIGNAL.

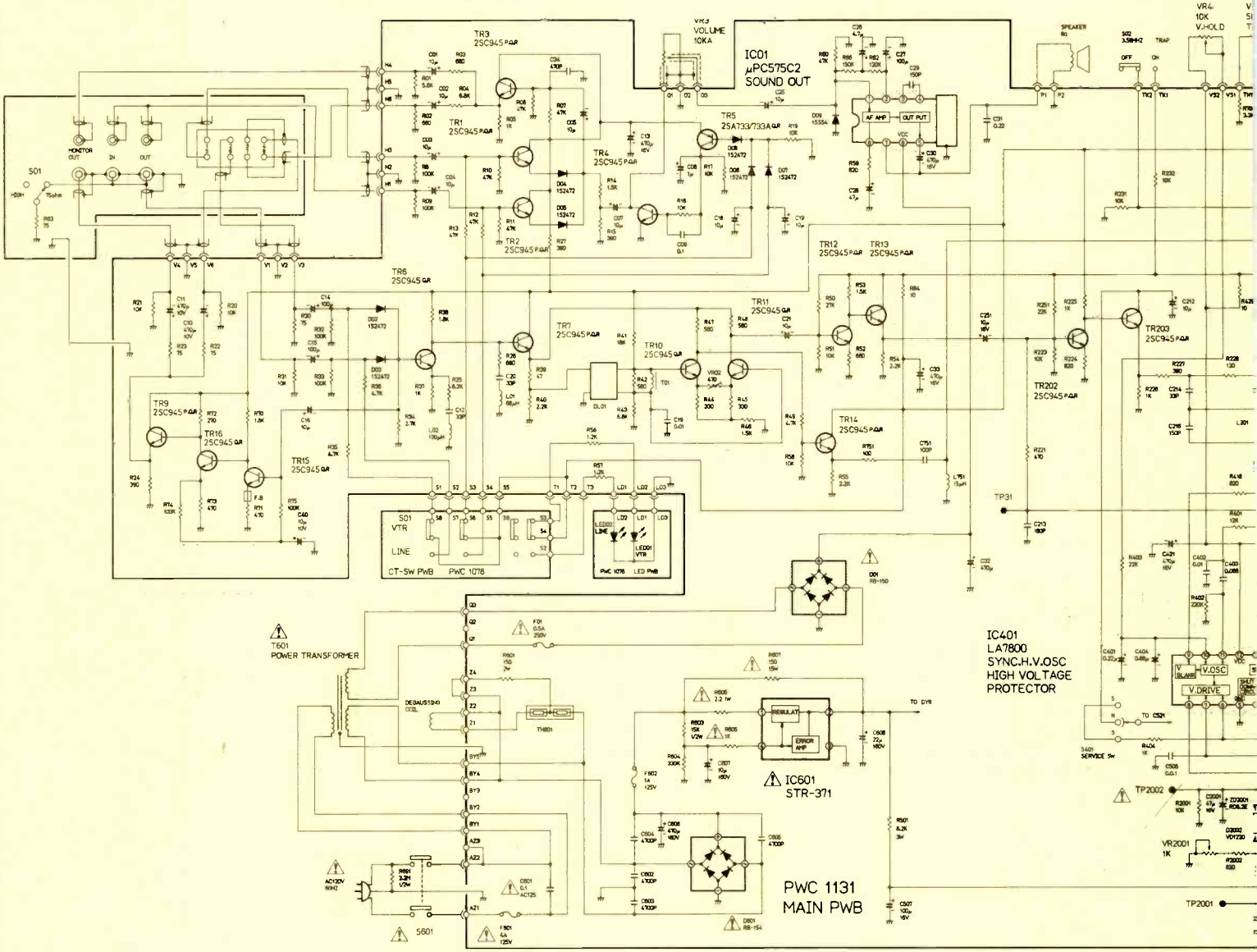
gy, P.O. Box 12901, Overland Park, KS 66212

ES&T

Manufacturers' schematics

PROFAX

	Schematic No.
NEC	
Color video monitor chassis Z7A	2000
RCA	
B&W TV chassis KCS 207B	2001
NAP	
Color TV chassis 09C201 CQ4X	2002



Reprinted courtesy of **NEC** Home Electronics (U.S.A.).

This schematic is for the use of qualified technicians only. This instrument contains no user-serviceable parts.

eliminates the ghost effect, contributing to a clearer picture, and the comb filter circuitry separates the color and black-and-white signals for better picture detail.

For expanded use with peripheral video equipment, the monitor provides two input jacks for video and two for audio L/R, throughout jacks for video and audio L/R, as well as a stereo headphone jack and L/R external speaker terminals. When used with a videodisc, the monitor provides 350 lines of resolution. Comb filter for high resolution, ColorPilot and Panabrite sharpness controls all contribute to the sharper picture.

The monitor's audio output is 4W per channel with 2% THD from 100Hz to 10kHz, with bass, treble and balance controls. The monitor is constructed with 100% solid-state chassis with a silvertone-finish cabinet.

The video control (model TU-1012) contains a quartz synthesizer electronic tuner and connects up to three other video inputs, such as a home computer or videodisc player. The control's tuner is cable-ready to receive up to 134 channels and 64 unscrambled CATV channels. It provides a snap in/out 16-function infrared wireless remote control, 4-mode video switch, three video and audio L/R input jacks, video and audio L/R output jacks, three ac outlets with two switched and one unswitched, and a stereo headphone jack. The video control provides CATV/master antenna connector and VHF and UHF antenna terminals. The unit is built on a 100% solid-state chassis.

A choice of two matched speakers is available with Panasonic's Omni Series component system. With 2% THD and 10W capability, both models provide magnetic shields to eliminate TV distortion. The speakers have a bass reflex system designed to enhance stereo TV sound.

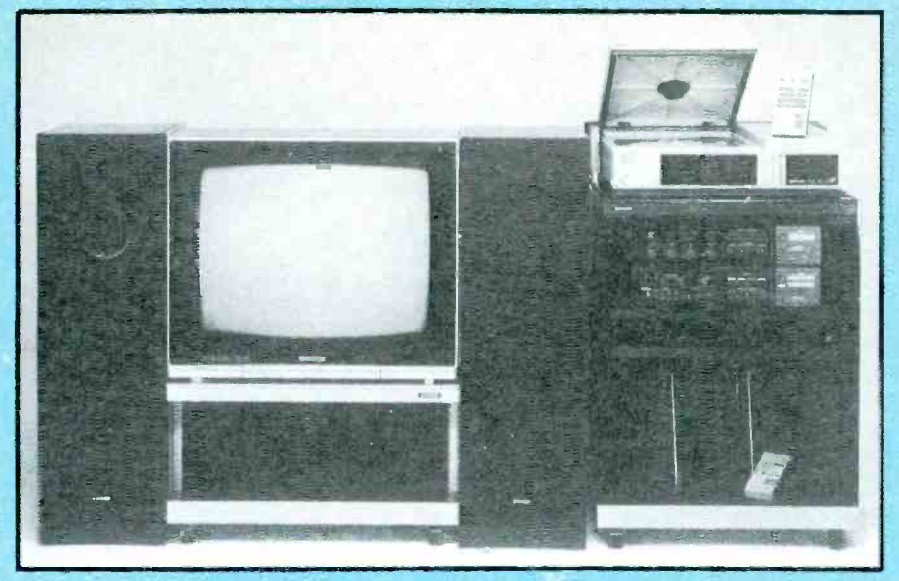
Panasonic's Omni series also offers two other systems that incorporate tuners and speakers into the color monitors. They provide add-on capability with multiple audio and video input and output jacks.

Pioneer

Pioneer Electronic Corporation has introduced two component systems: the Foresight 5000 and 7000. The Foresight 7000 high-fidelity component system consists of a 25-inch color monitor; a video control tuner; a stereo pre/main audio amplifier; a 3-way, 4-speaker system; a Laserdisc player; an audio-video component cabinet and a color monitor cabinet. The Foresight 5000 is identical to the Foresight 7000 except for the color monitor, which is 19 inches rather than 25 inches, and the color monitor cabinet.

Both color monitors incorporate a comb filter as well as the following circuits that improve the video over conventional TV pictures.

The black, or darkness, level of a video image varies widely with light conditions at the site of the original image pickup. When the contrast of an image is too high, the darker portions of the image tend to get lost in the shadows. The *Black Level Stabilizer Circuit*



Pioneer Foresight 7000

automatically adjusts the black level, permitting accurate reproduction of the shadow detail.

The higher the velocity of cathode-emitted electron beam, the shorter the irradiation time and the darker the image at a given point. Because a total image is made up of almost countless numbers of particles, overall image detail clarity depends on the accurate irradiation of each. Although ordinary televisions can suffer insignificant edge-blur, the *Velocity Modulation Circuit* in the Pioneer monitor controls the beam velocity by adding compensation signals to the auxiliary deflection coil.

To display single-frame "still" images on the video screen without jitter, color aberration or other defects, vertical deflection must be eliminated. Achieving this is the key to enjoying one of the capabilities of the noise-free, non-contact optical laser system of LaserDisc. Because the deflection speed of electrons varies with the current that flows in the picture reproduction process, according to the luminance brightness, vertical deflection can result in ordinary sets. The *Linear Deflection Circuit* prevents this by sampling the luminance signal for changes in current and controls deflection accordingly.

When the input luminance signal calls for maximum darkness, the current at the cathode decreases with a corresponding increase in the voltage at the anode. Conversely, maximum luminance requires a decrease in anode voltage and an increase in cathode current. If the luminance signals vary too widely, focus voltage stability may be adversely affected, and deflection speed may become uncontrolled to the extent that overscan results, causing variance in picture size. The *Anode Voltage Stabilizer* samples voltage and stabilizes it against such changes.

Other features of the monitor include automatic color temperature, computer memory picture control, feather-touch buttons, multifunction input/output facilities, non-glare screen, picture muting and remote control capability.

The 25-inch model has 400 lines horizontal resolution while the 19-inch has 350 lines.

The video control tuner (model VC-T700) employs a 127-channel PLL-synthesized tuning system capable of pinpointing VHF, UHF and CATV channels in your area. Memory tuning allows for initial station tuning to be entirely automatic: As each station is found and tuned to the desired quality, its "address" is entered into the on-board microcomputer and memorized. Channel numbers are displayed on the digital readout, and any station may be recalled by using the manual or auto search buttons on the remote-control unit.

In addition to its TV/CATV tuning capabilities, the tuner can also video control your entire audio/video system. Facilities are provided for selecting LaserDisc, Video-1 and Video-2 inputs and sending them through to your connected color monitor or ordinary television as well as to audio amplification and reproduction equipment.

Interconnection with an ordinary television is possible with the RF out/thru terminal and selector. Stereo audio in/out terminals are available for use with stereo TV multiplex demodulator adapters.

The unit also has a simulated stereo feature for adding ambience to monophonic audio inputs.

Sanyo

Sanyo Electric has introduced their version of component television in the ProPonent Series. The system basically includes a color monitor (19 inch, measured diagonally), video control system and an audio component system.

The monitor (model AVM-195) offers 360-line resolution. Five separate processing systems contribute to the sharp picture: automatic contrast limiter, automatic black-level compensator, automatic beam limiter, white temperature compensation circuit and a comb-filter circuit. The monitor also has a built-in 5W-per-channel audio amplifier.

Other features of the monitor include black matrix picture tube with black glass; light power controls; and concealed controls for volume, sharpness, contrast, tint, color, vertical hold and brightness.

The video control system (model AVT95) is a separate video tuner that provides input capability for integrating signals from VCRs, videodisc players, video games, personal computers, audio sources and cable television. The tuner can accept all 82 VHF and UHF channels as well as 23 cable channels. The full-function wireless remote control has 17-button digital keyboard tuning for control of the programming.

The video control center has a sound expander circuit that creates a stereo effect from a mono input. Also, a headphone amp with tone controls allows viewing TV with headphones while using the system for records, radio and tape.

The audio component system (System 33) consists of a 25W-per-channel integrated amplifier (model A33) with moving coil phono inputs; an AM/FM frequency tuner (model T33) with soft-touch up/down tuning buttons; a stereo cassette deck (model D33) with switchable Dolby-B/Dolby-C noise reduction; and a linear-tracking, direct-drive turntable (model P33) with advanced tangential tracking tonearm. The speakers each offer 6-inch, 2-way design with a 3-inch tweeter and a passive radiator.

Sony

Sony has entered the age of high-fidelity television with their introduction of the Profeel Trinitron Component TV systems. Profeel will be available with two screen sizes in November – a 19-inch and 25-inch (measured diagonally).

Contributing to the increased resolution are the Dynamic Picture System, which automatically adjusts contrast levels for constant sharp definition in bright and dark areas; Dynamic Color Circuitry for whiter whites and natural facial tones; Colorpure Filter for improved fine picture detail without color spills or noise; and a Trinitron 1-gun, 1-lens picture tube. On the 25-inch model, a Velocity Modulation Scanning System increases sharpness and resolution.

The access tuner (VTX-1000R) is a cable-ready, frequency-synthesized tuner with a 10-key touch pad that can instantly call up any VHF, UHF, midband or superband cable channel. The user can go directly from one channel to another simply by pushing the proper channel numbers, or the tuner can be asked to sequentially scan the channels. Preprogramming the tuner will cause the search mode to skip channels that have no broadcasts or that have undesired programming. Along with its over-the-air and cable tuning features, the tuner has a special input and output for cable converters of coded broadcasts and auxiliary audio and video inputs to accept signals for Betamax recorders, home computers video

The comb filter: high-fidelity video resolution

Fig. A COLOR VIDEO SIGNAL COMPOSITE

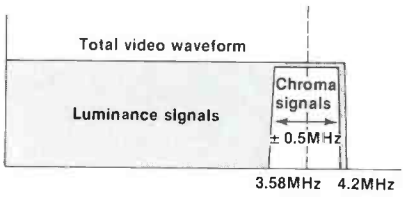


Fig. C:
CONVENTIONAL LUMINANCE/ CHROMA SIGNAL SEPARATION

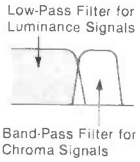


Fig. B: LUMINANCE/CHROMA SIGNAL CROSSOVER (Enlarged)

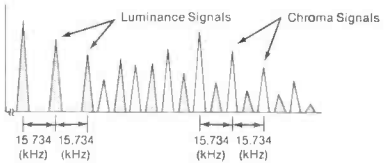
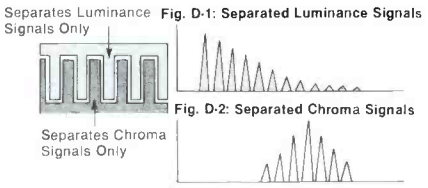
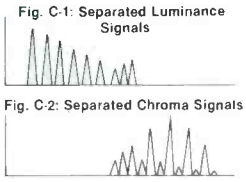
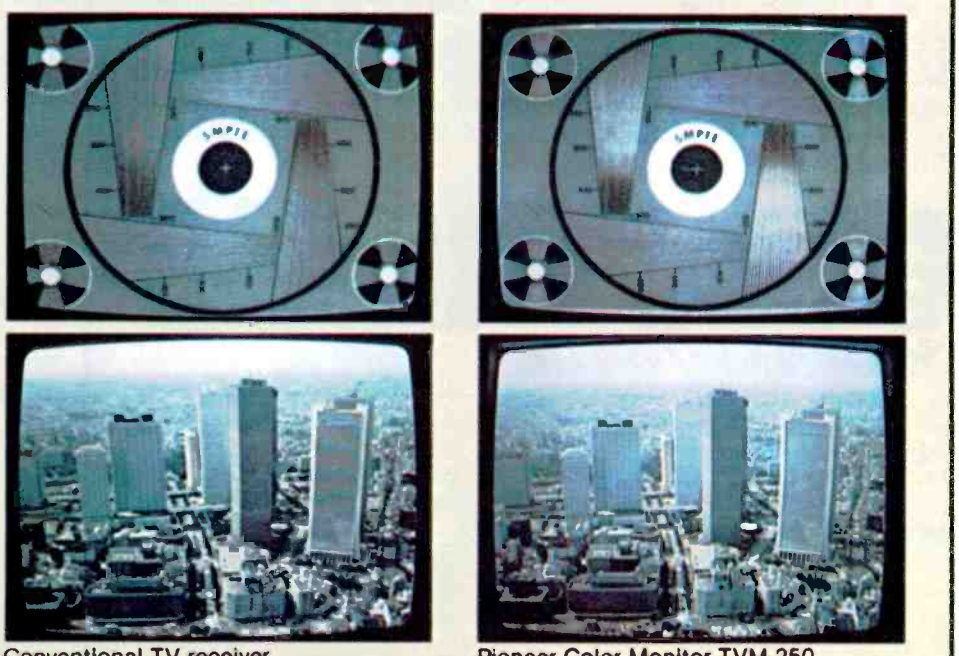


Fig. D: COMB FILTER







Conventional TV receiver

Pioneer Color Monitor TVM-250

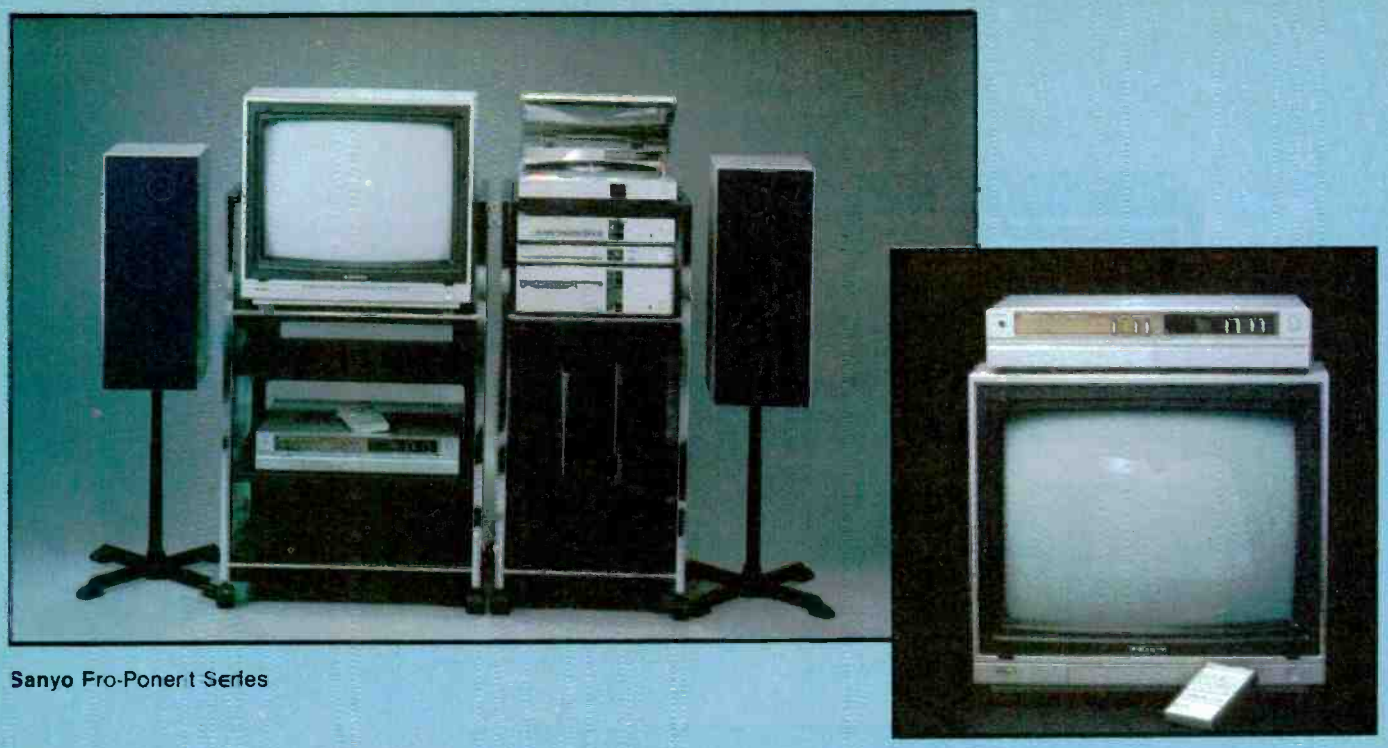
Indistinct picture resolution and "fringing" (cross-color interference) are two of the most serious problems plaguing the conventional color TV set or monitor. They typically result from inferior separation of two entirely different kinds of signals contained in the total, complex video waveform (Figure 1). Those are the luminance signals that determine the relative brightness of an image and cover the wideband of 0Hz to 4.2MHz, and the chroma signals that control color and are present in the upper end of the video waveform carrier, centered at 3.58MHz, with 0.5MHz plus-minus range. This means that some luminance information is mixed in with the chroma (Figure 2).

Normally, in all but the most expensive, professional-class video monitors, luminance/ chroma-signal separation is achieved by lowpass and bandpass filters respectively (Figure 3). But this results in the cutting off of some of the luminance signals; consequently horizontal resolution is severely limited, and free-line distinctions are lost.

Separate filtering also allows the leakage of some of the remaining chroma signals into the luminance signals (Figures 3A and 3B) and vice versa, resulting in the annoying fringing effect, seen at its worst as a vibrating moire-pattern "rainbow" further limiting picture resolution.

To eliminate these problems entirely, many monitors employ a specially developed comb filter (Figure 4), normally found only in extremely expensive, professional-quality video monitors. It electronically "combs" the total waveform to separate the luminance signals (Figure 4A) from the color signals without cutting off any of the former, and without the least trace of leakage of luminance signals into the chroma band (Figure 4B). The result: increased resolution in the color monitor over conventional TV sets (280 lines) or VCRs (250 lines).

(Information provided courtesy of Pioneer Electronics.)



Sanyo Fro-Ponert Series

games, videodisc players and other signal sources.

With the optional multifunctional Express Commander (model RM-705) infrared remote-control unit, all tuning functions can be controlled from anyplace in the room. Profeel users can select from the five signal inputs for VHF/UHF/direct cable, cable converter box or the auxiliary inputs with switching done automatically at the access tuner or by using the remote control.

Inside the Profeel monitor is a stereo amplifier that will accept multichannel broadcasts when they become a reality or give new dimension to the stereo simulcasts (using a separate FM tuner) that are aired now.

In addition to making standard broadcasts come to life on the monitor, the Profeel picture quality will show the viewer the full potential of multiple-source programming available now and in the future. The system is adaptable to handle such program sources as multichannel and stereo broadcasts, satellite direct, teletext, videotex and interactive communications systems.

The monitor has separate RGB signal input and is capable of 80-character graphic display, which is twice the character capacity of a conventional television. This proves especially beneficial when the monitor is used in conjunction with a home-computer display.

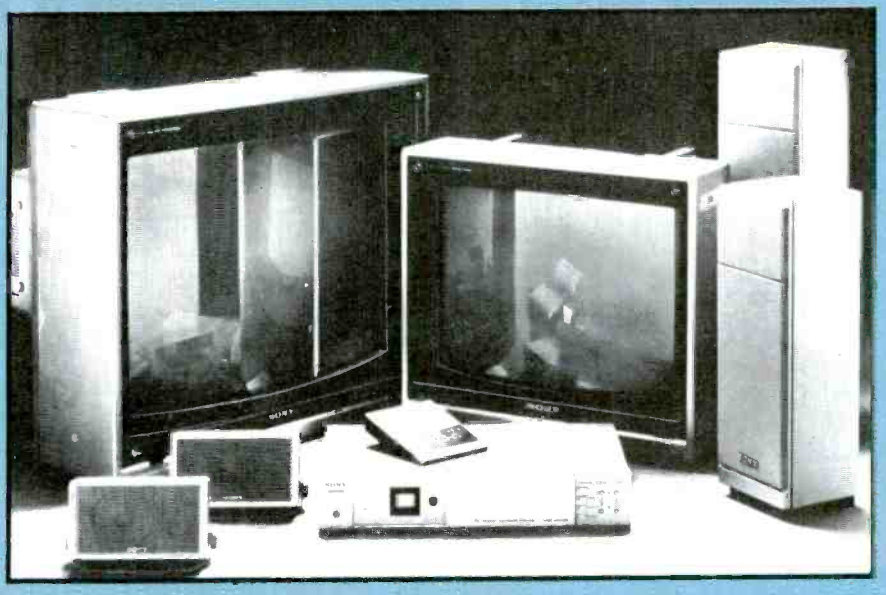
The 19-inch monitor is rated to have approximately 340 lines horizontal resolution while the 25-inch model has approximately 350 lines.

There is a choice of two dual-speaker systems featuring 2-way designs. Each system has magnetically shielded woofers that will not interfere with the picture image as well as precision tweeters. Buyers can choose between speakers designed to mount on the side of the Profeel screen or to stand alone.

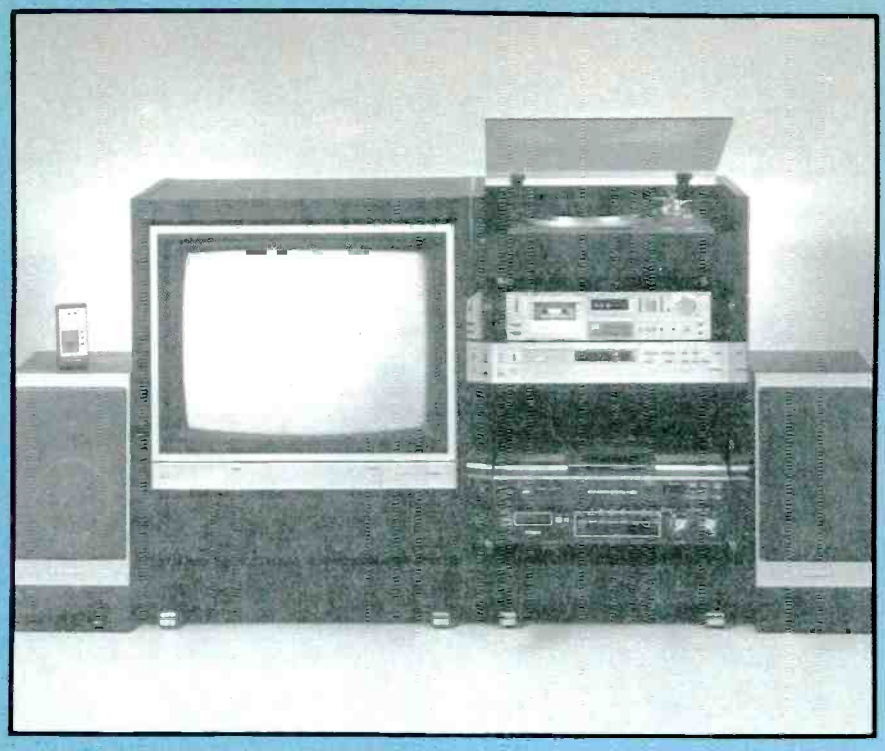
Teknika

Teknika Electronics Corporation offers two monitor sizes to match with their component TV system: One is 19 inches (ATV-19) and the other is 25 inches (ATV-25), measured diagonally.

The receiver (ATV-R) serves as a receiver control center. It includes 105-channel TV capability with VHF (Channels 2-13) and UHF (Channels 14-83), cable midband (Channels A-I) and cable superband (Channels J-W). The receiver contains an FM stereo synthesized



Sony Profeel System



Teknika ATV-25

tuner plus a high-quality audio amplifier that maximizes sound capability from either TV or FM broadcasts using the matched 2-way speakers.

The monitors also offer a microprocessor, infrared, wireless, remote control that enables you to control any video or audio components in the system.

You can direct access television and FM or scan the entire broadcast spectrum using the Autosearch feature. View/Listen can be split if a program is being simulcast. You can see your favorite show and listen to it being broadcast on FM stereo.

The speaker system (ATV-S) includes two speaker elements and an L:C crossover network to ensure high-quality sound. The speaker system is a 2-way pipe duct bass reflex type with 8-inch, polyurethane, roll-type woofers and 2-inch, cone-type tweeters.

Zenith

Zenith Video is marketing their Video High-Tech Component TV system, which includes a 19-inch diagonal color video monitor, TV tuner, source selector, stereo audio amplifier and Allegro speaker system.

The component TV monitor (CV1950) is equipped with the TriFocus picture system. It consists of an EFL® electron gun with three focusing actions to concentrate the electron beam and produce a smaller spot size. The 3-in-1, in-line TriFocus system, with RGB guns in horizontal alignment and the lens system focusing voltage patterns minimize electron deviation.

The monitor's color-control system, the Advanced Color Sentry, combines eight picture and color subsystems. The Sentry corrects the picture 30 times each second and changes picture brightness as room light changes. The unit also has an "electronic eye" light sensor that will automatically adjust picture brightness while maintaining proper color and contrast levels. The Color Signal Monitor is an automatic signal adjustment that minimizes oversaturation of color from scene to scene, channel to channel.

Other capabilities of the monitor are dynamic tint stabilizer, blend-

Zenith Video High-Tech Component System

ing chroma, color-level lock, contrast regulator, high-gain color control and color threshold. The tuner (CV510) features quartz control, which allows for tuning accuracy and ease of operation. The advanced microchip circuitry is specifically designed to convert RF TV signals into baseband video and audio information. Electronic quartz precision gives direct push-button access to available channels without need for fine tuning. The unit is solid-state.

The expanded channel capability lets you select CATV channels without the need for an external converter (except scrambled programs). With direct-access control, you can select regular VHF and UHF channels and 42 cable channels including 30 midband, superband and hyperband frequencies.

The direct-access keyboard channel selector allows push-button pinpointing or scanning.

The unit also features LED channel display and PLL tuning. In the "Normal" position, the AFC switch automatically locks in broadcast TV signals for trouble-free reception. Off-frequency signals of the type that may be received from auxiliary units, such as videodisc players, video games or CATV and MATV antenna systems, can be pulled in for improved picture performance with the AFC switch in the "Special" position.

The tuner includes an infrared remote control unit, the Computer Space Command 2900, which allows for tuning from anywhere in the room. The keyboard of the unit provides direct access selection, favorite-channel scanning, volume up/down, mute sound and power on/off control.

The Program Source Selector is designed to give you access to the entire range of possibilities with your various audio/video components. The selector allows for connection of up to six audio/video program sources to the color video monitor at one time. You can connect your VCR, videodisc player, video game and home computer, plus selected out-of-home program sources such as cable television, subscription television, regular VHF/UHF or even a satellite system, and you never have to change the connections.

The selector provides low-loss electronic switching of six modulated RF signal sources and direct input of six baseband video/audio signals from the source to the monitor for viewing. It can even route signals in mono and stereo audio, baseband video or RF from any source to another for recording.

The 2-channel stereo amplifier (CV520) provides a full 20W minimum continuous RMS power per channel from 20Hz to 20kHz into 8Ω with 0.2% or less THD. The audio source can be either in monaural or stereo from a broadcast TV signal or an FM receiver.

There are currently several other manufacturers offering component TV systems but information about those systems was not available at the time of this writing. Watch future issues of **ES&T**, particularly in our New Products section, for further updates on these new home entertainment systems.

ES&T

BOOKS

Editor's note: *Periodically* ***Electronic Servicing & Technology*** *presents reviews of books dealing with subjects of interest to our readers. Please direct inquiries and orders to the publisher at the address given in each review rather than to us.*

ARRL Antenna Book; American Radio Relay League; 328 pages; $8.

The acceptance of this publication is proved by the fact that more than 600,000 copies of previous editions have been sold to radio amateurs, engineers, technicians and students.

The book is divided into three sections. The first seven chapters deal with the principles of antennas and transmission lines, wave propagation, and the performance characteristics of directive antenna systems. Beginning with Chapter 8, there is a series of chapters in which complete data are given on specific antenna designs for the various amateur frequency bands. The remaining chapters deal with related subjects such as measurements, test equipment and antenna orientation. Finally there is an appendix with a glossary of terms and useful tabulated information.

American Radio Relay League, Newington, CT 06111.

Ready-Reference Guides to Electronic Circuits, by John Markus; McGraw-Hill; $12.50 each.

Five new ready-reference guides designed for anyone who works with electronic circuits – from engineers to hobbyists – are now available in convenient paperback editions.

With material taken from the pages of the *Modern Electronic Circuits Reference Manual* by John Markus, these paperbacks feature practical diagrams of predesigned ICs and solid-state devices. Each guide focuses on one area of interest: communications circuits, digital circuits, electronics projects, popular circuits or special circuits.

The manuals are organized and indexed for quick reference, with related circuits grouped together for easy access to the required diagram. Essential information is included with each circuit: type numbers or values of all significant components, an identifying title, a concise description, performance data and suggestions for additional applications.

The source of the information for each circuit is included, with citations taken from hundreds of diverse sources, such as U.S. and foreign electronics journals and magazines, the publications of electronics manufacturers and recent books on the subject.

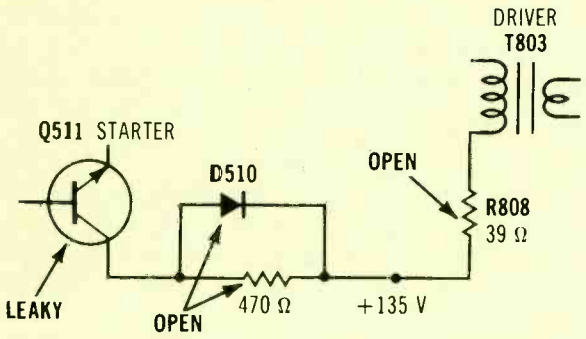
McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020.

ES&T

SYMCURE

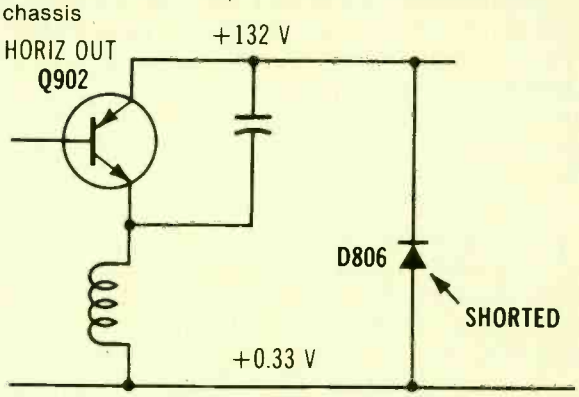
Symptoms and cures compiled from field reports of recurring troubles

Chassis – Sony models KV1910, 1920 and 1921 1
PHOTOFACT – 1708-2 (chassis SCC-100F-A/G-A)



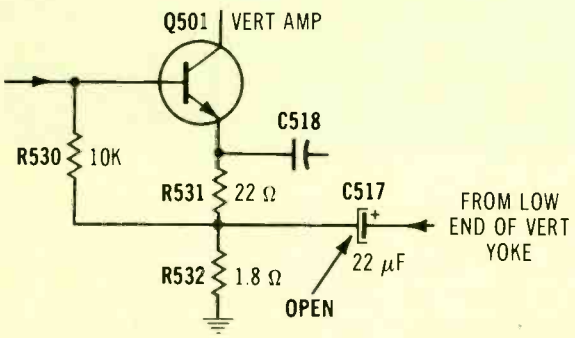
Symptom – No sound, picture or start-up
Cure – Check R808, R556 and diode D510, and replace if open. Also, check Q511 for leakage.

Chassis – Sony models KV1920 and KV1920-D 2
PHOTOFACT – 1708-2, 1455-2 or 1627-2 for SCC-100 chassis



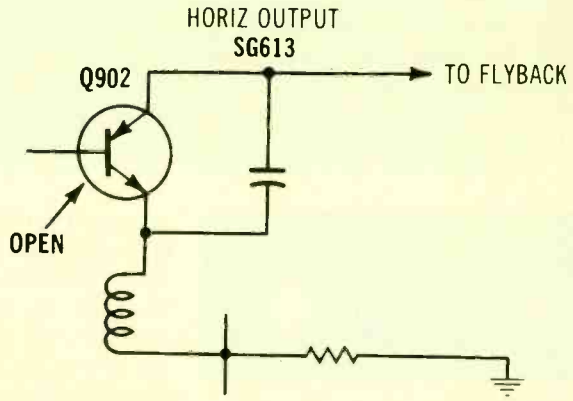
Symptom – + 135V supply shorted to ground, no sound or picture
Cure – Check damper diode D806, and replace it if shorted

Chassis – Sony KV1722 with SCC-41A-E chassis 3
PHOTOFACT – 1524-2



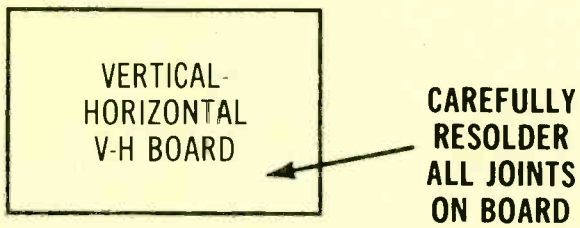
Symptom – No height (same signal at each end of the vertical yoke)
Cure – Check C517 (yoke low-side coupling), and replace it if open.

Chassis – Sony KV1941R with SCC-100B chassis 4
PHOTOFACT – 1651-1



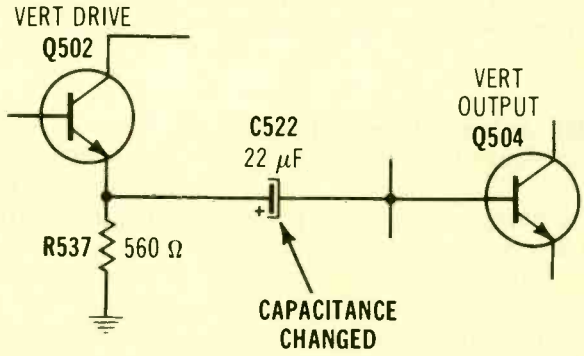
Symptom – B + is normal, but no raster or sound
Cure – Check Q902 horizontal-output SCR, and replace it if open

Chassis – Sony KV1722 with SCC-41A/B chassis 5
PHOTOFACT – 1432-2



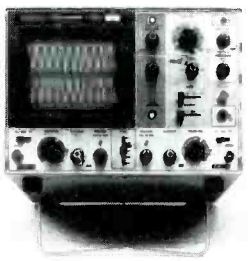
Symptom – Raster flashes on and off about one time per second
Cure – Poor solder dipping requires careful resoldering of all suspicious joints

Chassis – Sony KV1722 with SCC-41A/E chassis 6
PHOTOFACT – 1524-2



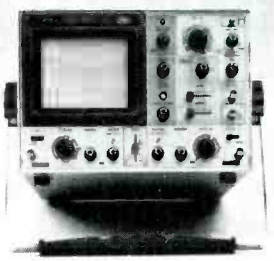
Symptom – Vertical foldover at bottom of picture
Cure – Check capacitor C522, and replace it if the capacitance is incorrect or leakage is excessive

"When will someone introduce high-performance scopes without the high prices?"



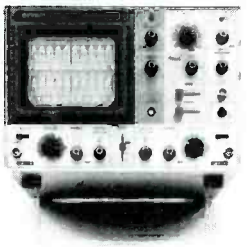
V-152F —15 MHz

$595



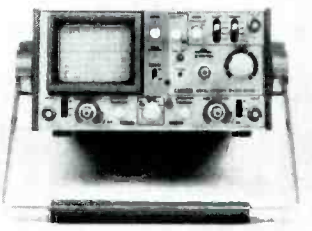
V-202F —20 MHz

$695



V-302F —30 MHz

$799

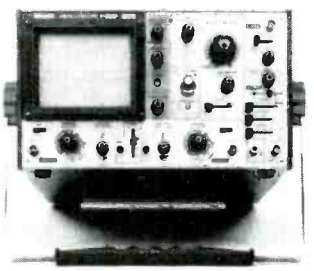


V-209 —20 MHz

$945

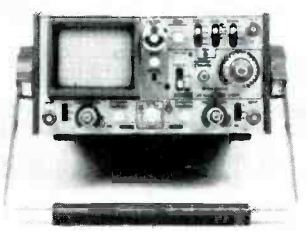
V-353F —35 MHz

$949



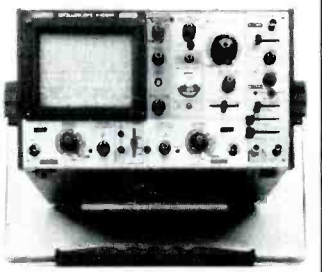
V-650F —60 MHz

$1,195



V-509 —50 MHz

$1,650



V-1050F —100 MHz

$1,980

HITACHI HEARD YOU.

Ask no longer. Hitachi has just answered your question with 8 new portable oscilloscopes. In fact, they're the highest-quality scopes around for the money.

We call them our F series. They range from 15 MHz to 100 MHz and can be used for all types of bench and field work. There are dual-trace and quad-trace models. Several have delayed sweep. All are lightweight. Compact. And feature functionally grouped operating controls and bright, easy-to-read CRTs. Here's a closer look at each model:

V-152F. A 15 MHz, dual-trace scope, sensitive to 1 mV/div at 7 MHz. It has a 5″CRT. **$595.**

V-202F. A 20 MHz, dual-trace scope, sensitive to 1 mV/div at 7 MHz. It has a 5.5″CRT. **$695.**

V-302F. A 30 MHz dual-trace scope, sensitive to 1 mV/div at 7 MHz. It features signal delay and a 5″CRT. **$799.**

V-353F. A 35 MHz, dual-trace delayed sweep scope, sensitive to 1 mV/div at 7 MHz. It features a 5.5″square CRT. **$949.**

V-209. A 20 MHz, dual trace, mini-portable scope, sensitive to 1 mV/div at 5 MHz. It features AC/DC operation and has a 3.5″CRT, and weighs only 10 lbs. Battery included. **$945.**

V-650F. A 60 MHz, dual-trace scope, sensitive to 1 mV/div at 10 MHz. It features delayed sweep and a 6″CRT. **$1,195.**

V-509. A 50 MHz, dual-trace, mini-portable scope with optional battery pack, sensitive to 1 mV/div at 10 MHz. It features delayed sweep and a 6″CRT, and weighs 11 lbs. **$1,650.**

V-1050F. A 100 MHz, quad-trace scope, sensitive to 0.5 mV/div at 5 MHz. It features delayed sweep and a 6″CRT. **$1,980.**

There they are. High-performance scopes without the high prices. And all are backed by Hitachi's reputation for quality. To learn more, write or call us today. Hitachi Denshi America, Ltd., 175 Crossways Park West, Woodbury, NY 11797. Phone: (516) 921-7200. Offices also in Atlanta, Chicago and Los Angeles.

Circle (29) on Reply Card

Digital building blocks: Data selectors, multiplexers, decoders and demultiplexers

By Bernard Daien

Even simple problems in digital logic seem complicated, what with Boolean Algebra, Veith Charts, Karnaugh Maps and other conventional methods of solving such problems. For example, have you ever wondered how each memory word stored in a memory bank with 64,000 different locations can be located via a cable consisting of only 16 wires? Or how it is that many different users can communicate with a computer using only a single telephone line? The means of solving these problems have many applications that are not limited to digital or computing systems. They also find use in control systems and in many analog applications.

If you are interested in discovering how these problems can be solved, simply, quickly and inexpensively, then read this article. It explains, in an easy-to-read style, how you can become an expert in solving many digital problems in just a half hour. And, what you learn will help you to better understand the general field of digital electronics, too.

If you have ever thumbed through a digital circuits *Data Book* supplied by several IC manufacturers, you have probably noticed circuits listed as data selectors, multiplexers, decoders and demultiplexers. The data for these formidable-sounding ICs usually includes complicated-looking charts and technical terms. Despite this, the ICs themselves are easily understood and simple to apply. These useful circuits deserve considerably more attention in fundamental electronics courses that indicate ICs.

Perhaps the most convincing argument for learning about these circuits is the fact that they are able to replace very large pieces of circuitry with just one IC. In the process, practically all of the design problems are eliminated. There is no necessity for Veith Charts, Karnaugh Maps, etc. All the user really needs to know is how to read a simple *truth table,* which shows the output resulting from each of the possible input combinations. Stated simply, if you know what the inputs are, the truth table tells you what the output will be. Conversely, if you know what output you want, the truth table tells you the combination of inputs required.

It should be noted that truth tables are sometimes labeled *function tables,* but there is one small difference between the two. In one case, positive logic is used; in the other case, it is not assumed. In positive logic, a "1" is high, and a "0" low. In negative logic, they are inverted. Generally positive logic is used (and understood). Negative logic is infrequently encountered, and when it is, there is some notation, or clue, that it is being used. Negative logic is easily converted into positive logic, for almost all practical purposes, by means of inverters (simple logic blocks frequently used in digital circuitry). So, whether the table is titled truth table or function table, use it; the remarks in this article apply for all practical uses.

The use of inverters is common in digital electronics. Sometimes inversion is called by other names, such as negation or complementation. Thus to invert is to complement or negate. The inversion process is indicated by the use of an overbar, so that A inverted is expressed $\overline{A}$. This is also described as A negated, or A complemented.

To avoid further confusion, notice that the circuits in this article also have several different names, depending in part on how we use them. The data selector is also known as a multiplexer and as a data router. The demultiplexer is often called a decoder or a data distributor. These names are accurate descriptions of the functions the circuits can perform.

One thing both of these useful circuits have in common is that the ICs performing these functions are termed Medium-Scale Integrated Circuits (MSI). Less complex circuitry is referred to as SSI (Small-Scale Integration), while large and complex integrated circuits are LSI (Large-Scale Integration).

As you will see later in the basic logic schematic for the decoder, this MSI circuit has the equivalent of 16 5-input NAND gates, eight inverters and one 2-input AND gate, with all the necessary interconnections between them included on the chip. Of course, all the logic design for this circuitry has been done by the IC manufacturer. You just plug it in, and it operates.

What they do

Figure 1A is a basic multiplexer/data selector made up of simple toggle switches. With information (data) coming in on eight lines, we can select any one of the incoming lines and route it through to the single output, by means of the toggle switches. Only one toggle switch can be closed at a time, and there is another switch in series with the common output. When this switch is closed, output can be obtained (enabled). With the switch open, the circuit has no data routed through.

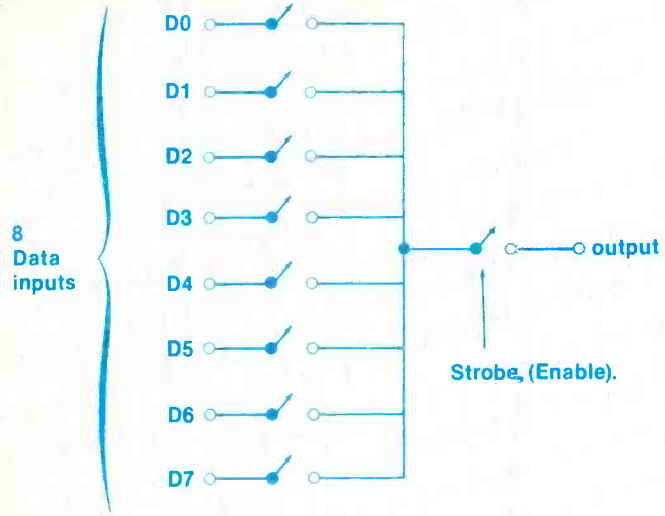


Figure 1A. The elementary switch equivalent of an 8-input data selector/multiplexer.

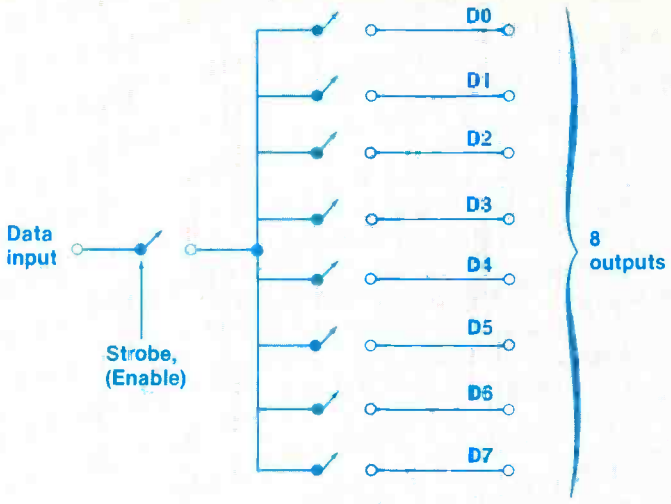


Figure 1B. The elementary switch equivalent of an 8-output decoder/demultiplexer. This circuit is also known as a data distributor.

Figure 1B is a basic demultiplexer/decoder circuit. The switches perform much the same functions, but the circuit is reversed, having only one data input and eight output lines.

If we connect the output of the multiplexer to the input of the demultiplexer with a single line (using a ground return as usual), we can select any one of eight data lines for long-distance transmission over a single cable, and at the receiving end we can sort them out so that they are routed to the proper destination. This is like a railroad system in which many trains use the same track to go to and from different cities. Of course only one train can be on a section of track at the same time, but this is not difficult to do by means of timetables.

This is even easier to accomplish with modern digital technology, because computers run millions of operations per second. We can sample each line a million times per second without affecting the electronic circuits involved. This leads us to the problem of being able to switch our toggle switches quickly enough. Actually we use solid-state gates for switching. These are not mechanically actuated, but instead switch because of electrical input signals known as *select inputs*. These select inputs also have only two states: on/off, high/low or one/zero. Simply stated, they are digital signals.

Let's examine the block diagrams that include the input(s), output(s), enable and select terminals, shown in Figures 2A and 2B. The multiplexer and demultiplexer shown in the figures have either eight inputs or eight outputs, of which only one is selected. In order to select one, we need three select lines. It should be noted that both multiplexers and demultiplexers are commonly available in TTL and MOS low-cost versions with 16 lines. They can be had with open collector, totem pole and Tri-state outputs. This family of ICs is quite complete and fits into most existing systems easily. (Of course, a 16-line circuit would require four select lines.)

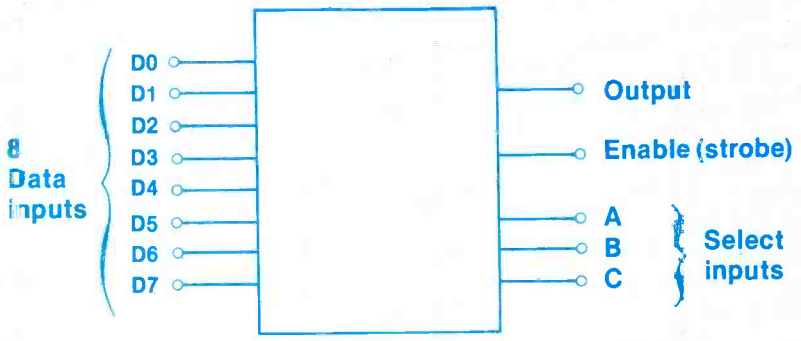


Figure 2A. An IC multiplexer with terminals labeled.

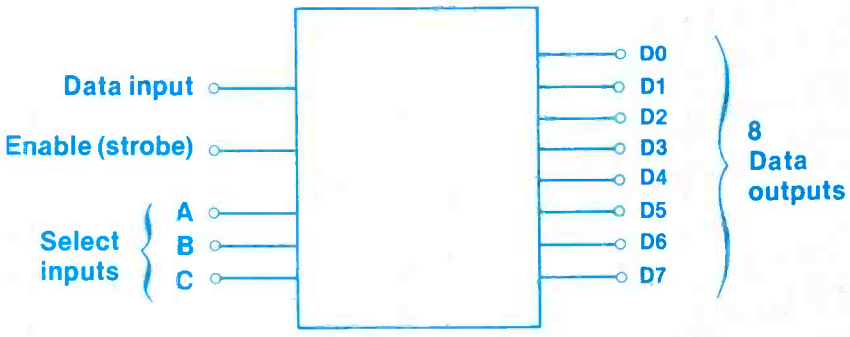


Figure 2B. An IC demultiplexer with terminals labeled.

What's inside the IC

Figure 3A is the logic diagram of the internals of a type 74154 de-

coder. In this circuit there are 16 output lines and four select lines, hence it is often called a 4-line-to-16-line decoder. There are two enable terminals, one labeled *enable*, the other *data*.

They both perform the same function in the same way. In fact, they are the two inputs to the same AND gate. When both are low, the circuit is enabled, i.e., we can get output. How do we know this? Figure 3B, the truth table for this circuit, shows that for the first 16 horizontal rows, one of the outputs is a "0", but in the lowest three rows, all of the outputs are "1s". Notice that in the lowest three rows, the select (address) lines all have "x" in them, denoting "it doesn't matter what state." Finally, look at the bottom three rows in the *Enable* and *Data* columns and you will discover a "1" in one or both. Now remember our earlier statement, "when *both* the enable and the data inputs are low, we can get output".

Stated another way, it doesn't matter what the address (select) lines do; both the enable and the data inputs must be low to get an output. Why then is one column labeled data and one enable? Simple: we can put data into the data input, and ground the enable input, in which case the enable is always at "0". The output will follow the data input, with the output appearing at the terminal (line) selected by the select inputs.

Notice in the truth table of Figure 3B, as the four address bits change, the output changes from line to line accordingly. Looking closely, you will see that the four binary bits (A, B, C and D) in the address rows add up to the decimal number 1 for an output on line 1, 2 for an output on line 2, etc. By entering the correct address in binary numbers on the four address lines, the corresponding output line is enabled *if* the enable and data inputs are both low. By entering data at the data input, with the enable input held low, the output from the selected (addressed) output line will go low when the data input goes low, and go high when the data input goes high. If the enable input goes high, *all* outputs will go high and stay high, regardless of the data input. Thus we can use the enable input to "shut off" the flow of data.

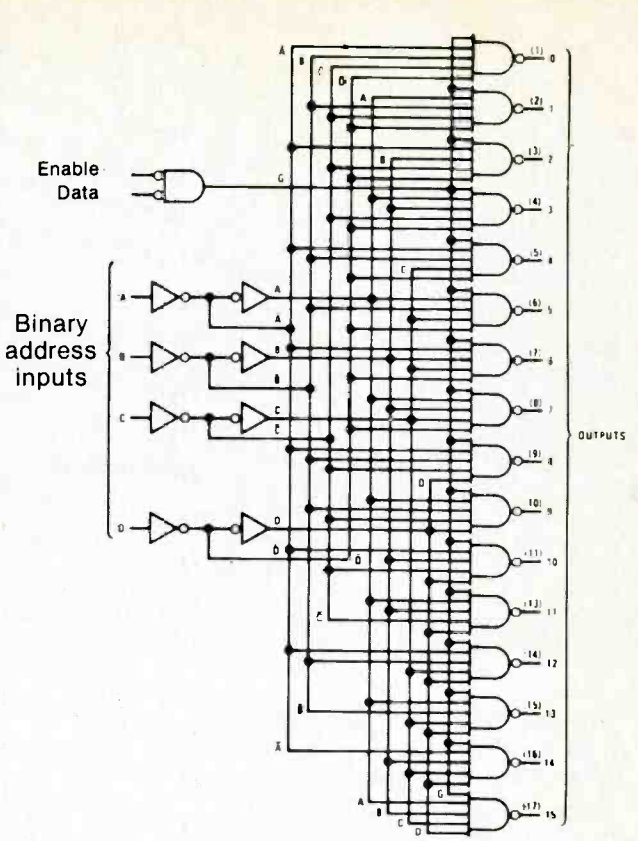


Figure 3A. A 74154 decoder/demultiplexer schematic.

Truth Table

INPUTS						OUTPUTS															
G1	G2	D	C	B	A	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
L	L	L	L	L	L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	L	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	L	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H
L	L	L	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H	H
L	L	L	H	H	L	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H	H
L	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H	H
L	L	H	L	L	L	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H	H
L	L	H	L	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H	H
L	L	H	L	H	L	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H	H
L	L	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H	H
L	L	H	H	L	L	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H	H
L	L	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H	H
L	L	H	H	H	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L	H
L	L	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	L
L	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	L	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
H	H	X	X	X	X	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H

H = high level (1), L = low level (0), X = don't care

Figure 3B. A truth table for the 74154 demultiplexer.

If you examine the logic diagram of Figure 3A, specifically the address inputs, you will notice that they go through four inverters, thus providing $\bar{A}$ (A inverted) from A, and $\bar{B}$ from B, etc. Then the inverted address inputs go through another set of four inverters, which provide A from $\bar{A}$, etc. By this means we have A, B, C and D available, and also $\bar{A}$, $\bar{B}$, $\bar{C}$ and $\bar{D}$, as shown in the internal labeling of Figure 3A. This will not be repeated in Figure 4A, the data selector, because the circuit is the same and would needlessly complicate the diagram. The balance of the circuitry consists of 16 5-input NAND gates.

Figure 4A is the internal logic

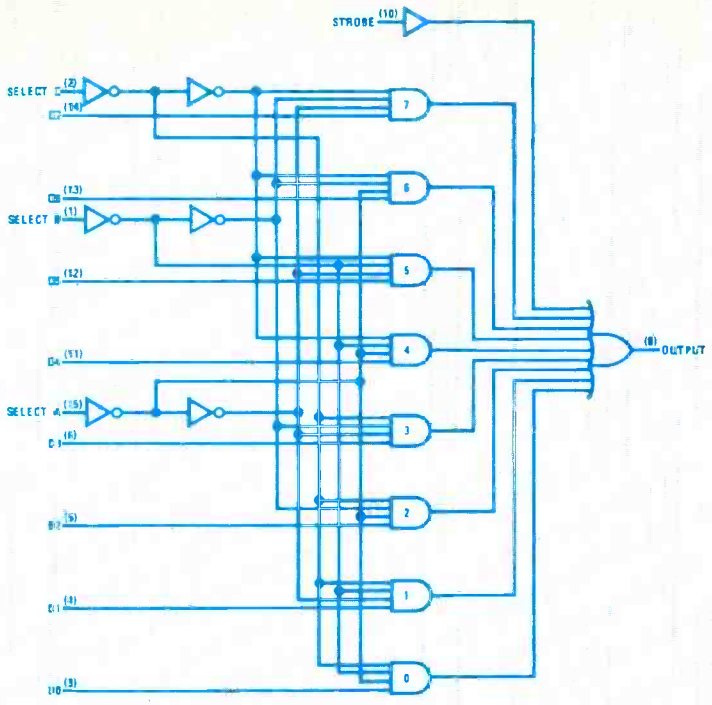


Figure 4A. A National Semiconductor data selector/multiplexer, type DM 7211/8211 schematic.

SELECT INPUTS C	B	A	STROBE (DM7211/DM8211 ONLY)	DATA INPUTS 0	1	2	3	4	5	6	7	OUTPUT
L	L	L	L	L	X	X	X	X	X	X	X	L
L	L	L	L	H	X	X	X	X	X	X	X	H
L	L	H	L	X	L	X	X	X	X	X	X	L
L	L	H	L	X	H	X	X	X	X	X	X	H
L	H	L	L	X	X	L	X	X	X	X	X	L
L	H	L	L	X	X	H	X	X	X	X	X	H
L	H	H	L	X	X	X	L	X	X	X	X	L
L	H	H	L	X	X	X	H	X	X	X	X	H
H	L	L	L	X	X	X	X	L	X	X	X	L
H	L	L	L	X	X	X	X	H	X	X	X	H
H	L	H	L	X	X	X	X	X	L	X	X	L
H	L	H	L	X	X	X	X	X	H	X	X	H
H	H	L	L	X	X	X	X	X	X	L	X	L
H	H	L	L	X	X	X	X	X	X	H	X	H
H	H	H	L	X	X	X	X	X	X	X	L	L
H	H	H	L	X	X	X	X	X	X	X	H	H
X	X	X	H	X	X	X	X	X	X	X	X	H

H = high level (1)
L = low level (0)
X = don't care

Figure 4B. The truth table for the DM 7211/8211 data selector/multiplexer.

diagram for a National Semiconductor data selector/multiplexer, type DM7211/8211. This type of circuit is often referred to as an 8-line data selector or 8-line multiplexer for obvious reasons. Figure 4B is the truth table for the same circuit.

The addressing procedure is the same as in the previously described decoder of Figure 3A, and so is the strobe (enable). The strobe must be kept low, otherwise the single output will remain high regardless of the data input. This data selector is only an 8-line circuit, and was chosen for simplicity of the logic diagram. It has six inverters for the A, B and C, select line inputs and eight 4-input AND gates, but unlike the decoder, ends up in a 9-input OR gate, which provides the single output. It is easy to see how the strobe (enable) input to the OR gate works.

The difference between the decoder described earlier and this data selector becomes obvious when you study the truth table, which now has eight data inputs instead of 16 outputs. The select (address) inputs now select one of the eight data inputs, and the output changes in accordance with the changes in the selected data input.

Practical applications

One of the most common applications for decoders is in memory addressing. The problem is that memories contain many different locations and each location stores information. It is necessary to immediately gain access to a desired location in order to write data into the memory or retrieve (read) data out of the desired location. Even with a small memory such as one with 256 separate storage locations, we would seem to need 256 wires and consequently 256 pins on the memory IC – a monster! And, of course, we would need a 256-wire interconnecting cable – another monster. But instead, we can use the scheme shown in the block diagram of Figure 5.

The memory in Figure 5 is a 256 x 8, which means 256 words of eight bits each. When we address a location in memory, we find that location stores a word of eight binary bits in length. The total capacity of the memory is therefore 2048 bits. We cannot address each individual bit, but we can, and do, address separate words. This is common practice in digital systems, such as microprocessors, in which 8- or 16-bit words move around on 8, or 16 parallel wire cables called buses. The problem we are going to solve is to reduce the number of wires needed for memory addressing with the aid of the decoder.

The memory itself is arranged in the form of a matrix, consisting of horizontal and vertical grids. Where a vertical line intersects with a horizontal line, we have the location (address) sought. Two decoders, with 16-line outputs are connected as shown. Decoder 1 does the horizontal addressing, while decoder 2 does the vertical addressing. Because these are the usual 4-line to 16-line decoders, we only need eight wires for the total inputs to both decoders; i.e., eight lines will provide eight binary select inputs. Thus we can address

256 locations, storing a total of 2048 bits in the form of 256 8-bit words, with only an 8-wire address bus. Many memories today incorporate decoders inside the integrated circuit memory, and we then use external decoders to further reduce the number of wires. By this means, we can store large amounts of information and still use relatively few connecting address wires.

Of course we are not limited to memories in this scheme. We also use this method to reduce the number of wires needed in control systems for a large variety of applications where many operations must be supervised via connecting cables.

This is a straightforward application for the decoder, but it is not limited to such obvious applications. As just one illustration of this, let's look at a backward use for the data selector of Figure 4A. Suppose we hook it up as in Figure 6, with the eight data inputs connected to single-pole, double-throw toggle switches. Each switch can be connected to the plus side of the power source or to ground. As shown, D0, D1, D2 and D3 are tied to ground by means of the toggle switches; D4, D5, D6 and D7 are tied to plus. The input signals are applied to the select lines, A, B and C. The strobe is tied low (to ground), which permits the circuit to operate continuously.

Now look again at the truth table in Figure 4B. Using it as a guide, let's construct our own table of outputs, for the conditions we have just "programmed" into the data inputs, namely D0, D1, D2 and D3 are low, and D4, D5, D6 and D7 are high. With three binary input

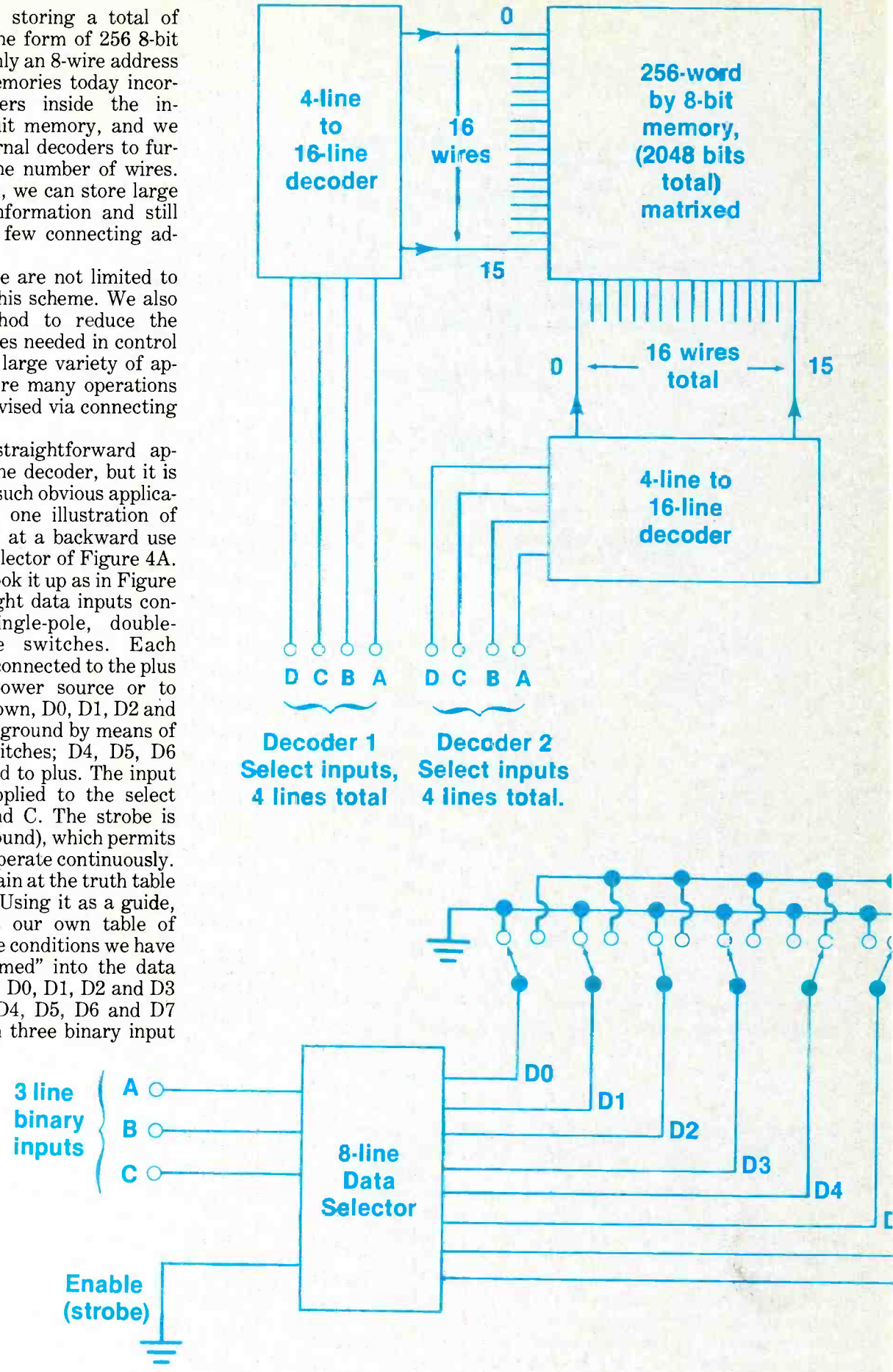
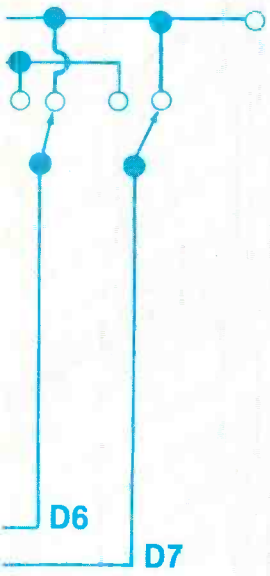


Figure 6. Another way to use the data selector.

Select Inputs C	B	A	Data Inputs D0	D1	D2	D3	D4	D5	D6	D7	Output
L	L	L	(L)	L	L	L	H	H	H	H	L
L	L	H	L	(L)	L	L	H	H	H	H	L
L	H	L	L	L	(L)	L	H	H	H	H	L
L	H	H	L	L	L	(L)	H	H	H	H	L
H	L	L	L	L	L	L	(H)	H	H	H	L
H	L	H	L	L	L	L	H	(H)	H	H	H
H	H	L	L	L	L	L	H	H	(H)	H	H
H	H	H	L	L	L	L	H	H	H	(H)	H

Figure 7. A truth table showing outputs for all possible combinations of binary select inputs, with data inputs "programmed" as in Figure 6.



Select Inputs C	B	A	Output
L	L	L	L
H	H	H	H
L	H	L	L
H	L	H	H
L	L	H	L
H	H	L	H
L	H	H	L
H	L	L	H

Figure 8. Can you solve this problem with logic gates and binary math? Try solving it with an 8-line data selector truth table. Notice that the combinations paired by brackets are the inverse of each other. Each binary coded combination of select inputs must provide the output shown. (This problem's truth table solution is actually the same problem solved in Figure 7 presented differently.)

lines, there are eight possible input combinations. What will the output be for each of these output combinations? Let's construct our new table, using the truth table as a look-up table. The result is shown in Figure 7.

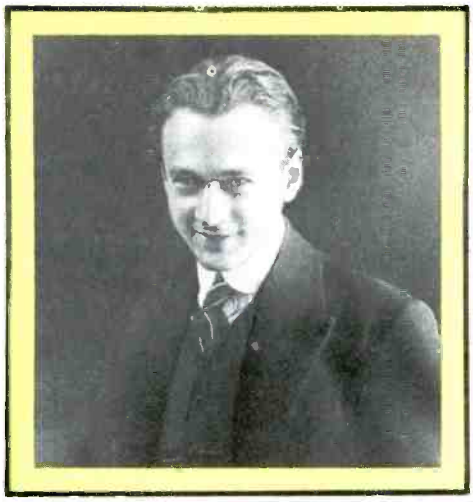
The truth table of Figure 4 shows that for each of the select input combinations, only the circled data input matter. All the others are "X" (don't care). Stated another way, only one data input is selected for each combination of the three select inputs.

What is the state of the data input selected? That depends upon the position of the switch connected to that data input. If the switch goes to plus, it's high; if it goes to ground, it's low. The condition of the data input, high or low, is transferred to the output, as each input is selected in turn. As a result, the data inputs (0,0,0,0,1,1,1,1), which are D0 through D7 respectively, appear in the same order in the output. (Of course we could have used any other combination of zeros and ones. Try another combination for yourself.)

We are really using the data selector backward, programming the data inputs with highs and lows and applying a binary coded 3-bit input to the select inputs. At this point, you may well be wondering why.

Suppose you were asked to come up with logic circuitry that could solve the problem in Figure 8. Could you do it? How long would it take? How many logic gates would it take? What means would you use? Boolean Algebra? Veith Charts? Karnaugh Maps? How would you begin?

To solve the problem, all you need is an 8-line data selector. You don't even need the switches, unless you want the ability to solve different problems. If you intend to solve one problem, as in a vending machine, you merely hard wire the data inputs to plus or ground, and the job is done. No math, no fuss, little time spent, and it's inexpensive. In effect, the data selector makes a novice into an expert logic problem solver.



Dr. Vladimir K.

Dr. Vladimir K. Zworykin (ca. 1910), is widely acclaimed as the father of television. His *iconoscope* camera tube and *kinescope* picture tube pioneered modern TV equipment.

TV pioneer Dr. Vladimir Kosma Zworykin died on July 29, 1982, at the Princeton Medical Center, Princeton, NJ, a day short of his 93rd birthday.

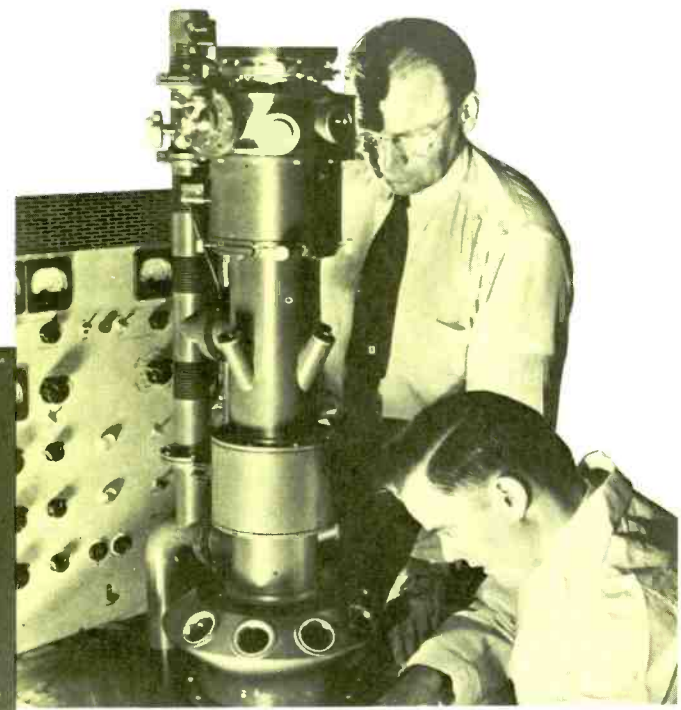
Elected an honorary vice president of the RCA Corporation upon his retirement in 1954, Zworykin was often called the *father of television.* However, he declined the accolade, telling interviewers that hundreds contributed to television's evolvement over many years. He preferred to compare television's development with the building of a ladder, explaining that, as each engineer added a rung, "it enabled the others to climb a little higher and see the next problem a little better."

Father or not, there is no question that the achievement of practical television stems, to a large extent, from Zworykin's pioneering work in the 1920s and 1930s. His conception of the first practical TV camera tube, the *iconoscope,* and his development of the *kinescope* picture tube formed the basis for almost all important later advances in the field.

As a Russian immigrant, he came to the United States after World War I and worked for Westinghouse in Pittsburgh from 1920 to 1929. It was there that he did some of his early work on television.

But it was not until he teamed up in 1929 with another Russian immigrant, Gen. David Sarnoff, later

In 1929 Zworykin demonstrated an early electronic TV receiver using the kinescope picture tube.



An intense scientist and engineer, Zworykin's interests were wide reaching. He is shown here (standing), with Dr. James Hillier, whom he recruited to develop the electron microscope. For his design of the system's vastly improved objective lens, Hillier was elected to the National Inventors Hall of Fame. (photo ca. 1947)

Zworykin: 1889-1982

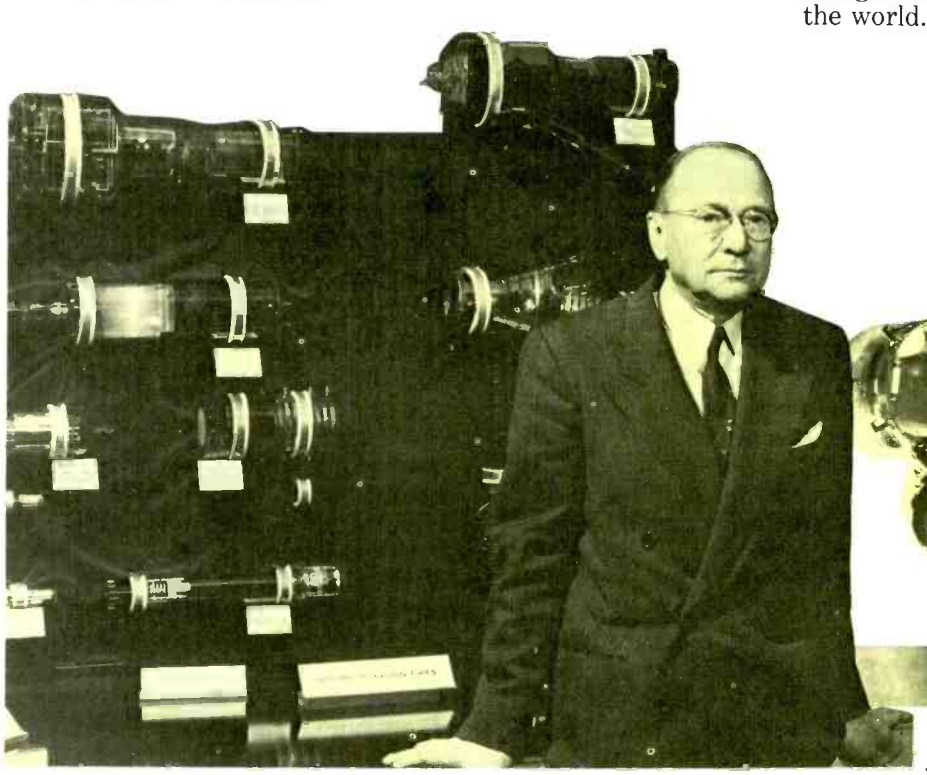
president and chairman of RCA, that his TV work got the management and financial backing that enabled Zworykin and the RCA scientists working with him to develop television into a practical system.

Both men never forgot their first meeting. In response to Sarnoff's question, Zworykin, thinking solely in research terms, estimated that the development of television would cost $100,000. Years later, Sarnoff delighted in teasing Zworykin by telling audiences what a great salesman the inventor was. "I asked him how much would it cost to develop TV. He told me $100,000, but RCA spent $50 million before we ever got a penny back from television."

Zworykin had left Russia and come to America because he wanted to develop his dream – television. His adopted country treated him well. In 1966, President Lyndon Johnson awarded him the United States' highest scientific honor, the National Medal of Science "for major contributions to the instruments of science, engineering and television, and for his stimulation of the application of engineering to medicine." Including the Medal of Science, Zworykin received 27 major awards and numerous others from groups throughout the world.

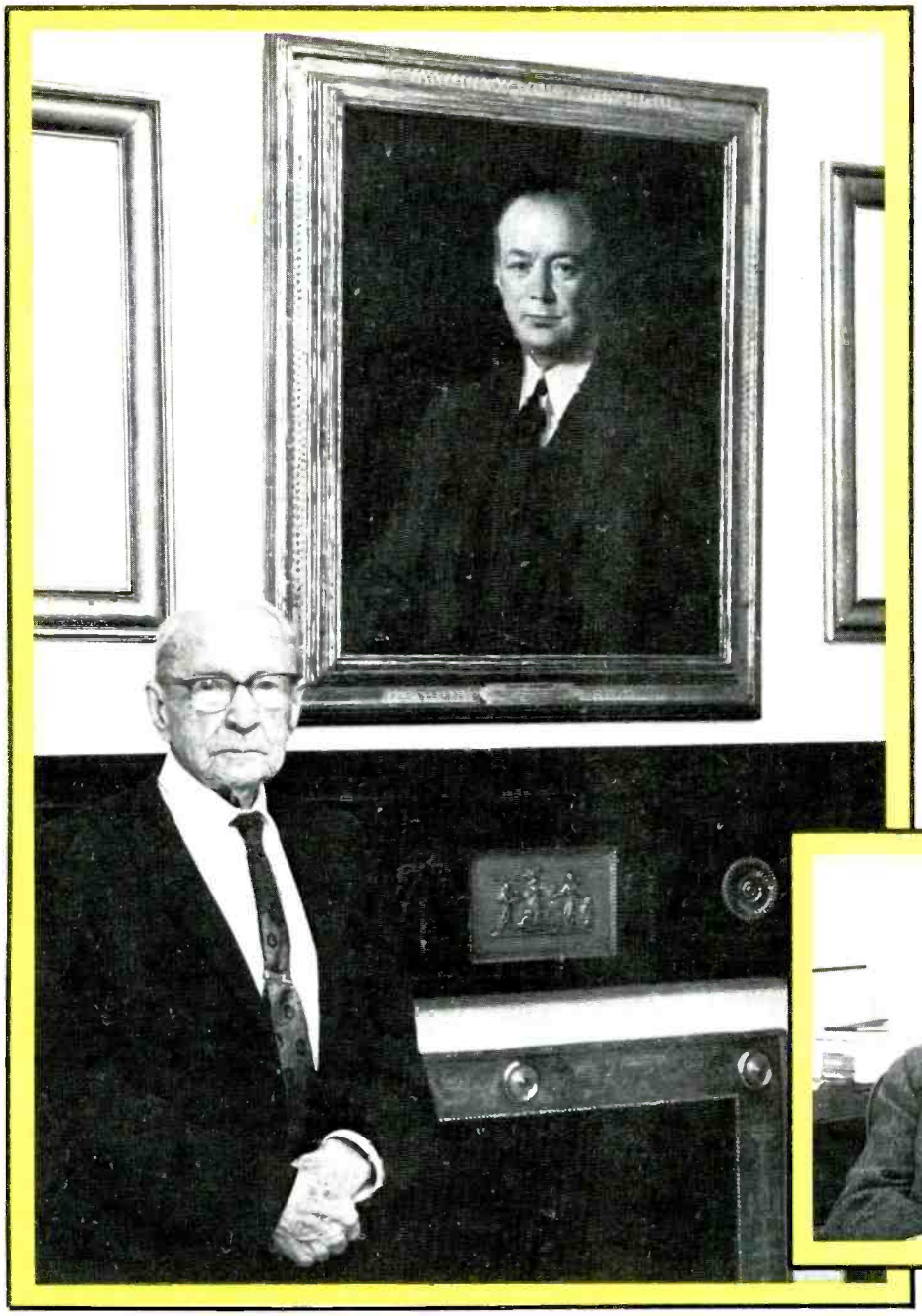
He was elected to such prestigious American societies as the National Academy of Sciences, the American Academy of Arts and Sciences, the American Philosophical Society, the American Association of the Advancement of Science and the National Academy of Engineering.

Zworykin was born on July 30, 1889, in Mourom, Russia, where his father owned and operated a fleet of boats on the Oka River. As the owner's son, he had the run of the ships and often played with the push-buttons used to signal the engine room from the bridge. Thus, Zworykin would tell interviewers, he was intrigued with electrical communications well before he was 10 years old.



Zworykin, posing with a display of historic TV tubes.

Zworkin (ca. 1940s), holding an early model of the iconoscope, which he developed as the *all-electronic eye* of the TV camera.



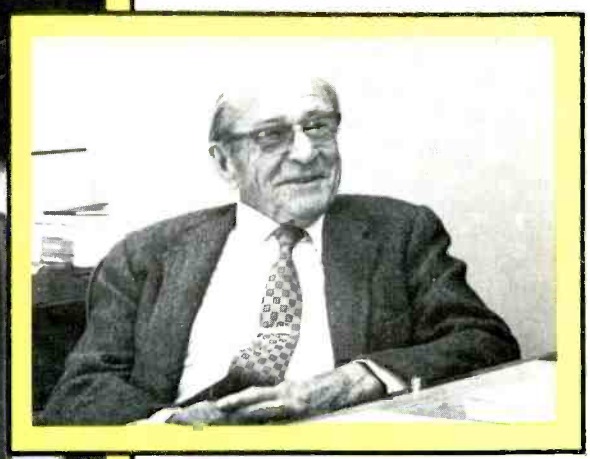
Zworykin (ca. 1980), posing in front of David Sarnoff's portrait. Also a Russian immigrant, Sarnoff was instrumental in bringing Zworykin to RCA, thus providing him the resources to develop electronic television. However, Zworykin credited Sarnoff with having the vision to foresee television as a new form of home entertainment.

States, Zworykin joined the Westinghouse research staff. He began investigations in the field of photoelectric emission and resumed his research in television.

Zworykin became associated with RCA in 1929. He served as director of the Electronic Research Laboratory, first in Camden, NJ, and from 1942 until his retirement, in Princeton, NJ.

In addition to television, Zworykin applied his talents to a broad field of electronics and held more than 120 US patents on developments ranging from gunnery controls to electronically controlled missiles and automobiles.

As a result of Zworykin's research activities, important devices such as various forms of secondary emission multipliers and image tubes were developed and perfected. The *Snooperscope* and *Sniperscope* – important military developments in World War II – were practical applications of research on infrared image tubes.



Even though he retired in 1954, Zworykin maintained an office in the RCA David Sarnoff Research Center in Princeton, NJ, until he was 91 years old. (photo ca. 1980)

Perhaps because of this interest in communications, his father sent him to the Petrograd Institute of Technology, which awarded him an electrical engineering degree in 1912. At the institute, Zworykin studied under and assisted Professor Boris Rosing, to whom Zworykin credited both his decision to become a scientist and his special interest in television and electronics.

As early as 1906, Rosing believed that the solution to practical television was to be found, not in mechanical systems, but in the employment of CRTs. Zworykin's iconoscope and kinescope followed this line of reasoning.

In 1912, Zworykin entered the College de France in Paris, where he studied X-rays under the noted scientist Professor Paul Langevin. His studies were interrupted by World War I, and Zworykin had to return to Russia to serve in the Army Signal Corps. After the war, he came to the United States, and became a citizen in 1924. He received a doctorate from the University of Pittsburgh in 1926.

Soon after arriving in the United

Zworykin's intensive study of electron optics directed his interest to the electron microscope. RCA's pioneering in the commercial development of the electron microscope typifies Zworykin's genius – not only his scientific expertise, but his ability to attract and motivate good scientists.

For example, in 1940, he hired a young Canadian graduate student, Dr. James Hillier, to work on the electron microscope. Hillier, who

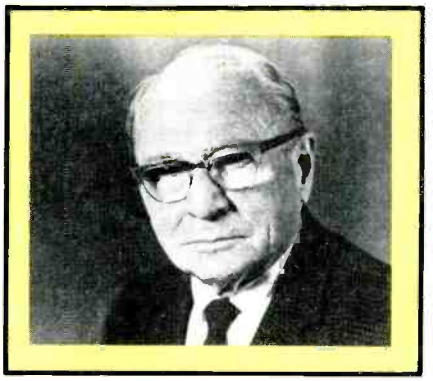
In the fall of 1980, Zworykin honored the 122nd Technical Conference of the Society of Motion Picture and Television Engineers with a taped interview of early TV developments and with a brief personal address. He is shown here (center), following his speech, talking to Charles Ginsburg (left), of Ampex, and Frederick Remley, then SMPTE vice president for TV affairs. They are gathered around the Emitron camera that served the BBC from 1936 to 1954, the year that Zworykin retired.

retired in 1977 as executive vice president and chief scientist of RCA, decided to work for RCA because Zworykin recruited him with one question – how long would it take Hillier to build an electron microscope – while other prospective employers engaged Hillier in theoretical discussions or emphasized their good working conditions and fringe benefits. Working under Zworykin's guidance, it took Hillier little more than three months to build the first RCA electron microscope.

Coincidentally, in 1980, just three years after Zworykin was elected to the US National Inventors Hall of Fame for his development of television, Hillier was elected for his work on the electron microscope.

Following his retirement, Zworykin directed a Medical Electronics Center at the Rockefeller Institute in New York. In this capacity, as national chairman of the Professional Group on Medical Electronics of the Institute of Radio Engineers, as founder-president of the International Federation for Medical Electronics and Biological Engineering, and as member of the board of governors of the International Institute for Medical Electronics and Biological Engineering in Paris, he worked toward the use of electronic methods in medicine and the life sciences.

Zworykin was often asked if, while working on television, he ever envisioned the worldwide entertainment medium it became. He would reply that he hadn't, and credited Sarnoff with seeing television as a new form of home entertainment. Zworykin would then explain that in his early years he looked upon television as a system that would enable man to see things in places where his eyes couldn't reach. Thus, he was delighted with the first TV pictures of the back side of the moon. And, when he visited the Jet Propulsion Laboratories in California to see the reception of pictures of Mars, he remarked, "This is what television is really for."



In October 1980, Zworykin received a special award from the Eduard Rhein Foundation for his many contributions to fully electronic television. (photo ca. 1970s)

As he grew older, Zworykin curtailed his activities, spending winters in Florida, but never gave up his interest in scientific research. For many years, he was a visiting professor for the Center for Theoretical Studies and the Institute for Molecular and Cellular Evolution of the University of Miami in Florida, and he maintained an office at RCA Laboratories. Even at the age of 91, he would drive from his home in Princeton to his office in the David Sarnoff Research Center to read from his large collection of scientific journals and reports.

It was in that office, after Zworykin's 85th birthday, that a *New York Times* reporter asked him: "You've been involved in scientific research for many, many years. When are you going to stop working and really retire?"

A smile gathered quickly on Zworykin's face, and he replied without hesitation, "When I die."

ES&T

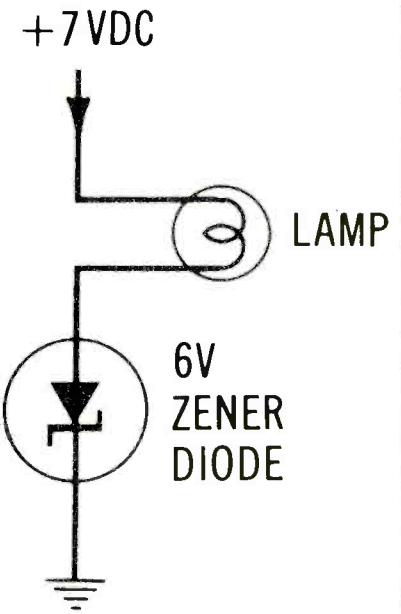
Answer to Quick Quiz

(From page 23.)

By Wayne Lemons, CET

Don't become confused by the zener-diode specification. Zener operation occurs only when the zener is reverse biased. If the anode had been grounded, the correct answer would be 1V, because zener action would result. However, when a zener diode is forward biased (as shown with cathode grounded), it has the same action as a conventional power-supply diode, which produces a voltage drop of about 0.7V across itself. Therefore, the lamp receives all except 0.7V of the 7V supply (the sum of voltage drops must equal the source voltage).

The correct voltage is 6.3V in answer #3.



Coming soon in

ELECTRONIC Servicing & Technology

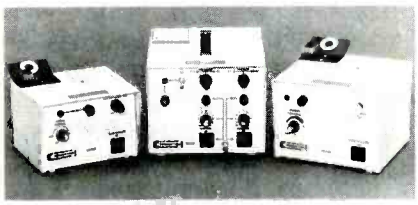
The basics of tape recording, part II (Physical operation of audiocassettes). Although details of components and operation can vary from model to model, the basic functions are identical for all.

NEW PRODUCTS

Desoldering units

Automated Production Equipment Corporation has introduced the APE models EX-500, EX-550 and EX-525 for desoldering printed circuit boards.

Models EX-500 and EX-525 are



self-contained and use a rotary and piston pump, respectively. Model EX-550 is pneumatically operated and uses a transducer to obtain vacuum. The air supply is controlled via a solenoid.

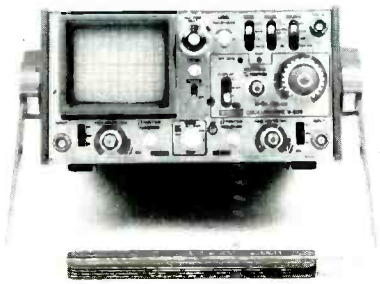
All three units come complete with APE model EX-1000 desoldering handpiece with an improved heater and SCR controller. Vacuum flow is foot-pedal operated, on all units, leaving the operator's hands free.

Circle (50) on Reply Card

Mini scope

Hitachi Denshi Test & Measurement Division has introduced the V-509, 50MHz, dual trace oscilloscope.

The 11-pound mini-portable, with calibrated delayed sweep, offers the field engineer a 12kV CRT, operation from ac/dc or optional battery pack, plus such unexpected features as single-shot



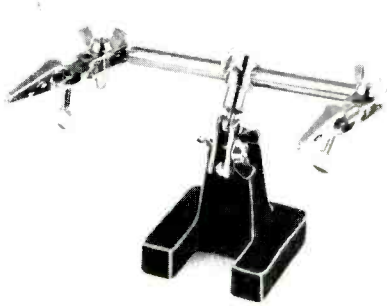
trigger, variable hold-off, auto focus and full TV triggering.

The V-509 offers a 3½-inch rectangular mesh-type CRT with metal-backed P31 phosphor and an internal graticule. The new mini scope has a convenient Channel 1 DVM output. This feature eliminates T-connector cabling and time-consuming cable switching.

Circle (51) on Reply Card

Holding fixture

The HPCB-15 assembly aid from *OK Machine and Tool Corporation* is a "2-handed" holding fixture for helping with all types of electronic and mechanical assembly work. The HPCB-15 features two strong alligator clips for reliable holding action plus quick and easy clamping and release. Both clips are mounted in ball joints, and the connecting bar is mounted in a third ball joint. All ball joints may be locked in any position, and the en-

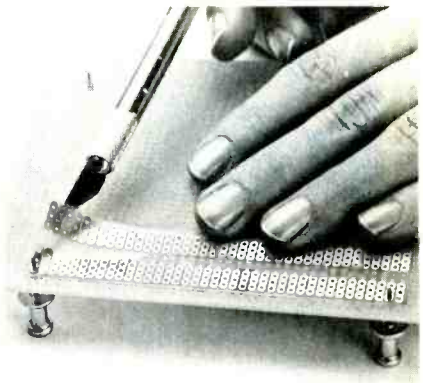


tire assembly is mounted in a heavy cast-metal base to provide stability during use.

Circle (52) on Reply Card

Electronic packaging/ prototyping system

Bishop Graphics recently introduced a new electronic circuit packaging, repair and prototyping system called E-Z Circuit. Designed for such applications as solid-state digital and linear systems and analog circuitry, the E-Z Circuit product line is ideal for electronic engineers, circuit designers, home hobbyists and experimenters and electronic students who want to build "instant" printed circuit boards, PC board prototypes, or make PC board repairs right on-the-spot.



The E-Z Circuit features pressure-sensitive copper component mounting configurations, donut pads, tape and Cut 'N' Peel copper sheets for building, modifying or repairing PC boards.

Circle (53) on Reply Card

Multiplexer

A low cost, 8-channel add-on oscilloscope multiplexer has been introduced by *Global Specialties Corporation.*

The model 8001 multiplexer extends the capability of an oscilloscope from one or two channels to eight. This permits a direct comparison of events happening simultaneously and in direct relationship to each other.

Input is via eight BNC connec-

tors and will accept signals of ±5V (10p-p) with a frequency response that is flat to 12MHz, −3db at 20MHz. Input impedance is 1MΩ.

Circle (58) on Reply Card

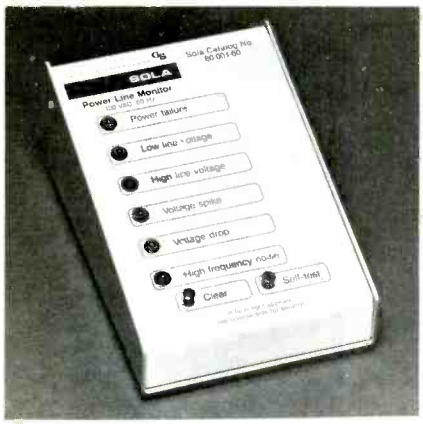
Portable line monitor

A power line monitoring device, which analyzes power line quality at potential electronic installation sites, is being introduced by *Sola Electric,* a unit of General Signal.

The monitor will detect and identify all common power problems including high frequency electrical

noise, voltage spikes and drops, longer term high and low voltage conditions and momentary power failures. It also offers a reference chart of typical causes and recommended solutions for the most common power problems detected on the line.

The portable device plugs into any 115 Vac outlet, drawing no



more than 5W. When a disturbance appears on the line, the unit sounds an audible alarm and lights any of six red LED indicators to identify the power problem.

Circle (54) on Reply Card

Antenna rotator

Winegard Company has introduced the WR-5000 automatic outdoor antenna rotator.

The WR-5000 features a solid 1-piece housing that eliminates the possibility of water penetration into the unit. Shaft construction provides easy mast installation.

Casting has a built-in stop for the drive unit support mast.

The drive unit incorporates a powerful dc motor for maximum starting torque.

Circle (55) on Reply Card

Static control samples

A free sample card of static control products is being offered by *Charleswater Products.*

The samples are suitable for preliminary testing and include high and low density foams, floor mat and tabletop material, nylon and transparent bags, wrist and grounding straps and shunt bars.

Circle (56) on Reply Card

Fused eyeletting system

Pace's PFP-30 fused eyeletting system permits field repair of damaged or missing plated-thru holes and terminals on PCBs with factory quality.

The PFP-30 permits installation of a variety of hot fused eyelets and funnelets for a broad range of setting conditions. It also eliminates the solder "blowout" problems associated with conventional eyeletting techniques.

The system includes a fused eyeletting machine, tool kit, Cir-

Kit (with pre-tinned/scored eyelets, Trak-Pads, etc.), and a heavy-duty power source.

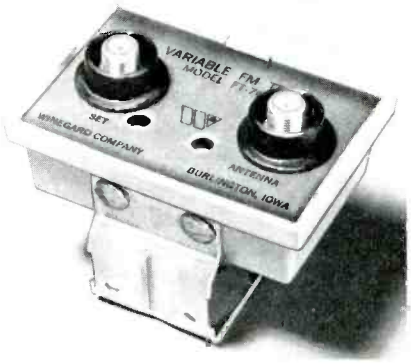
Circle (57) on Reply Card

FM traps

Two FM traps, FT-750 and FT-760, are now available from the *Winegard Company.*

Model FT-760 is a 2-stage variable FM trap designed to attenuate stations in the FM band 88 to 108MHz, −26dB. The trap may be tuned to two different frequencies or the same one.

Model FT-750 is a fixed trap that attenuates the FM band 88 to 108MHz, −26dB. Similar to its tunable counterpart, it can be used by the individual homeowner or by a commercial installer at an MATV headend.



Both traps are enclosed in weatherproof housings and can be mounted on an antenna boom, mast or wall. Both will pass power to operate an antenna-mounted preamplifier from a remote power supply.

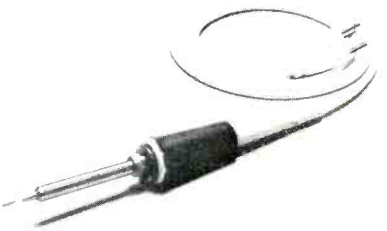
Circle (59) on Reply Card

Soldering iron

A new System 9300 soldering iron has been introduced by *Ungar*, a division of Eldon Industries. It uses the "Thermo-Duric" heating element that heats more efficiently and recovers faster than previous models.

The element is non-magnetic, and the iron conducts static electricity from tip to a grounded wall plug. Both factors help prevent static electricity damage to microcircuits.

Operating temperature of 700°F



or 800°F is determined by the heater, which can be quickly changed. Any of five standard Ungar tips can be used with either heater.

Circle (60) on Reply Card

LCD digital multimeter

The *Universal Enterprises* DM25 is a 3½-digit DMM with a basic dc accuracy of ±0.2% of full scale. It will measure dc volts from 0.1V to 1000V, dc current from 0.1mA to 200mA, ac volts from 1V to 600V, and resistance from 1Ω to 2MΩ.

The DM25 has a 0.4-inch display and features such as overload protection on all ranges, fuse protected current and resistance ranges (to protect against excessive overload), automatic zeroing and polarity, and over range

and low-battery indication. An automatic limiter circuit will allow up to 140Vac to be applied on all OHMS ranges without blowing the fuse.

Circle (70) on Reply Card

Test kit

TeleMatic's Update Kit (model 10J107) modernizes older test jigs for servicing the increasingly wider range of today's televisions, which require a test jig equipped with a selection of yoke-matching values.

The kit consists of two matching transformers and a yoke assembly, and allows quick selection of nine horizontal and five vertical impedance values. It adapts most 19-inch test jigs for servicing tube, hybrid and solid-state sets—domestic and imported.

Circle (76) on Reply Card

Function generator

Almost any waveform from 0.001Hz to 20MHz can be created by *Hewlett-Packard's* new HP 3314A function generator. Waveforms from precise sines,

squares and triangles to arbitrary waveforms can be made with the HP 3314A to meet a variety of signal-source needs.

Features include sine, square and triangle waveforms to 20MHz; variable symmetry for ramps and pulses; continuous, gated and swept signals; counted bursts from N = 1 to N = 1999; and new ½-cycle signals.

Circle (75) on Reply Card

Direct plug isolators

Electronic Specialists has expanded their Isolator line to include units that plug directly into the wall socket. Designed for installations that do not require extension cords, the direct-plug Isolators provide the same equipment interaction isolation and power-line protection as the line-cord Isolator series. A convenient

retention screw prevents accidental withdrawal from the wall socket.

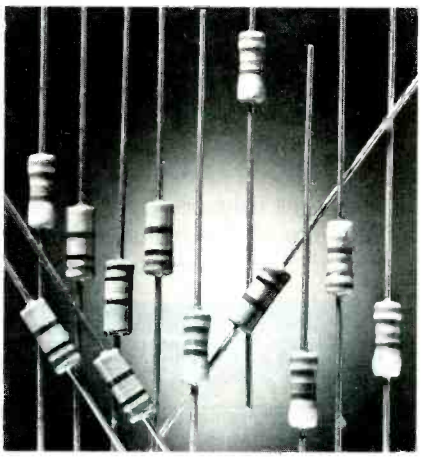
Direct-plug Isolators can accommodate a total 1875W load, with up to 1000W per socket. A high-capacity spike/surge suppressor is designed into each unit.

Circle (78) on Reply card

Flameproof resistors

Sylvania ECG has added 17 new flameproof resistors to their line. The new resistors are all ½W types with 5% tolerance. All additions have values under 1Ω and are used extensively in wide varieties of semiconductor equipment.

Sylvania ECG flameproof resistors are non-combustible because their metallic resistance element is sandwiched between an inner ceramic core and an outer



ceramic coating. This construction also provides stable resistance to normal operating current despite variations in ambient temperature, humidity or voltage.

Circle (77) on Reply Card

Dual-time base oscilloscopes

Leader Instruments Corporation has announced the introduction of two dual-trace, dual-time base 35MHz oscilloscopes, the LBO-524 and LBO-524L. The units are designed to meet applications in design, testing and service of both analog and digital circuits and equipment.

Both oscilloscopes have an 8 x 10cm PDA CRT that provides sharp, bright displays, even at highest sweep rates. Comprehensive triggering controls, including variable holdoff, alternate triggering and delayed sweep triggered functions, permit stable display for even the most complex signals. A channel-one output is available on the rear-panel to drive other less sensitive instruments, such as a frequency counter with an input level as low as 500μV. The dual-time base permits accurate observation and time interval measurements of complex waveforms.

Circle (81) on Reply Card

NEW LITERATURE

The **Association of Audio-Visual Technicians** has announced the publication of the fourth edition of their *Annotated Directory of Parts and Services for Audio-Visual Equipment.* The purpose of the directory is to assist audio-visual technicians in locating parts service sources and manufacturers for audio-visual equipment and their current parts sources. Many of these sources are no longer the original manufacturer because the brand has been sold, discontinued, or because the manufacturer has moved or is no longer in business.

The price of the directory is $17.95 plus $2 shipping and handling to AAVT. The non-member price is $27.95 plus $2 shipping and handling.

Circle (90) on Reply Card

A new 216-page catalog, published by **Tucker Electronics,** lists approximately 3800 pieces of reconditioned electronic test equipment and microwave components. Instrument categories include amplifiers, analyzers, bridges, frequency measuring equipment, signal generators, lab standards, meters, scopes, power supplies, recorders and RFI/EMI equipment.

All instruments available for either sale or short-term rental, and all units are reconditioned and calibrated to manufacturer's specifications.

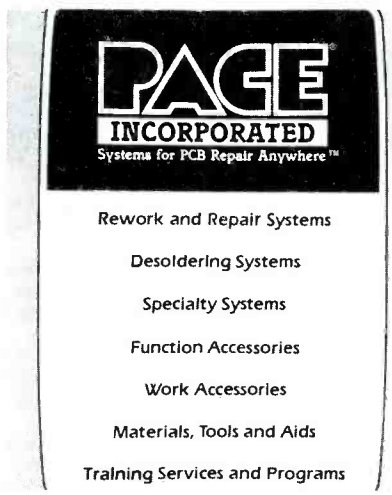
Circle (91) on Reply Card

Desco Industries has released a new 8-page catalog of tools for electronic assembly and repair. This catalog introduces a complete new line of soldering aids with both wood and plastic handles, and it expands the Desco line from 62 to 85 items.

A new price sheet, effective July 1, 1982, was released with the catalog. The new price schedule has one additional volume-price-break column. This new column, for assorted orders of 1000 or more units, will enable distributors to purchase Desco products at close to 1980 prices.

Circle (92) on Reply Card

Pace has released a new catalog of equipment that includes descriptions of Pace rework and repair



systems, desoldering systems, function accessories, work accessories, materials, tools and aids.

The catalog also includes information on Pace's motion picture/video training courses – "Basic Soldering" (now available in 11 langauges) and "Rework and Repair for Electronics."

Circle (93) on Reply Card

A new 48-page catalog describing the complete product line is available from **BP Electronics.** The catalog includes test equipment and instruments, intercoms, headphones, video products and accessories, CATV hardware, microphones, audio accessories and speakers for home and auto, CB hardware and accessories, antennas, tools, pocket stereos, and TV replacement parts.

Circle (95) on Reply Card

ES&T

THE MARKETPLACE

CLASSIFIED

Advertising rates in the Classified Section are 50 cents per word, each insertion, and must be accompanied by payment to insure publication.

Each initial or abbreviation counts a full word.

Minimum classified charge $10.00.

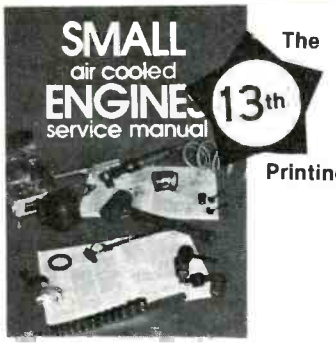
For ads on which replies are sent to us for forwarding (blind ads), there is an additional charge of $3.00 per insertion to cover department number, processing of replies, and mailing costs.

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

For Sale

Service Manuals

The ever popular SMALL ENGINES Service Manual



Fix your own small air cooled engines
Covers virtually all makes & models

- 336 pages
- 8x11" softbound

$9.95

Chain Saw

$9.95

Small Engine/ Chain Saw FLAT RATE

Save your shop $ $ $

$8.95

Manuals cover nearly all makes/models

Check these other important manuals

•Large Air Cooled Engines	$8.95
•Snowmobile	$8.95
•Small Tractor Vol. 1	$7.95
•Small Tractor Vol. 2	$7.95
•Light Utility Tractor	$3.95

Get more details from our FREE catalog...Ask for it!

Do it yourself and SAVE!

Walking Lawnmower

- 128 pages
- 8x11" softbound

$8.95

Riding Lawnmower

- 192 pages...
- big 8x11" format

$8.95

Technical Publications invites you to join the thousands that are doing it themselves and saving

$ $ $ $ $ $ $

Outboard Motor Vol. 1

- 236 pages
- 8x11" softbound
- Motors below 30hp

$8.95

Inboard/Outdrive

- 272 pages
- 8x11" softbound

(The only full coverage service manual for inboard/outdrives on the market)

$8.95

Outboard Motor Vol. 2

- 232 pages
- 8x11" softbound
- Motors 30hp and above

$8.95

Inboard Engine and Drives

- 84 pages
- 8x11" softbound

We've got the Flat Rate

$5.95

TECHNICAL PUBLICATIONS

P.O. Box 12901 Dept. ES
Overland Park, KS 66212
(913) 888-4664

VISA master charge

Indicate number, expiration date and type of card

No COD outside US
POSTAGE PAID when payment accompanies order

For Sale (Cont.)

SENCORE VA48 VIDEO ANALYZER less than one year old, like new $750. Will ship In original box post paid. 319-552-1600. 10-82-1t

REPLACEMENT COLOR YOKES-DEALERS ONLY. Zenith 95-2501-2532-2887 etc. $22.95. Magnavox 361380-1 etc. $24.95. Sylvania $24.95. American-made fuses in bulk-example 3AG 2 regular price .23 each our price .12 each. Factory packaged GE transistors at discounts. Example GE-20 regular price $1.10 our price .65. Request circular on your letterhead. David Sims Enterprises, Inc., 665 East Jericho Tpke., Huntington Sta., NY 11746. 800-645-5030, NY State (516) 549-3925-1592. 10-82-tfn

SENCORE TF46 $200, SENCORE TC-162 $150, SENCORE DVM-38 with HV probe $240, leader wow and flutter meter $590, radiometer distortionmeter $575, Zenith frequency counter $110, Sams photofacts 1000-1640 with cabinets $500. All excellent condition with probes and manuals. 64 Lower Notch Rd., Little Falls, NJ07424, 201-256-6570 10-1-1t

HAMEG 70MHZ – Dual trace, triggered delayed sweep oscilloscopes (usable to 120MHz!) only $899. – Free freight, prepaid, excellent triggering & sensitivity (usable to 3000 VPP with optional probes) other models available from $395. One year limited warranty – made in Germany! Send check or money order to: Incredible Electronics Company, Box 117, Troy, NY 12180. 10-82-1t

INDIVIDUAL PHOTOFACT FOLDERS under 800, post paid $3.00 or will sell entire lot $1200. BRAULT, RR#6, 5703 Poplar Rd., Fond du Lac, WI 54935. 10-82-1t

USED RADIO-TELEVISION TUBES. All types. Working condition. 30 for $10.00 postpaid. Loeb, 414 Chestnut Lane, East Meadow, NY 11554. 10-82-3t

TEST EQUIPMENT tools, parts, aids, save, free catalogue. Color-tech Electronics, P.O. Box 12916, Rochester, NY 14612. 10-82-1t

RUBBER DRIVE BELTS – Lowest prices (26¢ up) brochures free to repair dealers list belts by size, includes cross-reference. Individuals send $2.00 (credited). Electronic Parts Co., 1015 E. Escondido Blvd., Escondido, CA 92025; (714) 741-2300/3868. 10-82-tfn

HAMEG 312 DUAL TRACE OSCILLOSCOPE, very little used by physician, used primarily with P-7 phosphor tube, which has been replaced by standard cathode ray tube and not used, case included, $400.00. 10-82-1t

SENCORE CB-42 ANALYST. Best offer. Sams CB-1 through CB-125. Best offer. Heathkit SB-300 and SB-401 complete w/manuals. Best offer. Stan Stevens, RR4, Box 26, Iowa City, Iowa 52240 (319) 354-9726. 10-82-1t

Business Opportunity

TV TECHNICIAN! Increase your Income up to $60,000 yearly. Rent-lease-sell TVs new-used, even from comfort of your home. Basic Preliminaries $10.00. Perrys TV Systems, Hwy 181, Box 142, Route #1, Bremen, KY 42325. 12-81-tf

MECHANICALLY INCLINED INDIVIDUALS: Assemble electronic devices in your home. Knowledge or experience not necessary. Get started in spare time. Turn your spare or full time into cash. NO investment. Write for free details. **ELECTRONICS DEVELOPMENT LAB,** Box 1560ES, Pinellas Park, FL 33565. 5-82-tfn

LEARN TO REPAIR ATARI'S: Did you know that more than 2 million Atari Home Video games have been sold and that most of them are now out of warranty? Why not learn how to repair these games and expand your shop's earning potential. At Electronic Institute of Brooklyn we have put together a Video Taped course for the T.V. technician which will take the mystery out of repairing Atari games. These repairs can be done using equipment you probably already own. Included in the course are the video tape, schematics for the two different boards, technical literature for the IC's, and a list of sources for replacement parts. We have condensed months of research into a neat package that will enable you to start repairing Atari's right now! Our course is available on VHS or Beta system tapes. For more information or to order CALL TOLL FREE 1-800-221-0834 or (212) 377-0369. Electronic Institute of Brooklyn, 4823 Ave. N. Brooklyn, N.Y. 11234. 7-82-6t

BEAUTIFUL MONTEREY PENINSULA, Busy, successful repair shop for sale. Fixtures, parts, Sams, tools, equipment, contracts, lease. Priced 'far below' investment. (408) 899-1688 10-82-3t

TV-VIDEO SALES & SERVICE. Established over 20 years in growing Chicago suburb, Gross $70,000. Low rent and utilities, main street location, inventory, equipment and service van included, $20,000. (312) 231-1310. 10-82-1t

DEALERS EARN EXTRA PROFIT selling cable TV converters, Video accessories and other great items in our brand new dealer catalog. Request a FREE copy on your letterhead. ETCO, Wholesale Division, Dept. 535, Box 840, Champlain, N.Y. 12919. 9-82-12t

TV REPAIR SHOP in Mid-Tennessee showing good profit. owner will train or stay on split. Terms available. Electronics Servicing & Technology P.O. Box 12901, Dept. 100 Overland Park, KS 66212. 10-82-1t

HIGH PROFITS – LOW INVESTMENT: with our CRT rebuilding equipment. Complete training and technical assistance. Guaranteed result. Atoll Television, 6425 Irving Park, Chicago, Illinois 60634; PH. 312-545-6667 8-82-3t

NORTHWEST SIDE CHICAGO TELEVISION REPAIR BUSINESS. Good neighborhood-full stock of parts and test equipment including truck. Bachelor apt. Included. $27,500. Or pay 6.9K down and $139.00 per week. After 48 months its all yours. 312-685-2772. 10-82-1t

Wanted

WANTED FOR CASH: 53, 7F7, 7N7, 6AF6, 6HU8, 304TL, 4CX1000A, 4-1000A, all transmitting, special purpose tubes of Eimac/Varian. DCO, Inc., 10 Schuyler Avenue, North Arlington, New Jersey 07032, Toll Free (800) 526-1270. 5-82-tfn

WANTED: $1.00 for Sams Photofacts number 1300 and later and MHF series. Write Mr. Russell; 112 North Turner; Fairbanks, AK 99701. 9-82-2t

NATIONAL SALES MANAGER
Greg Garrison
P.O. Box 12901
Overland Park, KS 66212
Phone: (913) 888-4664

LONDON, ENGLAND
John Ashcraft & Co.,
John Ashcraft
12 Bear Street, Leicester Square
London WC2H 7AS, England
Phone: 930-0525 Telex: 895-2387

AMSTERDAM, Holland
John Ashcraft & Co.
John J. Lucassen
Akerdijk 150A
1171 PV-Badhoevedorp, Holland
Phone: 0-2968-6226 Telex: 18406 HARKE NL

TOKYO, JAPAN
International Media
Representatives, Ltd.
Sumio Oka
2-29, Toranomon 1-chome
Minato-ku, Tokyo 105, Japan
Phone: 502-0656

NORWOOD, AUSTRALIA
Hastwell, Williamson, Rouse PTY. LTD.
P.O. Box 419
Norwood, S.A. 5067
Phone: 332-3322
Telex AA 87113

TAIPEI, TAIWAN, R.O.C.
Antony Liu
Long Life Advertising Agency Co.
P.O. Box 17-134
Taipei, Taiwan, R.O.C.
Telephone: (02) 561-6629
Cable: Photop Taipei

ADVERTISERS' INDEX

Don't touch that connection!

New Zenith push-button VIDEO ORGANIZER permits switching from one program source to another without changing cable connectors. Lets you select up to six different program sources for viewing. Up to three different sources for recording. Even lets you view one program source while simultaneously recording another. All this without changing cable connections!

Model S10V1

At last the nuisance of manually changing cable connections is a thing of the past.

With Zenith's new Video Organizer, separate input and output jacks enable you to make a complete connection of TV and VHF antenna or cable TV antenna, subscription TV decoder, video disc player, video cassette recorder, video game and home computer or other auxiliary video equipment.

So you switch from one program source to another with pushbutton ease – without changing connections.

Equally important, the Video Organizer's advanced engineering design by Zenith results in low insertion loss and high isolation. Eliminates electromagnetic interference for maximum picture quality. And permits greater flexibility in use and ease of operation for more hours of uninterrupted home video enjoyment.

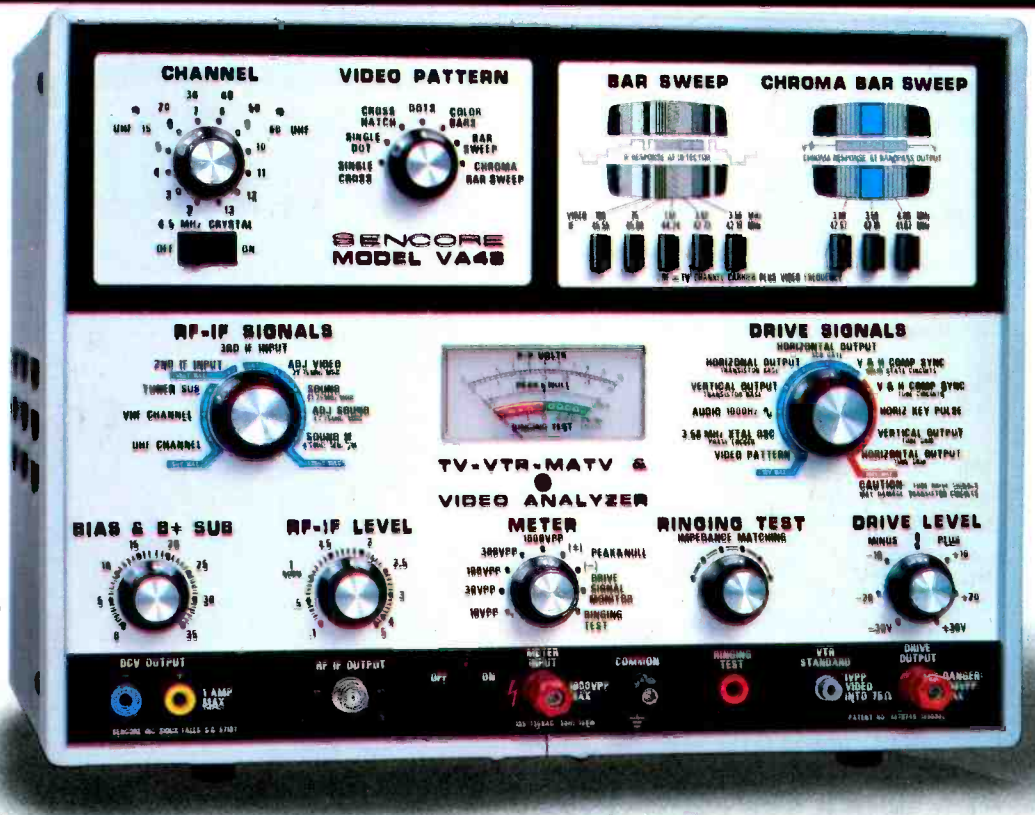
Write now for more information!

ZENITH®

The quality goes in before the name goes on.

Zenith Radio Corporation/Service, Parts & Accessories Division/11000 Seymour Avenue/Franklin Park, Illinois 60131

Now Cut Your TV-VCR Service Time Absolutely In Half.



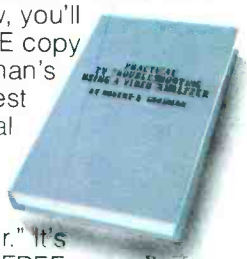
$1395

Cut your time in half. You WILL cut your service time in half with a Sencore VA48 Video Analyzer. Over 1500 VA48 owners nationwide report an average time savings of 54%! These techs quickly and easily learned the VA48's Signal Substitution Method of troubleshooting. It's the key to DOUBLING your service output.

Signal Substitution is the key. Our double-patented Signal Substitution Method lets you inject known good signals from the VA48 into any stage of a TV or VCR. If you get a good picture, you know everything is working from that point forward. You back up stage by stage until the defect appears on the screen. You then know you are injecting into the defective stage. It's just that simple, and only the VA48 provides ALL signals necessary to inject from antenna to CRT. It literally cuts your service time in HALF.

Join the thousands . . . 22,000 VA48 users know this video analyzer is the new standard of the industry. So do manufacturers who are specifying the VA48's patented Bar Sweep patterns on their schematics. Look in Sams Photofact schematics. The VA48 Bar Sweep is there, too.

Money back guarantee. We're so sure you'll cut your TV-VCR service time in half, we offer your money back in 30 days if you're not absolutely satisfied. PLUS, when you order now, you'll receive a FREE copy of Bob Goodman's new $18.95 best seller, "Practical TV Trouble-shooting With A Video Analyzer." It's yours to keep FREE regardless.



Call toll-free. Call now to order or to talk about the VA48 features with a qualified Sencore enginerring representative.

SENCORE

3200 Sencore Drive, Sioux Falls, SD 57107 605/339-0100 TWX: 910-660-0300

For More Information or To Order Phone Toll-Free **1-800-843-3338**

In Alaska, Hawaii, and Canada, phone collect: 605/339-0100

For Information Circle (2) on Reply Card
For Demonstration Circle (3) on Reply Card