ET/D

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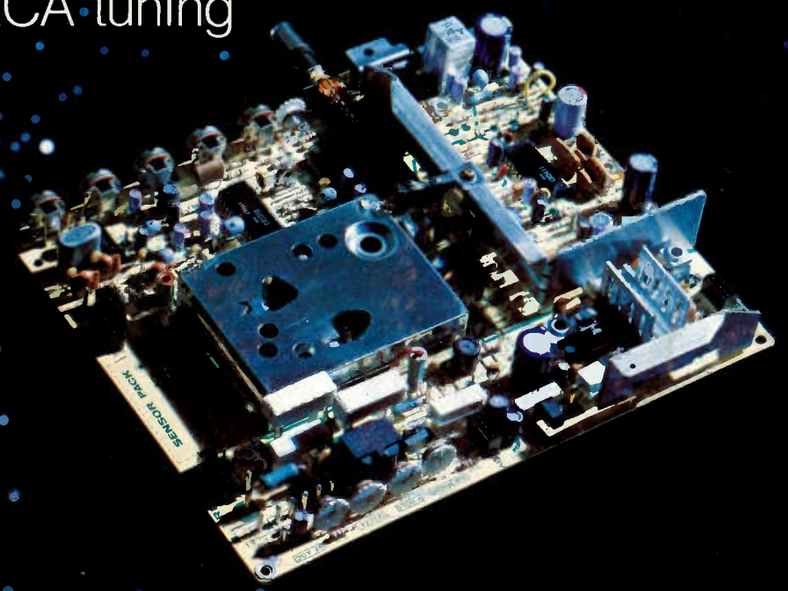

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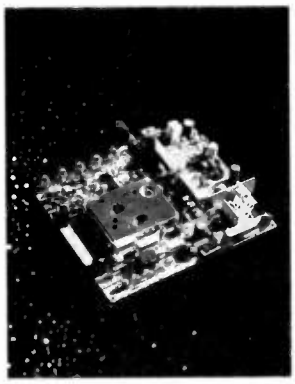
SEPTEMBER 1978, VOL. 100, NO. 9



On the cover:
Symbolizing state-of-the-art electronics technology which comprises today's modern television chassis design is Quasar's ultra compact "Dyna-Module" for 1979. *(Cover photo courtesy of Quasar Electronics Company)*

FEATURES

DEPARTMENTS

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INDUSTRY REPORT

ET/D Names Schwartz Managing Editor

Walter H. Schwartz, 42, owner and manager of Braham Electronics, Braham, Minn., has been appointed Managing Editor of Electronic Technician/Dealer magazine.

Schwartz, who for the past seven years has operated a one-man electronics sales and service business, brings to his new position a well rounded and extensive background in servicing

virtually all types of consumer electronics equipment, including television, stereo, C.B., audio and microwave ovens.

He holds a bachelor's degree from the University of Minnesota (1961) in history and political science and has graduate school credits in library science and journalism. He began the formal study of electronics in 1953 at Dunwoody Institute, Minneapolis, from which he graduated two years later.

In his new position Schwartz will be based in Duluth, Minn., where he will be responsible for coordinating all production efforts. In addition to these duties, he will be contributing articles to ET/D on a regular basis which will deal with either the technical or business aspects of an electronics service business.

Adapt to Change or Die: Liska

VIZ Marketing Director Robert J. Liska, in a talk before Georgia electronic service technicians, has warned that adapting to technological change is essential.

Not only is such change essential for continued growth and operations, but it is inevitable to survival and can lead to more and greater profits.

Citing the greatly reduced need for service on solid state televisions, Liska warned that "adapting to change is a matter of do or die. On the other hand the growing opportunities in other areas of service are becoming more attractive," he said.

Liska urged service companies to secure periodic service contracts in order to provide a leveling of income and a smoothing out of the work load and sales curves.

Technology, its rapid growth, is another major factor now impacting on every electronics service technician in the country. "You don't need to understand programming to test a power supply or a circuit board," Liska said, but it is essential that every technician have a solid grounding in digital technology.

Liska said areas which offer particularly attractive opportunities are data communications (especially home computers), voice communications, security systems, and video recording equipment.

NARDA Business School Dates Set.

The National Association of Retail Dealers of America has announced the dates of its annual four-day schools of Service Management.

John Gooley, Manager of NARDA's Service Division says the schools will be held this February on three college campuses in the east, midwest and west. The year's sessions, according to Gooley, will be held Feb. 4-7 at Arizona State U., Tempe; Feb. 18-21 at Notre Dame; and Feb. 25-28 at the University of Maryland, College Park.

NARDA has been conducting schools of service management in conjunction with major universities for more than 20 years to determine the methodoligies of operation of a service management shop. NARDA also conducts annual Costs-of-Doing-Business surveys as well as maintaining computerized records of actual service businesses with an eye toward analyzing service business operations from a financial manager's point of view.

Further information may be obtained by writing NARDA, 2 North Riverside Plaza, Chicago, Ill., 60606.

RCA, GE Show High Second Quarter Gains

RCA's second quarter earnings set a record and General Electric's first half results did likewise with all operations showing a gain.

According to financial statistics released by the two electronics industry giants, RCA's second quarter net income was up 12 per cent from a year earlier to $78.3 million while GE's second period earnings rose 17 per cent to $319.4 million.

According to news statements re-

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leased by the firms the consumer electronics products and services divisions took part in the general advance which was registered.

GE's Reginald H. Jones said consumer products and services continued to show "good gains," while RCA's Edgar Griffiths said the RCA Service Company was among eight divisions and subsidiaries showing new high results for the reporting period.

Additionally, Griffiths said, "Heavy world-wide demand stimulated a strong showing by RCA's color picture tube manufacturing, which operated at full capacity and advanced in sales and earnings."

GTE to Develop "Flat Panel" Television

General Telephone and Electronics Corporation has announced plans for a concerted research effort to develop large screen, flat panel, color television. It should be ready for consumer consumption five to 10 years from now, according to GTE estimates.

Announcement of the project comes just a month after Sharp Electronics Corp. showed its 6-inch, flat panel "black and yellow " television set at the Summer Consumer Electronics Show in Chicago. GTE said it has signed a three year contract with a Chicago based research organization, Lucitron, Inc., for development of the flat panel color screen.

Lucitron, GTE reports, is a research firm founded by three scientists formerly associated with the Zenith Radio Corp., which cut back drastically on research and American based production facilities in an economy move late last year.

According to a GTE spokesman, Lucitron is headed by Joseph Markin, president; Dr. Alan Sobel, vice president for operations; and Michael DeJule, vice president of research and development. The group has extensive experience in flat panel technology and will be working in close conjunction with GTE Laboratories in Waltham, Mass., and with Sylvania television and picture tube engineers in Batavia and Seneca Falls., N.Y.

According to George Konkol, president of GTE Consumer Electronics Group, which has worldwide responsibility for the development of new concepts in television; "Our objective is to develop the technology capable of providing flat, thin displays suitable for use in large-screen color television and other commercial applications." A working system should be available on a research basis in three to five years GTE spokesmen report, with commercially available systems entering the consumer market anytime five to 10 years hence.

Industry Marks 11% Expansion

Electronics was a $46 billion industry last year, up 11 percent (or $5 billion) from the previous year, according to statistics contained in the Electronic Industry Association's 1978 Electronic Market Data Book.

Published annually by EIA, the data book contains figures on consumer electronics, communications and industrial products, government electronics, electronic components and related information on world trade.

The current edition is available by writing EIA's Marketing Services Dept., 2001 Eye St., N.W., Washington, D.C. 20006. The cost is $15 for EIA members and $25 for non-members.

VCR Sales Figures Released

The Electronic Industries Association has added a new category to the statistics it reports on each month. For the first time in history EIA has added "sales to dealer" figures on home video cassettes and tape recorders.

According to Charles Hoffman, of the EIA/consumer Electronics Group, this category will be included from here on in EIA's regular monthly sales-to-dealers reports.

EIA has for many years reported on the sales-to-dealers of television sets, audio products and radios. ETD

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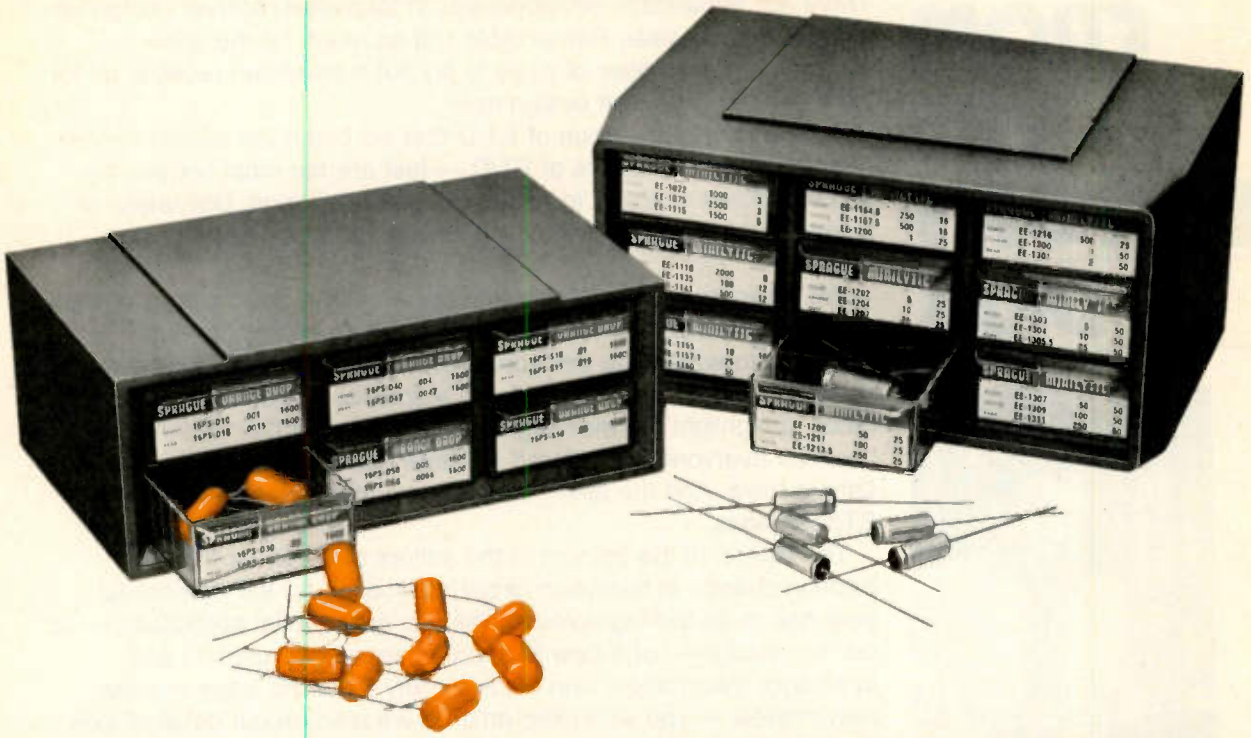

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FROM THE EDITOR'S DESK

There are remarkable developments in television receiver design for the 1979 model year. Remarkable just as much for the sheer variation in the number of ways to lay out a television receiver as for the innovation in circuit design itself.

Thus it is with this issue of ET/D that we begin our annual review of what we — the editors of ET/D — feel are the most noteworthy and significant changes in television receiver design. Ultimately, of course, such design changes will have an impact on you at your bench.

We begin our annual "television issue" with a basic survey of the chassis innovations which have thus far been brought to our attention. In addition to this survey article, each issue during the next several months will concentrate on a specific manufacturer in greater detail to highlight the most significant changes in the 1979 model line. Not everyone has offered significant changes in chassis design. Others have. And the latter, as such, are the ones to be featured in ET/D's pages.

The award, in the opinion of the editors of ET/D, for the most exciting change in television circuit application for the new model year has to go to Magnavox for the first commercial application — to our knowledge — of a new method for separating chroma and luminance information. Don't look for any 3.58MHz traps in these new models — you won't find any. So we lead off our detailed look at a specific manufacturer with Magnavox.

Zenith, on the other hand, has to get the award for the most drastic departure from previous standards for the placement of physical components. Their new "Systems 3" modularized receiver in effect has no chassis at all and is designed with 25 per cent fewer components.

At the other extreme we have Quasar out with a single board chassis that is 30 per cent smaller than anything they have offered up to this time, and, G.E. has become the first American manufacturer to offer a large screen projection color TV system in a single, compact unit.

As I said, it is a remarkable year for receiver design. I hope you find our annual television issue informative and useful. It is always a pleasure for ET/D to look around and see what is coming next in this high technology industry in which we find ourselves.

Sincerely,

Richard W. Day

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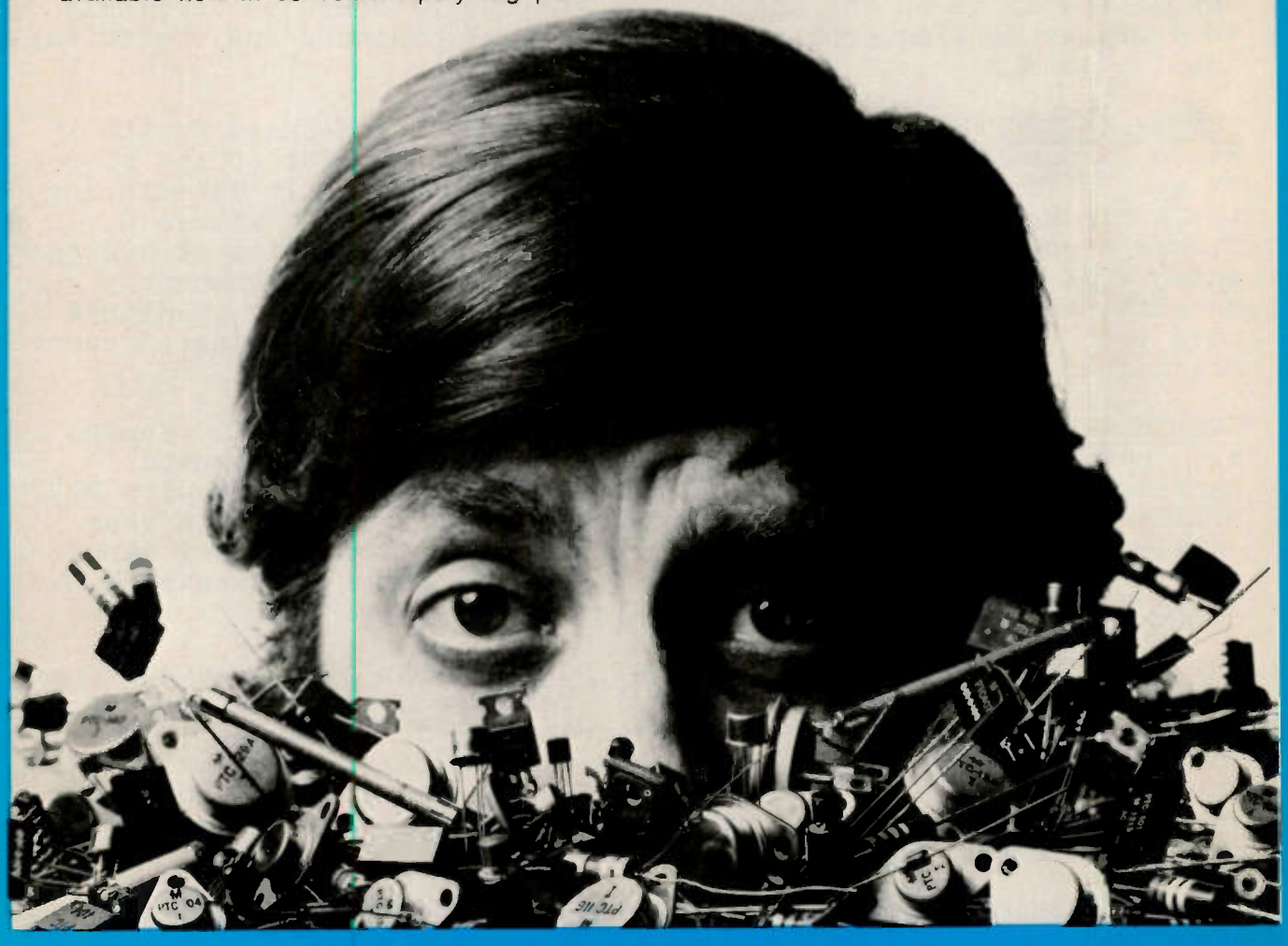

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NEWSLINE

NEWCOM CHANGES NAME, EXPANDS TO FOUR DAYS. The 1979 NEWCOM show, the annual gathering of electronic industry distributors and manufacturers, will return next year to Las Vegas, but with a different name. The show, scheduled to become a four-day event for the first time, has been renamed the Electronic Distribution Show to emphasize its general nature and purpose. NEWCOM, which stood for "new communications", too many times has to be explained to newcomers to the show, according to insiders. The 1979 show dates, incidentally, are May 1-4, which is Tuesday through Friday.

EICO FORMS NEW DIVISION. EICO Electronic Instrument Company, a well known name in electronic instrumentation for decades, has formed a new company--EICO Data Products. The new firm will specialize in the marketing and distribution of computer terminals. According to Linda Ashley, the chief executive of EICO Data Products, the primary emphasis will be on the application and use of computer terminals to everyday working problems faced by small business and educational institutions.

ZENITH ENTERS AUDIO COMPONENT MARKET. The Chicago-based Zenith Radio Corporation, which pioneered in the development of the stereo FM system finally adopted by the FCC, has announced it is entering the audio component market. Executive Vice President Walter C. Fisher reports Zenith will offer consumers a wide choice of systems which will include stereo receivers, record turntable/changers, cassette tape units, and new high performance speakers. Zenith's move into the audio components market was announced during a recent meeting of its distributors.

ZENITH ANNOUNCES REDUCED FINANCIAL RESULTS; NEW CRT LINE. Zenith also has reported that its first half results for 1978 showed earnings of $6.7 million, or 36 cents per share, compared with $13.5 million, or 72 cents per share, for the comparable period a year earlier. Meanwhile, Zenith says it plans on entering a new market area, industrial computer CRT displays. The first shipments of the 12-inch monochrome CRTs are scheduled for October.

RCA CHASSIS RECEIVE NESDA/ISCET RATINGS. A team of inspectors from NESDA/ISCET graded three RCA chassis for "serviceability" during a recent RCA training session for distributors in Las Vegas. According to an ISCET statement, the three chassis rated were the CT92A, which received a "good"; and the CTC93D and the CTC88AC, both of which received "excellent" ratings. The possible rating grades are excellent, good, fair, and poor, according to ISCET.

EUROPE'S CONSUMER ELECTRONICS MARKET SLOWS. The market for consumer electronics products in Western Europe, at $12.5 billion this year, will show only a four per cent growth rate over the next 10 years, according to a study just released by Frost & Sullivan, Inc. Surprisingly, however, the market research report indicated that certain categories are expected to show "vigorous growth", one such category being radios which are expected to post a 31 per cent market gain by 1985. The overall European consumer electronics market is expected to total $16.6 billion by 1985, Frost & Sullivan reported.

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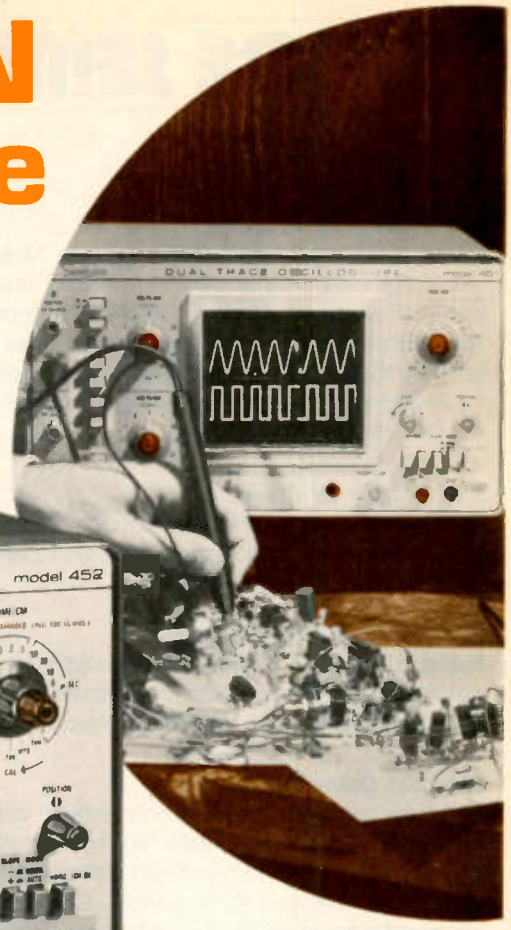

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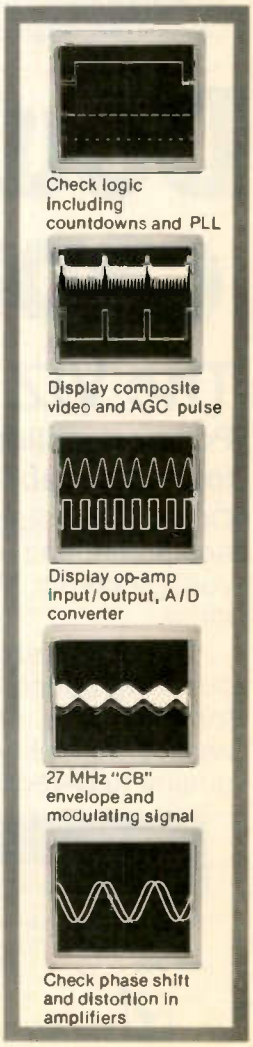
- Human-engineered front panel controls



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EDITOR'S NOTE: *We have had reports of these chokes opening in other areas of this and other chassis causing various trouble symptoms.*

GTE SYLVANIA

E21-9 Color TV Chassis.
Heavy black line on right side of picture. Most noticeable on weak channels, very obvious on unused channels. Extends into UHF channels. Varies in intensity with channel change. Most noticeable when using set antenna. Being picked up on antenna. Cause: Q400, horizontal driver radiating; set had GE 13-39098-1 in it (tan color). Changed to another type (black), not GE, eliminated problem.

E21-3 Color TV Chassis.
Overload on strong signals, sync touchy when medium signal tuned. Okay on fringe signals. Cause: T220—½ of primary open.

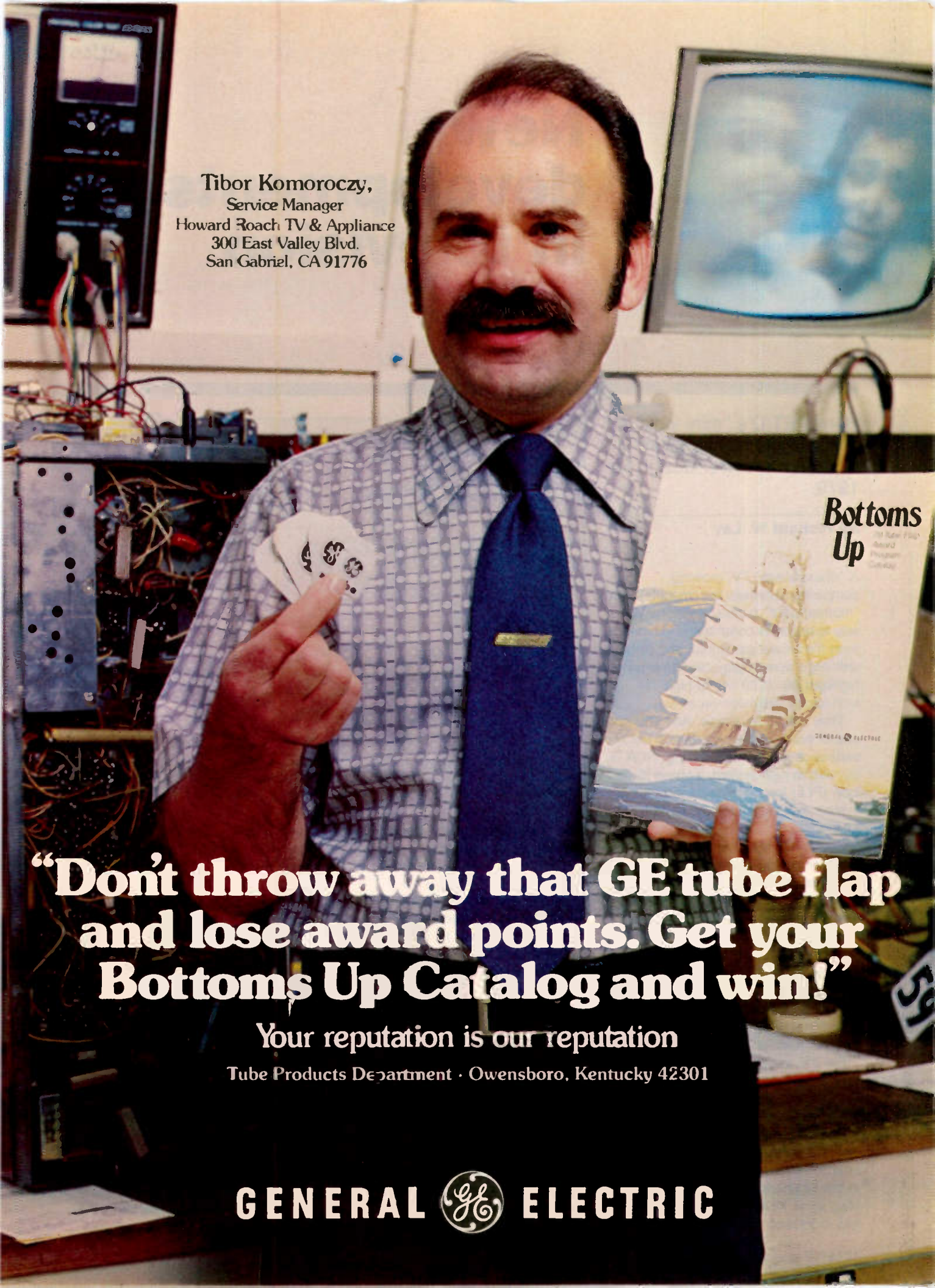
E210307 Color TV Chassis.
Red and blue bottom vertical lines would not converge. Tuning control only covered bottom of picture to fold up. Cause: SC808 breaking down with load. Checked okay out of set.

E20, E21 Color TV Chassis.
Full color control setting has only enough color to see a difference from black and white. Voltage check in the chroma circuitry uncovered no significant discrepency. All active devices were changed to no benefit. Checking with a scope showed the presence of all waveforms but with little amplitude. Cause: L605, 33μH choke open.

MAGNAVOX

T979/T989—Resistors inside CRT socket.
A ½-watt resistor (apprx. 2K ohms) is connected in series with each of the CRT pins (except filaments) to prevent damage from CRT arcs. These resistors are located inside of the CRT socket assembly. If one of these resistors becomes intermittent (open), it may result in a picture complaint. For example, if the resistor connected to the CRT focus pin should fail, you may observe intermittent focus. If any intermittent picture condition is encountered, check these resistors and replace any defective ones with resistors of comparable value and wattage or replace the entire CRT socket assembly, part No. 180935-2 (T979 chassis) or 180935-3 (T989 chassis).

T991 TV Chassis—No video with sides of raster pulled in.
These symptoms may be the result of an activated HV limiter circuit on the Horizontal Oscillator/Driver module. The HV limiter circuit monitors the DC supply voltage to the horizontal output circuitry. This DC level determines the HV level. When the DC supply surpasses a predetermined point, the HV limiter circuit causes the horizontal oscillator to increase drastically in frequency. The visual results on the screen are: sides of raster pulled in, no video, vertical retrace lines, and sound OK. The circuit will not reset until the malfunction has been corrected. CAUTION: The HV limiter circuitry is factory tested and must never be serviced. If a malfunction is suspected, replace the Horizontal Oscillator/Driver module. ETD



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GENERAL ELECTRIC

New developments in television

For 1979

Here's ET/D's "mini look" at some of the highlights in television receiver design for 1979.

By Richard W. Lay

A "chassisless" TV, growing competition between the "modular" and "motherboard" purists, a visionary new way to separate chroma and luminance from the broadcast signal, and single unit large screen projection television, highlight the 1979 line of high technology television receivers.

They are all here now. And you can add to this the continuing march toward saturation in electronic tuning. RCA is out with its new system, a phase locked loop (PLL) frequency synthesized system that eliminates the need for fine tuning.

Zenith has made the scene with a modular design connected via cables, and thus has effectively produced the first "no chassis" television. Its new sweep generation system also has resulted in the elimination of the horizontal and vertical controls—again through the use of PLL control.

Quasar and RCA, meanwhile, are out with what essentially amount to single board chassis to effectively confront the Zenith "modular" philosophy.

But the award for the 1979 model year's most significant advance in TV theory application goes to Magnavox for developing a new system for separating the chroma and luminance information from the video signal. The result has been the elimination of the 3.58MHz trap in the luminance channel of high end Magnavox 19 and 25 inch sets and this has increased the resolution and fine detail (vertically) in high frequency luminance information.

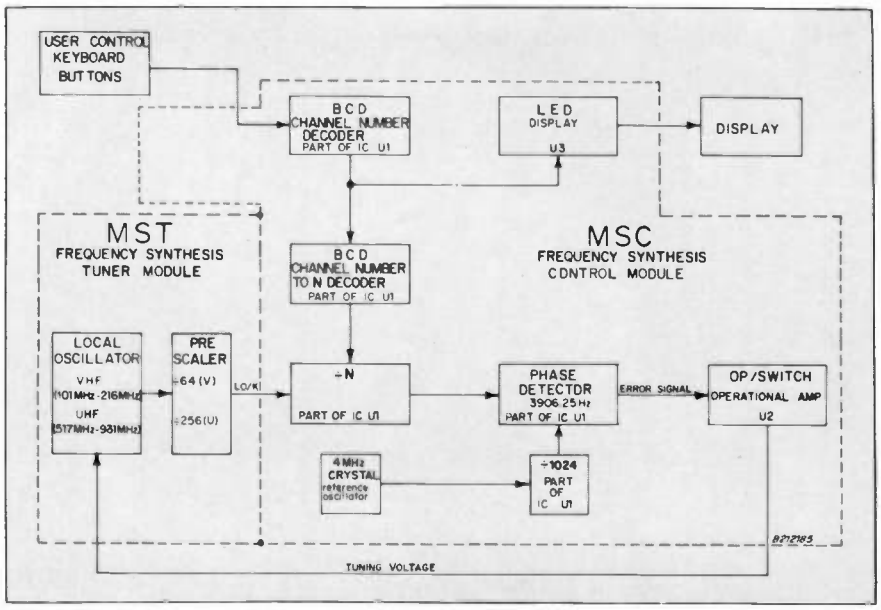


Fig1–Block diagram of RCA's phase locked loop controlled frequency synthesis sytem.

RCA

RCA reports that it is continuing its emphasis on reduced energy consumption levels. Its color television line now varies in average energy use from 69 watts for a small portable model to 113 watts for a large remote controlled console, the company reports. In addition, its black and white sets use less than 50 watts of power.

However, the new electronic tuning system, featured in the CTC92 (25-inch) and the CTC91 (19-Inch) chassis, plus the CTC87 one-module chassis, are the major changes in RCA for 1979. The tuning system, called "ChanneLock" by RCA, eliminates the need for fine tuning through the use of large scale integration ICs which develop a frequency synthesized, PLL-controlled form of tuning. This tuning system will be available on all 27 ColorTrak Receivers, RCA reports, including three 19-inch models.

Both the CTC92 and 91 utilize 10 modules which contain nearly all chassis circuits. The CTC92 also uses an advanced solid state voltage regulator circuit which enables it to operate over an AC range of 105-to-135VAC.

The MDR 001A regulator module employs five transistors in a comparator and oscillator circuit to provide control of an SCR that switches regulated 114DC to the horizontal output stage on a duty cycle basis. The module, RCA emphasizes, is factory adjusted and is not serviceable.

The electronic tuning systems incorporated into the CTC92 and 91 chassis contain two separate modules—the frequency synthesis

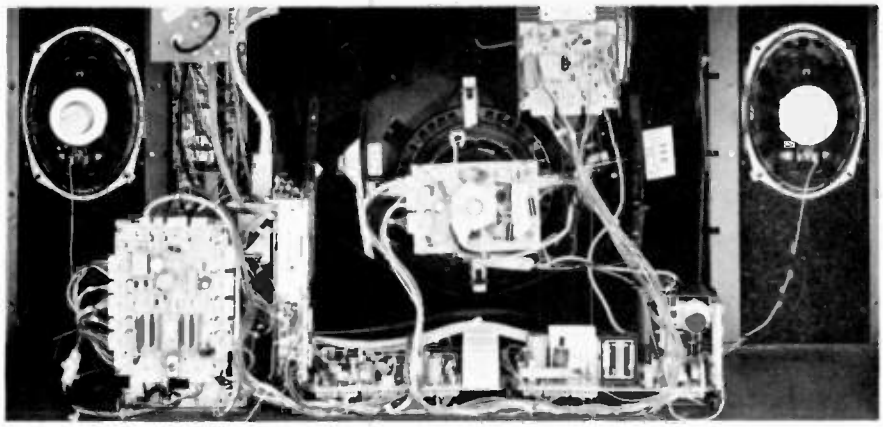
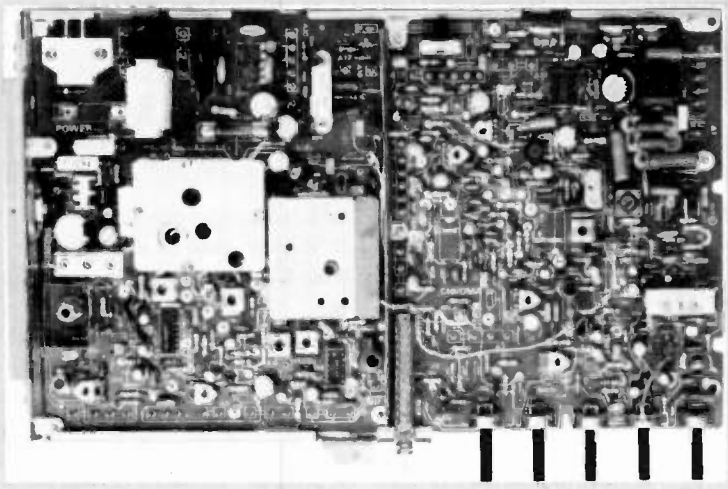


Fig 2–Zenith's System 3 "chassisless" configuration, showing placement of modules and interconnecting cables.



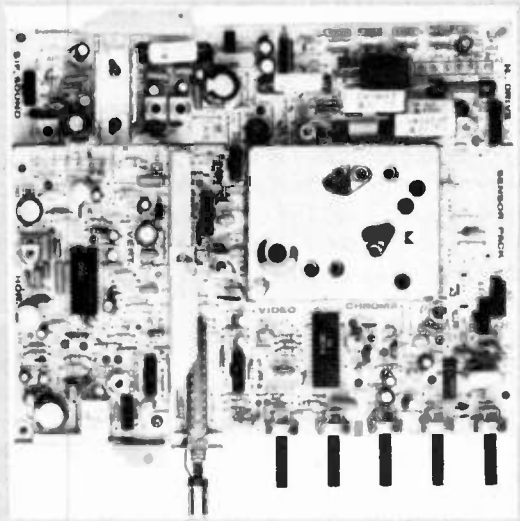


Fig 3–Quasar's 30 per cent smaller "Dyna Module" chassis, right, compared with its predecessor.

control module and the frequency synthesis tuner module (see illustration).

The control module utilized three LSI chips. One accepts channel change commands, decodes them into binary coded decimal form, and then applies them to a programmable counter which produces a frequency. This frequency is compared to a reference, and the difference frequency is used to control the second (frequency synthesis) tuner module. This module, according to RCA, is a highly refined version of its predecessor, the combined VHF/UHF varactor controlled tuner.

CTC87

The CTC 87 is of the "U" type construction, a previously used concept. It features one main module, the MCK002A IF/AFT, and four printed circuit boards. These five elements contain all circuitry except the horizontal output stage.

RCA reports the module contains the IF/AFT, AGC and sound detector functions, PW600 is the B+ Regulator and Horizontal Centering circuit, PW3000 (main) circuit board handles video processing, luminance and chroma, sound processing, the vertical oscillator and deflection, and horizontal oscillator and drive circuits, as well as the derived operating power supply circuits.

Another board, PW3700, contains AC input circuitry, degaussing and the +150VDC nonisolated rectifiers, while PW5000 contains video output circuits and the picture tube socket.

Additionally, there is a new type integrated high voltage transformer on this chassis and special start up circuitry for the horizontal oscillator and driver stages. RCA derives voltages for these from the high voltage transformer secondary winding. However, a special start up circuit is required. Once the horizontal' output circuit is operable, the necessary low B+ (27-and-22VDC) for sustained operation of the horizontal oscillator and driver stages are derived from the high voltage transformer secondary windings.

Zenith

Zenith has come up with what it terms a "new concept" in television chassis design, if chassis is what you want to call it. In effect the new modular system, termed "System 3" by Zenith was first introduced in some late "J" Line receivers and features a main "chassis" of plastic brackets which support the vertical modules.

All interconnections between modules are accomplished via cables and edge connectors that are appropriately labeled. Zenith reports the new design carries eight separate modules, each containing related circuits. The new design has permitted engineers to reduce component parts by 25 per cent and to reduce the number of interconnections, a major repair problem in modular sets, by as much as 60 per cent.

Special features of the System 3 are the elimination of horizontal and vertical hold controls and the use of Zenith's Surface Wave Integrated Filter (SWIF). This solid state component replaces the three stage bandpass shaping IF network usually found in TVs, thus eliminating many of the coils and capacitors found in most conventional

tuned circuits.

Horizontal and vertical sweep rates are developed in radically different ways. Zenith reports a "master scan oscillator" operates at 32 times the horizontal frequency (at 503KHZ). This signal is divided by 16 on the vertical board and then by 2 producing the horizontal frequency of 15,734Hz. This signal is a square wave ready for input to the horizontal pre-driver stage. This pre-driver drives the horizontal output transistor.

The output of the 32H clock oscillator is controlled by a phase locked loop circuit which samples the incoming horizontal sync pulses.

This system eliminates the necessity for either horizontal or vertical hold controls since all the frequencies are generated by the PLL controlled clock oscillator. And, Zenith says, this system performs equally well on non-standard as well as standard sync signals. "Non standard signals normally do not include equalizing pulses during the vertical interval but the system is designed to recognize this situation and still remained locked in."

System 3, Zenith says, is featured in four 19-inch and 28, 25-inch models. Zenith also has included electronic tuning in 80 per cent of its 1979 models. The 1979 color line, Zenith says, has models in five screen sizes, 13, 17, 19, 23, and 25 inch.

Quasar

Quasar for 1979 is out with a significantly reduced size chassis (see figure 3). It is 30 per cent smaller, contains fewer discrete components, and will be used in some of Quasar's 25-inch and 19-inch models.

The TS967, 19-inch, which also carries a newly added Vertical Interval Reference (VIR) module called "Dynalock" by Quasar, corrects distortion problems resulting in the broadcast signal (see figure 4).

The reduced size chassis, named "Dyna-Module" by Quasar, uses six newly designed integrated circuits to reduce the number of interconnections, wiring, and discrete components. There is less to go wrong with this fully field replaceable chassis, Quasar contends. Quasar is continuing with its previously introduced Dynabrite and Audio Spectrum (three speaker) Sound system.

The VIR circuit is contained on a separate module and its connection to the main circuit board is via three plug on cables. This module contains one 24-pin dual in-line IC, a transistor and the VIR

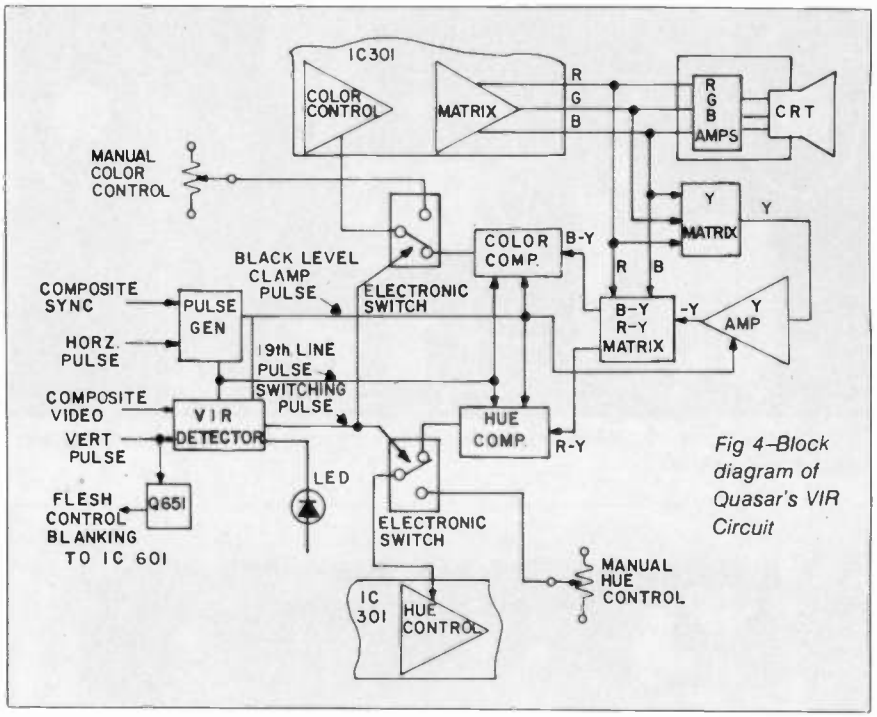


Fig 4–Block diagram of Quasar's VIR Circuit

circuits. This IC requires horizontal, vertical, video, R-Y and B-Y signal inputs to properly detect chroma and bust signal phase relationships.

Magnavox innovation

Magnavox (see related article this issue) has come up with a truly unique system to the television industry for developing its luminance and chrominance signals. Using the principle of a "Comb Filer" this method effectively extends luminance channel bandwidth flat up to 4.2MHz through the elimination of the 3.58MHz trap in the luminance channel.

Also, chroma information is more effectively filtered out of the luminance channel, and vice versa. The effect is a much higher vertical detail in high frequency luminance and the elimination of "color barberpoling" effects that often can be seen in fine detail black and white pictures. This feature is being added as a customer option to its new 19 and 25 inch chassis, the TS809 and TS815.

Also noteworthy from Magnavox for 1979, is the color/contrast/brightness system they are using. All three are tied together and they work to maintain proper color/contrast/brightness levels with one-button tuning. Essentially what happens is that as the customer turns contrast and color content picture control of his picture to a higher level, the brightness level is reduced.

Magnavox has introduced two small screen color television models. One, the BJ4010 is a 9-inch AC/DC operated portable and the other a 10-inch which features pre-set color and tint controls which limit the customer color and tint range variation to some 30 per cent of their total variability.

Sony

Sony has introduced 11 new Trinitron models which include remote units of screen sizes from 21 to 9 inches and non-remote from 19 to 12 inches. Sony says its new I-2 chassis is designed with service in mind, that only three screws must be removed once the back of the set is off to slide the chassis out to the "service" position.

The I-2 contains a newly modified horizontal section, which is basically a simplifed (from previous versions) and straightforward scan rectified operation. It produces +135VDC off a bridge rectifier.

The horizontal output circuit in the I-2 is multifunction. It provides low B+, a boost voltage, high voltage and CRT filament voltage. However, the main function, Sony says, is to develop the horizontal deflection current utilized by the deflection yoke.

Also, a pedestal clamp has been added for DC restoration and better reproduction of dark, contrasty scenes.

Improved convergence circuitry is also a mark of the chassis, according to Sony, and the Trinitron Plus CRT, which is said to produce a 30 per cent brighter picture, has been added.

Sony's newest Trinitron Plus CRT is an improvement over its previous Trinitron. The Trinitron uses only a single electron gun with three (R,G,B) cathodes, a single control grid and a common screen grid. The gun assembly

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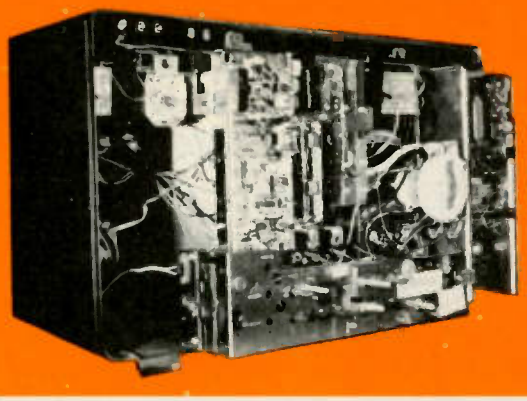

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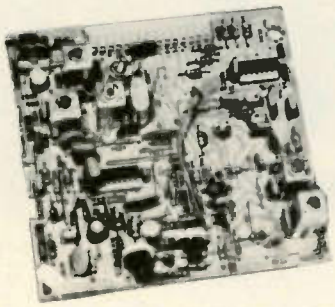

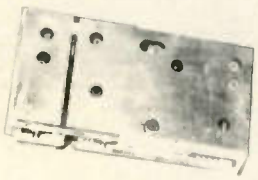

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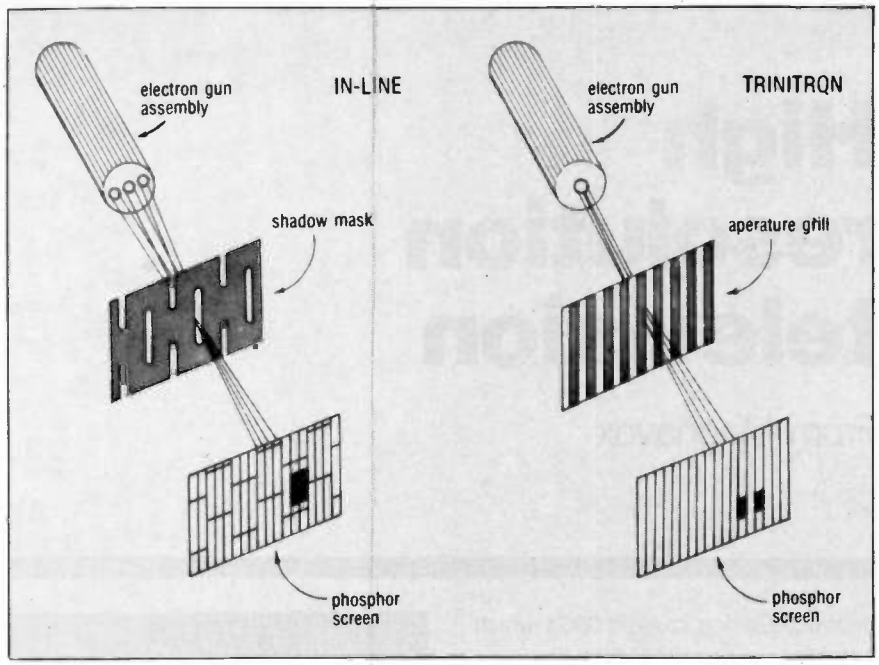

Fig 5–Comparison of the operation of an in-line gun assembly with that of Sony's one-gun Trinitron arrangement. Note shadow mask of the in-line assembly and aperature grill construction of the Trinitron.

of this CRT is relatively small in size because of the common "lens" assembly. The beam separation system of the Trinitron also employs an aperature grill system, rather than a shadow mask (see figure 6). This aperature grill, you will note, has only one vertical slot for every group of three primary colors. The benefit of this arrangement, Sony contends, is most of the electrons tend to strike the phosphor, as opposed to many being "lost" on the shadow mask.

In addition, new brightness levels are being achieved in this year's Trinitron Plus through the addition of black matrix type material between the vertical stripes to absorb more ambient light.

General Electric

GE's most striking development is in the large screen field this year. Its 1,000 square inch "Home Television Theater" projection system amounts to one completely enclosed unit. It's a rear projection unit that offers a viewing area about three times the size of a standard 25-inch color television. Significant in GE's projection system design, which uses a specially designed 13-inch "high voltage" CRT with 31.5KV on the anode, is the elimination of the separate projector usually associated with projection systems. This new GE unit is 70 inches long and 50 inches high.

Sylvania

Sylvania's introductions for 1979 include the Superset Plus models which, in addition to GT-Matic features, color correcting VIR circuitry contained on an additional module and automatic sharpness control circuitry, a new Sylvania exclusive.

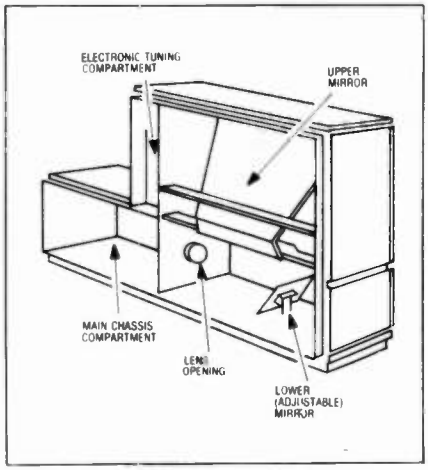

Fig 6–The cabinet assembly section which houses GE large screen 1,000-inch projection system television.

Sharp

Sharp Electronics has entered the 1979 television picture with seven new color models with screen sizes ranging from 19 to 9 inches. The line includes the 19-inch Automatic Signal Searcher System TV which automatically adjusts its tuning to any of 12 channels within its receiving range. The system searches for the best signal in the area for each channel, locks it in and permanently remembers it.

The unit is part of Sharp's newly introduced Sigma 2,000 chassis, which features increased reliance on highly integrated IC circuitry. ETD

High resolution television

From Magnavox

Here's a brand new way to process signal information that extends luminance channel bandwidth to 4.2 MHz.

By Richard W. Lay

Design Engineers for the Magnavox Consumer Electronics Company were obviously doing more than snuggling by a warm fireside last winter. And that's the gospel truth! Because what they have come up with this year in the way of new large screen television chassis shows the most innovative basic circuit design to hit the television industry in years.

In what is a break with traditional methods of processing picture signal information, Magnavox is offering a new high resolution picture option with its new T809 (19-inch) and T815 (25-inch) chassis with picture development circuitry built-in that extends high frequency response flat to 4.2 MHz—or up to 1 MHz beyond past industry capability since the development of color TV.

The T809 and T815 chassis are eventual replacements for the current T991 and T995. The high resolution capability, using "comb filter" technology to filter luminance and chroma information will be made available initially with Magnavox's Star System and Touch Tune models.

But, before we get into this new signal procedure, let's take a look at other Magnavox changes for 1979.

There is a 9-inch, AC/DC operable color chassis, Model BJ4010 being introduced, using chassis 09C1 which features four circuit boards—the signal board, the power and deflection board, the CRT board, and converter board.

Two line cords are supplied, one for use off the 120VAC line and the other from a 12 VDC source. The signal board contains three ICs which perform sound, luminance, chrominance, AFT, AGC and Sync functions. The converter board is used when the set is operated DC to convert the 12VDC to 116VDC for application to the horizontal output and audio circuits.

Another new model, BJ4020 on chassis 10C1, is a 10-inch color set featuring pre-set sub-color and sub-tint controls that work in harmony with the customer adjustable brightness, contrast, color and tint controls when the "auto" switch is "on." This feature limits the color and tint controls to about 30 per cent of their range. This set also has provision for 300 ohm UHF input and 75 or 300 ohm VHF inputs.

It's also a servicer's dream to get into. Six screws all that need to be removed to take off the back cover. Both the 9 and 10 inch models feature in-line CRT's.

Also new to Magnavox is LED channel readout display for its 25 and 19 inch color models. This feature uses two readout switches which attach to the VHF and UHF tuner shafts (Fig. 1). Multiple contacts within the switches are controlled by the position of the tuner shaft and a copper pattern etched on the PC boards within the switches opens or closes individual contacts to light seven-segment readout LEDs.

The T809 and T815 chassis

However, the big new changes from Magnavox for 1979 are reserved for its 19 and 25 inch models. Both use less power ... the 809 draws about 16 per cent less current than its counterpart, the T991, and the 815 about 24 per cent less than the T995.

Magnavox's new AC/DC color portable with 9-inch CRT

Here's a quick rundown on the newest features of the T815 and T809, as provided by Magnavox Service Training Specialist Ron Hughes at a recent training seminar in St. Louis. These are similarities between the two, we'll get into differences later:

—Comb Filter: Both are capable of processing the picture signal via the "comb filter" method for extended picture detail (frequency response). However, the comb filter module

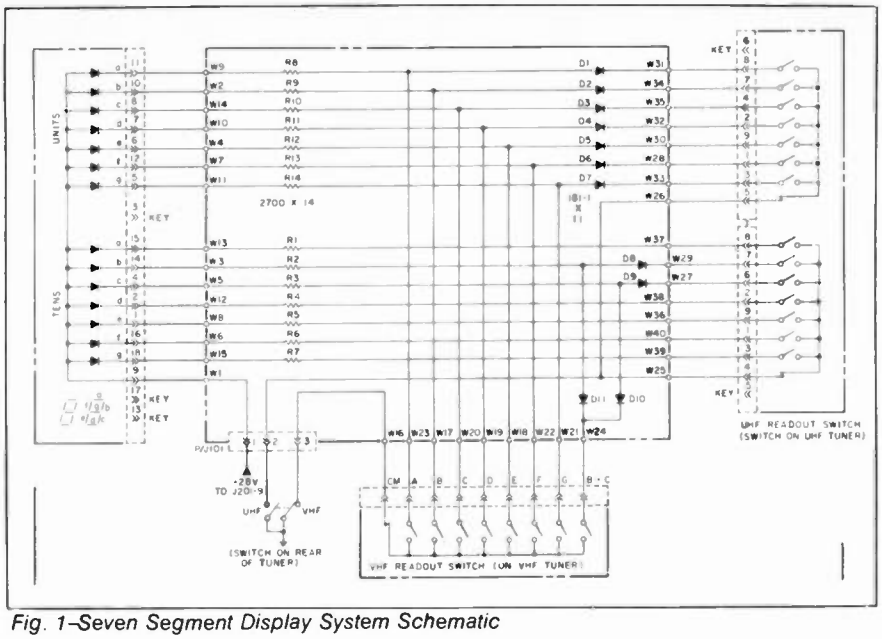

Fig. 1–Seven Segment Display System Schematic

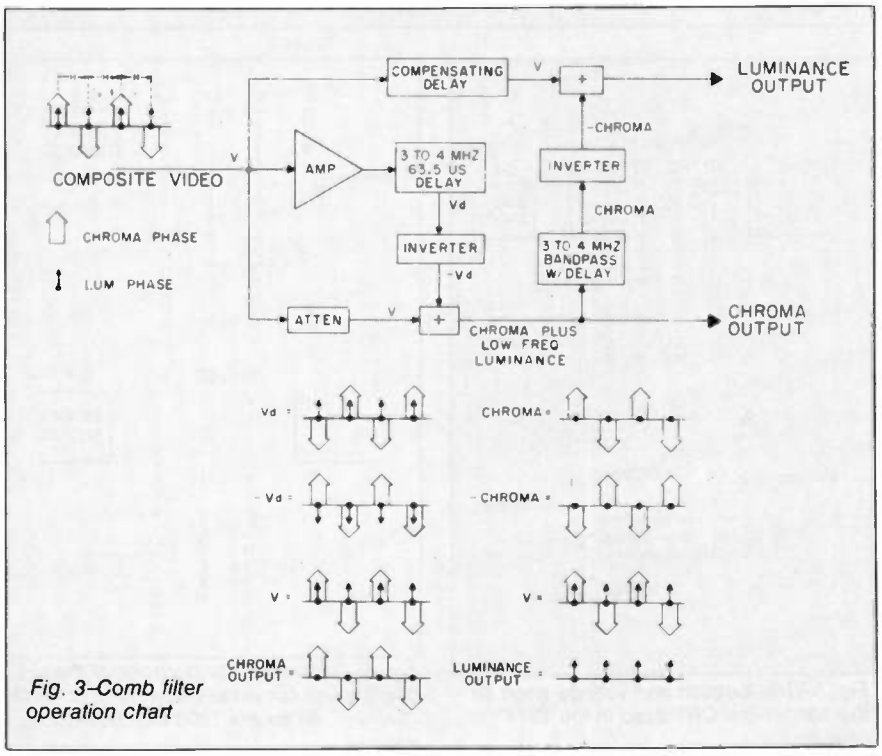

Fig. 3–Comb filter operation chart

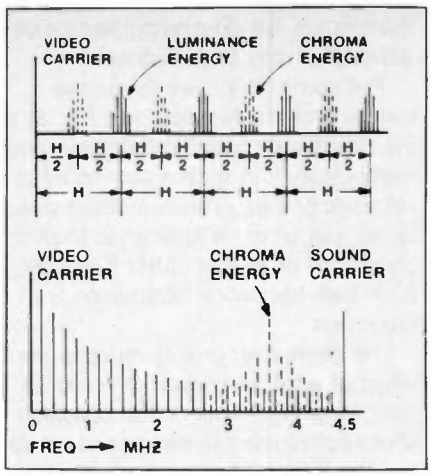

Fig. 2A–(Top) Chroma and luminance energy distribution 2B–(Bottom) Chroma and luminance interleaving

eliminates the normal 3.58MHz trap in the luminance channel, therefore models (some Star and Touch Tune) built for use with this special filter cannot be used without it, and vice versa.

—New auto contrast circuit which maintains proper levels and prevents washout; plus, it maintains stability from channel to channel.

—New automatic color level circuit which works independently of the transmitted color burst amplitude.

—And, the customer's "picture control" which varies color level and contrast level simultaneously. In addition, when picture contrast is turned down, brightness level automatically increases slightly to prevent gray intelligence from going black and being lost.

—New 100 degree deflection in-line CRT guns for sharper detail to compliment the comb filter system.

—The elimination of the vertical linearity controls.

—Elimination of automatic tint controls for more reliable color reproduction throughout the spectrum.

—And special "edge enhancement" circuitry. This feature controls preshoot and overshoot for more defined (less smeary) borders when changing from black to white.

The T809 contains fewer modules than any previous Magnavox modular chassis. There are 10 with the comb filter and nine without. The T815 has 12 or 11 modules. Seven of the modules are common to both chassis, they are the IF, Sound, Comb Filter, Low Level Video, Chroma, Vertical, and Horizontal modules.

In addition, Magnavox reports, the only modules interchangeable with the T991 or 995, are the sound modules.

Non-interchangeables are the power supply (the 815 has the familiar power supply sub-chassis which is brand new), RGB boards, the voltage regulator module, and the pincushion circuitry. The major differences are the regulating voltages, the high voltage development circuits, and the pincushioning circuits. The pincushion circuits in the 809 have been removed from the regulator module and it's now done magnetically—as opposed to electronicallly.

Also, the 815 carries a new tri-potential CRT.

The comb filter

But let's get to what you really want to hear about, the comb filter.

Comb filters are nothing new. They are basically bandpass filters that "pass" certain frequencies, 1, 2, 4, 8 times, etc., the base frequency, while frequencies of 1½, 2½, 4½, 8½, etc., times are blocked. (See Fig. 2 A & B.) Thus the term comb.

This special circuit is essentially a new way of separating the luminance and chrominance information and it eliminates the need for a 3.58MHz trap in the luminance circuit which in the past has effectively reduced the bandpass characteristics of this channel by about 1MHz less than was actually broadcast. Thus fine detail, that is high frequency

information, was lost on the picture tube although it may be broadcast.

The comb filter uses the phase inversion characteristics (see Fig. 3) of the broadcast chroma information and manipulates it in such a way so as to strip (comb) it out of the composite video signal, permitting a luminance channel bandwidth of up to 4.2MHz if indeed such high frequency information is broadcast.

The comb filter greatly reduces the effect of what Magnavox refers to as "barberpoling." That is, the condition where colors seem to stick to and run up and down high frequency information, such as pinstripped shirts or suits. This condition exists because some luminance information, in the color bandpass region, has not been filtered out.

Here's how Magnavox describes the effect. "Customarily this separation is accomplished by sending the entire video signal through a bandpass network into the chroma circuitry. Typically this network passes frequencies in the order of 3.08-to-4.08MHz. Thus 1MHz is processed by the chroma circuitry. Unfortunately, if luminance information happens to fall into this region, it also passes into the chroma circuitry and causes interference ... the resulting chroma interference looks like random colors moving around in the highly detailed portions of the picture. This type interference is called "crosscolor" interference and has been around ever since the NTSC television format was invented."

3.58MHz distortion

Recalling your television theory, you know the purposes of the 3.58MHz trap is to prevent 920KHz beat patterns from appearing on the face of the picture tube during a color broadcast. This is caused, of course, by the mixing of the color sub carrier with the sound carrier at 4.5MHz. However, this procedure for developing the luminance information obviously severely distorts the passband of the channel, limiting high frequency response to about 3MHz.

However, Magnavox design engineers have taken advantage of two properties of the TV signal to increase overall picture resolution by some 25 per cent. These are those frequencies which are odd multiples of one half the horizontal rate (color info) are 180 degrees out of phase with each other from line to line in a TV field. Secondly, the luminance signal is in phase from TV line to TV line.

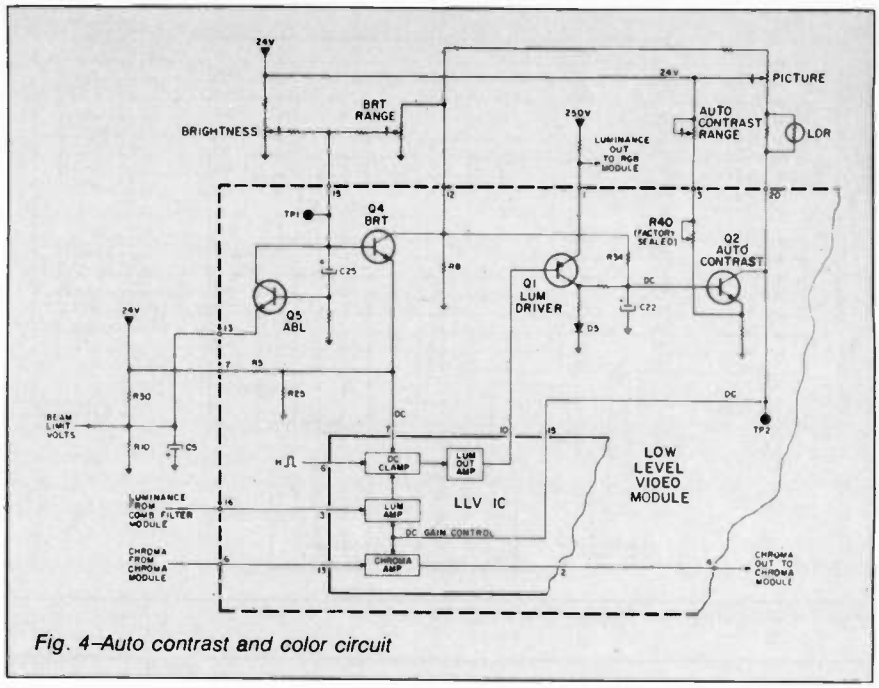

Fig. 4–Auto contrast and color circuit

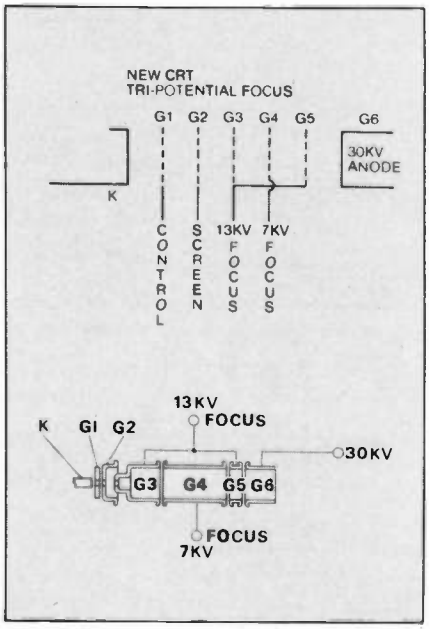

Fig. 5–Grid location and voltage chart for the 100° in-line CRT used in the T815 chassis.

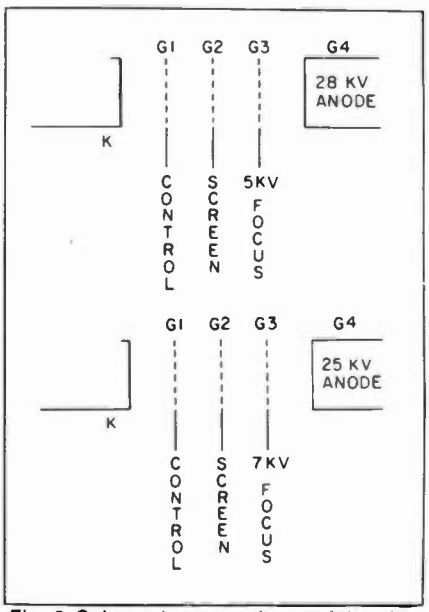

Fig. 6–Schematic comparisons of the old bi-potential (Above) and new "hi-bi potential" (Below) CRT for the T809 with higher focus voltage.

Development of chroma

Referring to Figure 3, the composite video signal is applied to the compensating delay line, an attenuator that reduces the signal by half, and an amplifier. The amplifier is used because the signal applied to the delay line loses half of its amplitude via insertion losses. The signal coming out of the delay line is labeled Vd (video delayed). Now, here's Magnavox describing what happens next.

"It is then inverted and becomes −Vd. The −Vd is applied to an adder (+) along with the attenuated Vd signal. When −Vd and Vd are added, the high frequency luminance cancels and the

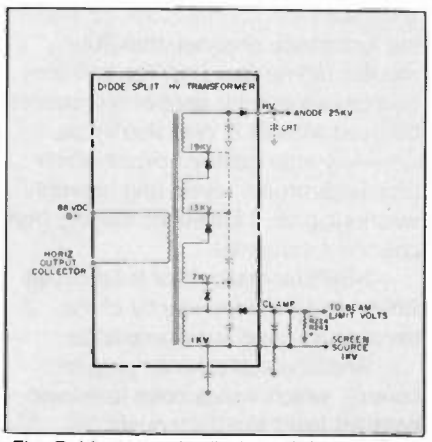

Fig. 7–Magnavox's diode split high voltage transformer produces the 25KV CRT anode voltage.

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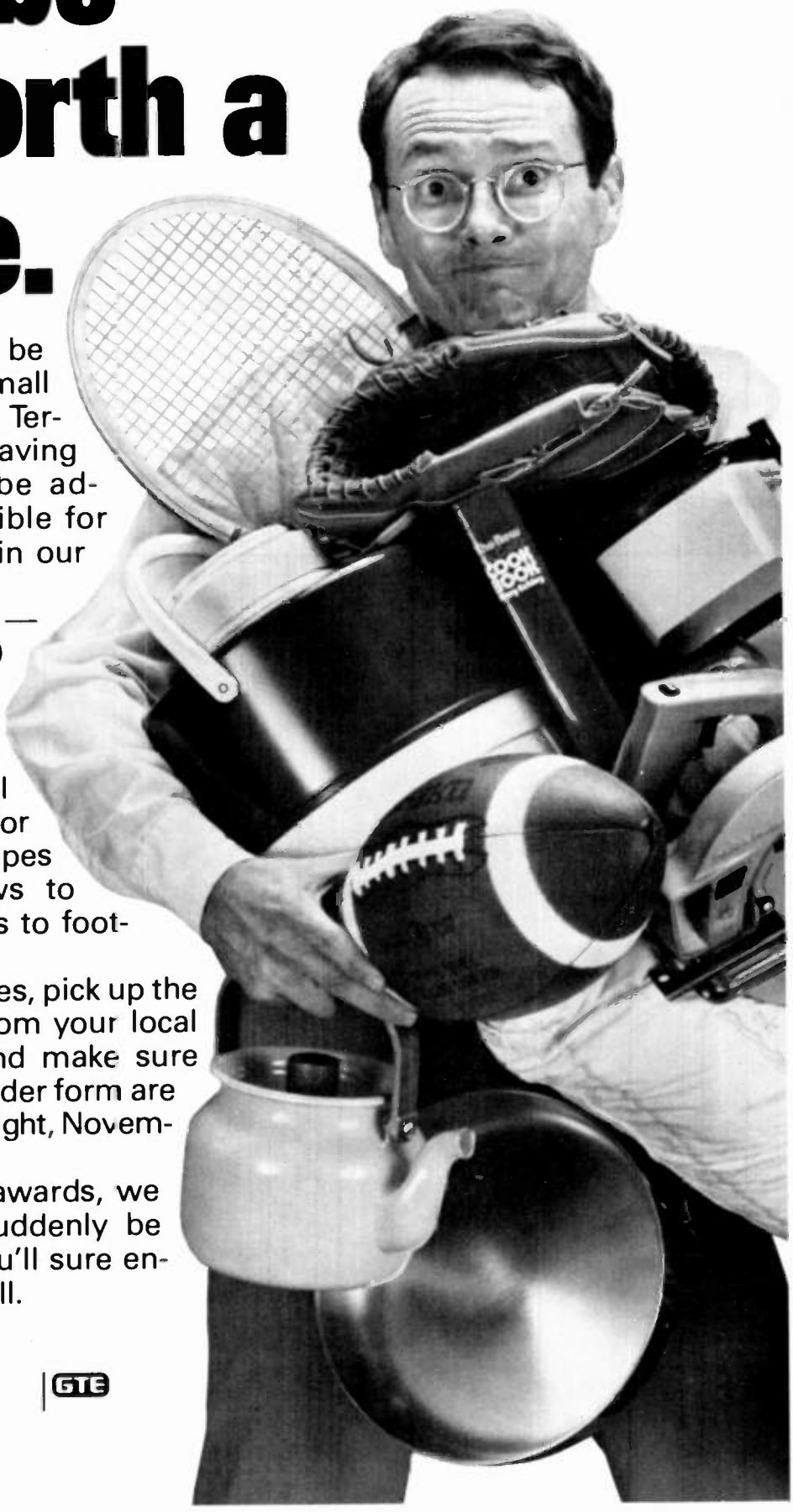

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chroma reinforces itself leaving only chroma" plus low frequency luminance. Low frequency luminance is left because of the characteristic of the 63.5uS delay line which passes only frequency around 3-to-4MHz. When this 1MHz band of signals is inverted, the high frequency luminance contained therein cancels out the non-inverted high level frequency arriving at the adder from the original Vd signal. However, since low frequency information is also contained in this signal, it is passed to the output of the adder stage.

However, it is of no consequence because the signal now goes through another 3-to-4MHz passband on the chroma module and is thus eliminated here. So the chroma information has now been effectively "combed" out of the composite video signal.

Developing Luminance. The output of the chroma adder is now passed through a 3MHz-to-4MHz passband and *signal inversion* circuits on the module and then sent on to an adder in the composite video circuit line. A delayed composite video signal also feeds this adder and the proper phase relationships have been developed so as to effectively cancel the chroma and leave only "combed" luminance information—up to 4.2MHz.

Auto contrast/color

The automatic contrast and color control circuit is another addition to both the 815 and 809 for 1979. What it does is keep the color and contrast constant regardless of variations in the incoming signal. The result is a constant picture from channel to channel and scene to scene. Most television sets require readjustment of these controls when one of them is changed. For instance adjusting a picture more contrasty requires adjusting the brightness to bring out the dark area detail—plus making compensating adjustment to increase color intensity. However, in the new Magnavox chassis, these three circuits are all tied together (see Fig. 4).

When the customer increases brightness, the DC level of the luminance signal goes up and the resulting auto contrast reference voltage at the base of Q2 normally would too. This is undesirable, so to prevent this R34 couples the pin 12 voltage to the base of Q2. When brightness is increased and Q4 increases its conduction, its collector voltage (pin 12) goes down. The reduction in voltage exactly offsets the increase at the base of Q2 so TP2 voltage does not change.

Other biasing arrangements are used in connection with the luminance and chroma signals, which are also tied to TP2. The effective results are to provide relatively constant contrast and color levels.

In-line tubes

Both the 809 and the 815 contain new 100 degree deflection in-line picture tubes for 1979. The 809 carries a special "hi-bi potential" in-line while the 815 is equipped with the tri-potential CRT with an added focus voltage grid. The latter produces a 30 per cent reduction in spot size, thus adding to increased picture resolution and also is three inches shorter than previously used 90 degree deflection CRTs. This results in a TV cabinet which is three inches shorter than previous models.

According to Magnavox, the tri-potential actually provides the best improvement in spot size, but its noticeable advantage over the hi-bipotential is very marginal in small screen sets.

The tri-potential has the same arrangement for G1 and G2 grids, but three grids are used for focus. G3 and G5 are tied together with a 13KV focus potential while G4 is at 7KV (see fig. 5).

The assembly in the hi-bipotential CRT used in the 809 has a focus (G3) voltage modified from 5KV to 7KV for smaller dot concentration. This CRT is 1.5 inches shorter than the previous model used. The voltage difference between G3 and G4 on the "hi-bi" is less, therefore shortening the focal point effectively creating a smaller dot size and higher resolution.

New high voltage transformer

The 19-inch T809 chassis is equipped with a new device used to produce the 25KV for the CRT. All voltages are developed within this transformer, a Diode Split High Voltage Transformer, eliminating the need for a high voltage

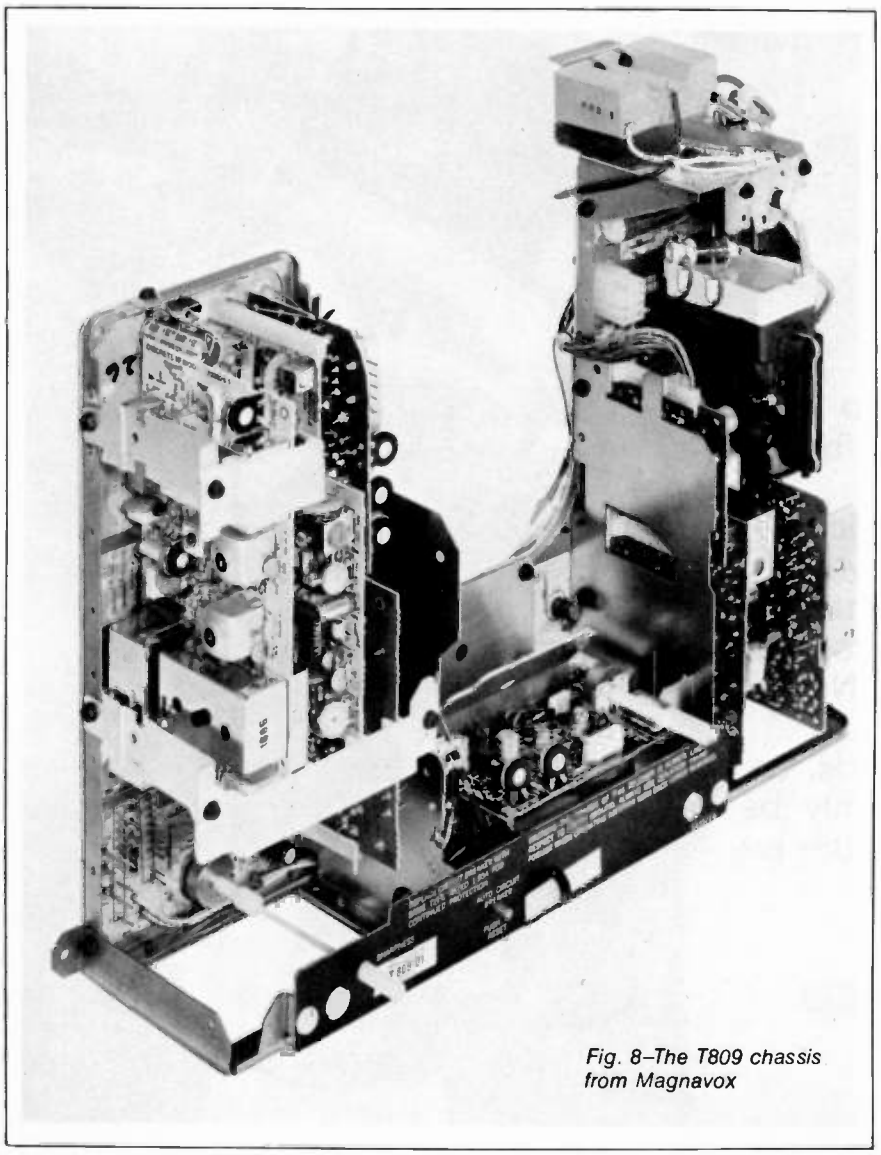

Fig. 8–The T809 chassis from Magnavox

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tripler circuit as used in the T815. Magnavox says this arrangement should increase reliability.

This transformer is completely plug-in and no soldering is required for replacement. Referring to Figure 7, the primary winding off the collector of the horizontal output transistor provides pulses for four separate tertiary windings. These windings are stacked one on the other with rectifier diodes interspersed. As a 6KV pulse from the primary appears across each winding, it is rectified and then filtered by the inter-layer capacitance (dashed lines in Fig. 7). The next winding and its pulse ride on the resultant DC, thus each provides a set-up of 6KV until the desired 25KV is attained. The anode voltage is also filtered by the distributed capacitance in the circuit to ground through the CRT itself.

A diode from the top of the first tertiary winding is used as a clamp to keep its cathode from going negative. This rectifies pulses through the capacitive and resistive network at the anode to provide 1KV for the screens.

A negative 2VDC at zero beam current is created when R224 and R243 draw current as the capacitor at the anode of the clamp discharges during off times. This electron flow creates additional negative voltage and when beam current increases to about 1.5ma the negative bias begins to turn on the Brightness Limiter circuitry.

Horizontal and high voltage

The horizontal oscillator IC on the horizontal module provides the signal for the horizontal driver stage. Also located on this module is the high voltage limiter circuitry. A horizontal output transistor (off the module) drives the flyback transformer which in turn feeds individual windings on the yoke and the high voltage transformer. The high voltage limit circuitry monitors the amplitude of the horizontal pulse. If high voltage does become excessive, the pulses will increase in amplitude and trip the limit circuitry. The end result is a drastically increased horizontal frequency which lowers the high voltage so that the sides of the raster will pull in considerably.

According to Magnavox, the T815 boasts "impressive features and advantages over previous television receivers." From what I've seen of this unit myself, I'd have to agree. **ETD**

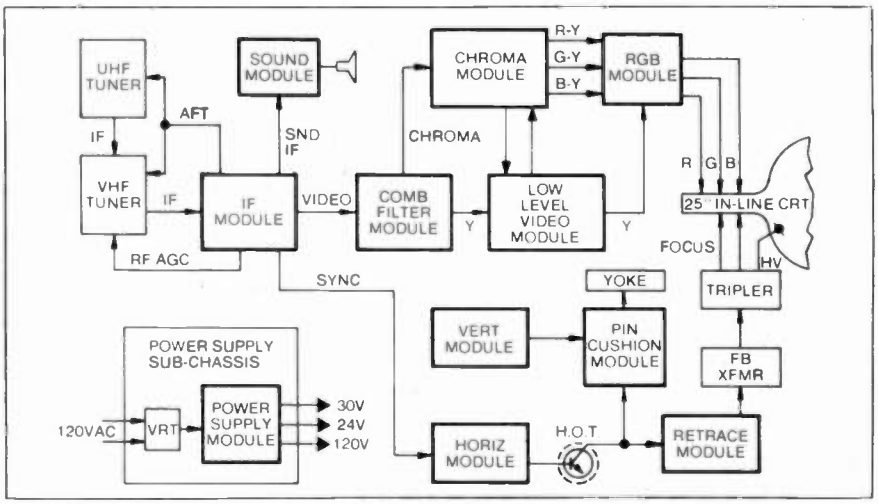

Fig. 9–The T815 signal flow block diagram showing position of the innovative "comb filter"

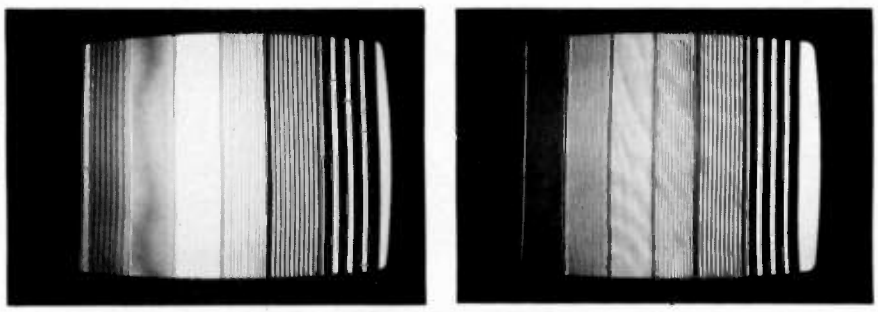

Fig. 10–Comparison of IF response patterns using Magnavox set with a 3.58MHz trap in the video channel (left) and with the comb filter. Sixth and (4MHz bar) and seventh bars in left photo, in addition to loss of detail, contain magenta and cyan color, whereas photo at right is color free.

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2SA 525	.70
2SA 530	1.30
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2SA 545	.59
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2SA 695	.70
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2SA 699A	.90
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2SA 719	.59
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2SA 721	.59
2SA 725	.59
2SA 726	.59
2SA 733	.59
2SA 738	.70
2SA 740	2.65
2SA 743A	1.60
2SA 744	4.90
2SA 745R	4.90
2SA 747	5.80
2SA 748	1.00
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2SA 756	3.70
2SA 758	5.80
2SA 764	4.40
2SA 765	4.90
2SA 774	.59
2SA 777	1.00
2SA 794A	1.00
2SA 798	.70
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2SA 815	1.00
2SA 816	.70
2SA 818	1.30
2SA 837	2.80
2SA 839	2.15
2SA 841	.59
2SA 847	.59
2SA 850	.59
2SA 872A	.59
2SA 885	.70
2SA 908	11.00
2SA 913	1.20

2SB

2SB 22	.59
2SB 54	.59
2SB 55	.59
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2SB 178	.70
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2SB 220	.70
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2SB 539	4.90
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2SB 554	10.00
2SB 556	4.90
2SB 557	3.40
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2SB 564	.70
2SB 595	1.90
2SB 596	1.60
2SB 600	7.00

2SC

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2SC 353A	2.50
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2SC 377	.70
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2SC 383	.90
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2SC 403	.59
2SC 430	.90
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2SC 461	.59
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2SC 517	3.95
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2SC 536	.59
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2SC 738	.59
2SC 756	2.80
2SC 756A	3.00
2SC 763	.59
2SC 772	.45
2SC 773	.70
2SC 774	2.00
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2SC 1360	1.00
2SC 1362	.59
2SC 1364	.70
2SC 1377	4.90
2SC 1383	.59
2SC 1384	.59
2SC 1396	.70
2SC 1398	1.10
2SC 1400	.59
2SC 1402	4.90
2SC 1403	4.90
2SC 1407	.90
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2SC 1444	2.80
2SC 1445	3.00
2SC 1447	1.60
2SC 1448	1.60
2SC 1449	1.00
2SC 1451	2.25
2SC 1454	5.60
2SC 1475	1.40
2SC 1478S	.70
2SC 1509	1.10
2SC 1567	1.10
2SC 1567A	1.10
2SC 1584	8.50
2SC 1586	7.60
2SC 1624	1.30
2SC 1626	1.10
2SC 1628	1.30
2SC 1647	1.00
2SC 1667	3.40
2SC 1669	1.60
2SC 1674	.59
2SC 1675	.59
2SC 1678	2.25
2SC 1679	4.25
2SC 1681	.70
2SC 1682	.45
2SC 1684	.59
2SC 1687	.70
2SC 1688	.70
2SC 1708	.59
2SC 1728	1.90
2SC 1730	.59
2SC 1756	1.40
2SC 1760	1.90
2SC 1765	8.80
2SC 1775	.45
2SC 1816	3.90
2SC 1846	.70
2SC 1885	.70
2SC 1908	.59
2SC 1909	3.90
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2SC 1945	5.60
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2SC 1969	4.90
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2SC 1974	1.90
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2SC 2028	.90
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2SC 2074	1.90
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2SC 2091	2.80
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TA 7063P	1.60
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TA 7109P	3.40
TA 7120P	1.90
TA 7122AP	1.90
TA 7124P	1.60
TA 7129P	1.90
TA 7130P	2.80
TA 7136P	1.30
TA 7146P	4.20
TA 7150P	4.40
TA 7159P	2.50
TA 7200P	4.60
TA 7201P	4.60
TA 7203P	3.70
TA 7204P	3.40
TA 7205P	2.90
TA 7310P	3.95
TA 78005M	5.80
TA 78005P	5.80
TA 78012M	6.60
TA 78012P	5.80
TA 78015M	6.50
TA 78015P	5.80
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UHIC 005	5.80
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UPC 41C	3.70
UPC 554C	2.80
UPC 555H	2.25
UPC 563	3.70
UPC 566H	1.60
UPC575C	2.80
UPC 576	3.70
UPC 577H	2.25
UPC 592HZ	1.60
UPC 1001H	4.90
UPC 1008C	7.00
UPC 1016C	3.00
UPC 1020H	3.70
UPC 1025	3.40
UPC 1026C	3.70
UPC 1032	2.25
UPC 1152H	3.40
UPC 1156	3.00
UPD 857C	14.00
UPD 858C	9.50
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PLL 02A	8.80
PLL-03A	8.80
SN 7400	.19
SN 7490	.60

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IS 84	.60
IS 188	.25
IS 332	.45
IS 953	.25
IS 1007	.45
IS 1209	.45
IS 1211	.45
IS 1555	.25
IS 1588	.25
IS 1885	.25
IS 2076	.25
IS 2093	.45
IS 2473	.25
IN 34	.25
IN 60	.25
10D1	.40
10D10	.60
VO 6B	.40
VO 6C	.40

ZENER DIODES

WZ 050	.45
WZ 052	.45
WZ 061	.45
WZ 071	.45
WZ 075	.45
WZ 081	.45
WZ 090	.45
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RCA's direct address tuning system

Remote random access tuning

Here's an in-depth look at the overall system together with some troubleshooting hints from the field.

By Paul Shih

The direct address tuning system used in RCA's CTC 81B and 74K chassis has received wide acceptance since its introduction in 1975. There are a number of unique features offered by the system. Among these are remote random access to all 83 channels, remote volume, color and tint controls, and on-screen displays of the selected channel number and the time-of-day in hours and minutes. All of the control functions are initiated from a hand-held remote transmitter, called XL-100 Control Center. There are no major user's operational controls on the receiver. The only switches or controls which are not used frequently and are therefore concealed in the receiver's right-hand front panel are Master Off, Auto Color, AFT, Contrast, Brightness, Tone, Time Set and 12 VHF Fine Tune offset potentiometers.

Under normal conditions, the Master Off switch is on. In this way a small amount of power is applied constantly to the remote receiver to keep the remote system alive at all times.

Channel selection is carried out by pressing two buttons corresponding to the desired channel number on the calculator-like remote keyboard. A single digit channel number must be preceded by a zero. For instance, to select channel 2, press button "0" first and then button "2". As soon as the first or ten's digit is entered, the power is applied to the chassis, and the power indicator light located on the lower right-hand side of the TV receiver is lit. After the completion of entering the second or unit's digit, the picture and the sound will be evident. In addition to the program video and sound, displays of the selected channel number and the time-of-day will also appear in white at the bottom of the screen. The displays will remain on the screen for approximately 4 seconds after release of the last button. They can be recalled anytime by repeating the channel number entry or pressing "C" or "T" button. However, the displays may be made to remain on the screen continuously by setting a display lock switch to ON in the back of the receiver's cabinet.

If the second digit of the channel number is not entered within approximately 25 seconds after the first digit entry, a safety system, called "safety time-out" allows the receiver to be turned off automatically. This safety feature prevents accidentally turning on the receiver by false ultrasonic signals or other non-intended operations.

Volume is changed by pressing down the "Up" or "Down" button. As long as either button is held down, the volume continues to increase or decrease in steps every ½ second until the maximum or minimum volume is reached. Color control is initiated by first pressing the "C" button. The "Up" and "Down" buttons are now changed into color intensity controls. Holding down either the "Up" or "Down" button will increase or decrease color intensity in steps every ½ second. Tint is varied by first pressing the "T" button and then the "Up" or "Down" button. Depressing the "Up" button will change tint in increments toward magenta or more reddish color, whereas holding down the "Down" button brings in more greenish color.

In addition to the color or tint control function mentioned above, each time the "C" or "T" button is pressed, the channel number and the time displays are recalled in red or green. This feature not only allows the viewer to recall the time and the channel number displays any time with touch of a single button but also enables him during color or tint change to identify which function, color or tint, to be performed by the "Up" and "Down" buttons. The recalled displays normally remain on the screen for approximately 4 seconds.

If an invalid channel number (01 or 84 through 99) is entered, the sound will be muted and the screen will be blacked out except the display of the time and the invalid channel number. To turn off the receiver, simply enter "0,0" on the keyboard.

System operation

The complete system consists of an ultrasonic transmitter and the Direct Address Package (DAP) which, as part of the TV receiver, comprises an ultrasonic pre-amplifier, a post-amplifier, a five-module ultrasonic decoding and function command assembly including the VHF and UHF tuners, VHF offset potentiometer array and the Time-Set push-button switch assembly (Fig. 1.) Interconnected by means of plugs and jacks, all of the modules and assemblies are easily removable with no desoldering.

The system operation begins when the remote transmitter, in response to a proper keyboard entry, transmits an ultrasonic signal to the DAP in the receiver. There are 14 different ultrasonic frequencies employed in the remote transmission, and each

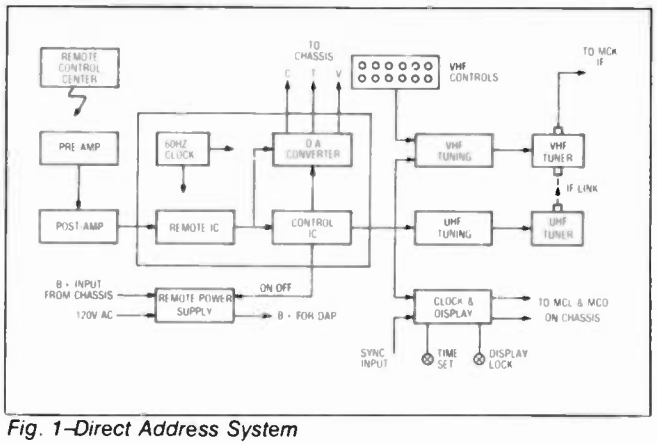

Fig. 1–Direct Address System

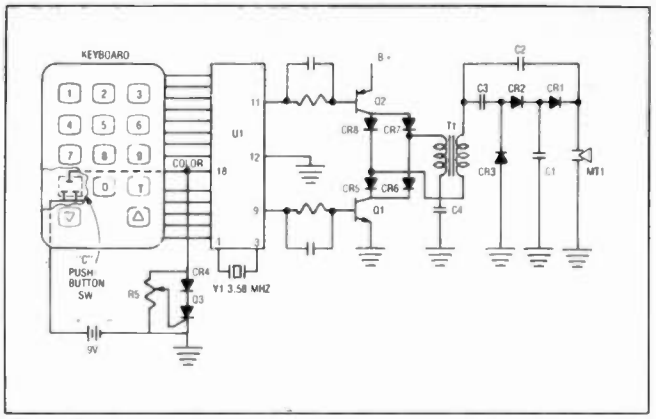

Fig. 2–Remote Control Center

frequency commands one or part of a control function.

Upon reception of the ultrasonic signals, the DAP system amplifies, decodes, and encodes the messages into a binary form suitable for inputs into control and digital-to-analog converter ICs. The Control IC in conjunction with the D/A converter commands various functions, such as channel selection, volume, color, and tint controls, and character displaying.

Remote transmitter

The remote transmitter consists mainly of an integrated circuit U_1, driving transistors Q_1 and Q_2, and an ultrasonic transducer MT_1 (Fig. 2.) The 24-pin U_1 contains part of a crystal controlled oscillator and a number of frequency dividers. In operation, the user presses appropriate push-button switches on the 14-button keyboard, and each closed switch completes a circuit from the DC supply to an appropriate terminal on IC U_1. The oscillator along with an appropriate divider is now activated, and the pulse train at the selected frequency (one of the 14 different frequencies, from 34020 to 54540 Hz) is produced at terminals 9 and 11. After amplification by transistors Q_1 and Q_2, the AC signal is coupled to MT_1 through transformer T_1.

Four diodes, CR_5 through CR_8, prevent the output current reversal as the primary winding of the transformer resonates with the boost capacitor C_4. A voltage tripler, consisting of CR_1, CR_2, CR_3, C_1 and C_3 in the secondary circuit, provides a DC bias for the transducer. The actual AC signal for the transducer is coupled through C_2.

A unique battery condition indicator, consisting of CR_4, Q_3 and R_5, is connected between the negative terminal of the 9-volt battery and the "C" push-button switch. As the "C" button is pushed, the B+ is applied to the battery condition indicator as well as to a terminal on U_1. The positive DC voltage turns on Q_3 and lights the LED indicator CR_4. However, with the control R_5 properly adjusted, Q_3 will not conduct and thus the LED will not glow if the battery voltage drops lower than 6.5 volts.

TABLE 1

DIGIT OR FUNCTION	TRANSMITTER CENTER FREQUENCY (Hz)	CONTROL	OUTPUT CODES D_4	D_3	D_2	D_1
9	34020	0	1	0	0	1
8	35100	0	1	0	0	0
7	36180	0	0	1	1	1
6	37260	0	0	1	1	0
5	38340	0	0	1	0	1
4	39420	0	0	1	0	0
3	40500	0	0	0	1	1
2	41580	0	0	0	1	0
1	42660	0	0	0	0	1
0	43740	0	0	0	0	0
(Up)	51300	1	1	0	0	1
(Down)	52380	1	1	0	0	0
C (Color)	53460	1	0	1	1	1
T (Tint)	54540	1	0	1	1	0

Transmitter functions and remote IC output codes. (Courtesy RCA Consumer Electronics)

Receiving and decoding

Each of the 14 different ultrasonic waves sent by the remote transmitter is picked up by the receiver transducer MT901, which then converts the received ultrasonic energy into electrical signal. The signal is pre-amplified by Q901 and Q902 and band-limited by an ultrasonic filter which is tuned to pass frequencies from 30 to 60 KHz. The post-amplifier further amplifies the signal and limits its output to about 12 volts, peak-to-peak (Fig. 3.)

Functioning as a frequency counter and as a decoder, a large-scale Remote IC, U3102, counts the frequency of the output pulse train from the post-amplifier and then produces a corresponding binary code for each input signal. Each of the ten ultrasonic frequencies corresponding to the transmitted digits 0 through 9 is converted to its respective binary number as represented by a combination of logic 1 and logic 0 appearing at the Remote IC output terminals D_1 through D_4. Each of the remaining 4 frequencies corresponding to functions "Up", "Down", "C" and "T" is also converted to a binary number. In addition, there will be a logic 1 output at the Control terminal on the Remote IC for each of those four-function frequencies. The logic 1 is equivalent to approximately +12 VDC while the logic 0 is equivalent to 0 VDC. Table 1 shows the output binary codes from the Remote IC.

A unique safety feature, which prevents the digital tuning operation from being affected by false ultrasonic signals, is built into the system. Each ultrasonic input is sampled by the Remote IC at a 120-sample-per-second rate. Any input must be present for at least 16 consecutive sampling periods before it is recognized by the remote receiving system as a valid input. In response to each valid input, the output at the "Flag" terminal on the Remote IC

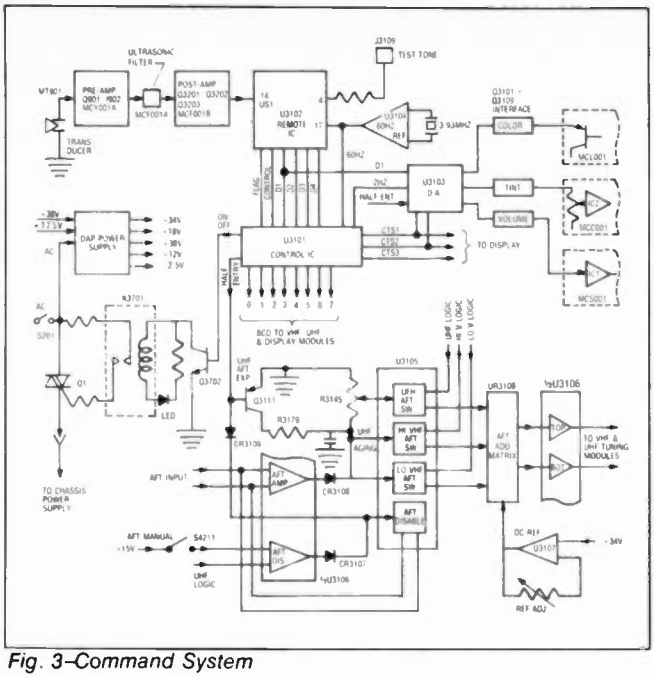

Fig. 3–Command System

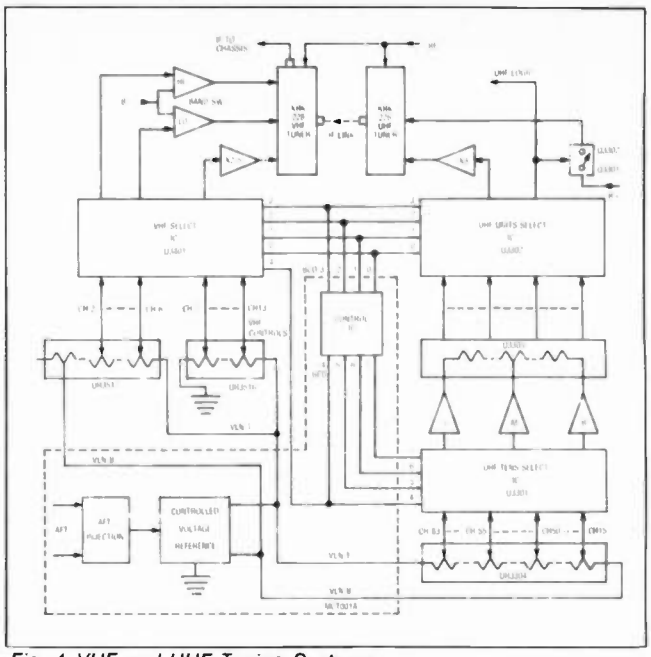

Fig. 4–VHF and UHF Tuning Systems

shall go to logic 1, causing the Control IC to accept the output from the Remote IC. If the input fails to register for 3 consecutive sampling periods, the "Flag" output will go to logic 0, thus preventing the Control IC from processing the output out of the Remote IC.

An auxiliary frequency divider contained inside of the Remote IC divides the ultrasonic input at terminal 14, by 36 to produce an audio frequency output at terminal 4. The signal is then coupled to J3109 through a high impedance resistive network. It may be used to produce a test tone during remote system testing or troubleshooting.

A 60-Hz master timing clock is used to provide a stable reference frequency for the Remote IC, the Control IC, and the Clock and Display IC. The 60Hz clock pulse is obtained by dividing the output from a 3.93 MHz crystal controlled oscillator. Both the oscillator and divider circuits are contained in IC U3104.

System on/off operation

Upon reception of a valid binary code corresponding to one digit 0 through 9 from the Remote IC, the Control IC produces a positive output voltage (logic 1) at its On/Off logic terminal. This positive DC voltage turns on an NPN relay driver transistor Q3702 on the remote power supply module (Fig. 3, left.) The transistor energizes the relay K3701, which in turn completes the gate circuit for the triac switch Q_1. The 120-VAC power is now applied to the main chassis through Q_1. A power indicator LED 101 glows to signify the "ON" condition.

As the receiver is turned on by the entry of the first digit of the channel number, the Control IC also produces a logic 1 output at its Half-Entry terminal. This positive DC voltage is routed to the AFT Disable stage, the Sync Mute Inverter and the D/A Converter, causing the AFT and video sync sections to be defeated and the color, tint, and volume control circuits to be disabled. Meanwhile, the Control IC also sends BCD codes 0 through 7 to the Clock IC U_1 and CTS (control and tuning system) codes 1 through 3 to the Display IC U_2 to cause the time-of-day and the first digit of the channel number to be displayed in white on the screen and the picture and sound to be muted.

A safety time-out system is also activated by the Half Entry. If the second digit of the channel number is not entered within approximately 15 to 25 seconds after the initial turn-on, the internal logic of the Control IC will cause the output at the On/Off terminal to go to logic 0, thus turning off the chassis power.

If the second digit of the channel number is entered within approximately 25 seconds, the output at the Half-Entry terminal goes to logic 0 to disable the safety time-out system but enable the AFT, sound and video sync. Shortly, the program video along with sound will appear.

The receiver is normally turned off by entering a "0,0" command on the keyboard, as was previously explained. What actually happens is that the entry of the first "0" activates the half-entry system; but as soon as the second "0" is entered, the On/Off logic goes to 0, turning the receiver off.

Color, tint, and volume

The important link between the digital control IC's and the analog control circuitry of color, tint and volume is the digital-to-analog converter, U3103. IC U3103 contains 3 resistive matrixes coupled to 3 respective four-bit, 16-count registers which convert the digital input voltages to their analog equivalents. Two of the 3 CTS codes from the Control IC, CTS 1 and CTS 2 are applied to the 3 registers through the resistive matrixes (Fig. 3, upper right.)

Logic conditions (0 or 1) of the two CTS codes determine the conduction state of each register (Table 2.) However, the volume register is normally on except during channel selection, color or tint control operation.

A 2-Hz clock pulse train derived from dividing the 60-Hz reference pulse inside the Control IC is also applied to each of the 3 registers. Once a register is turned on by the CTS codes, it is stepped through its 16 possible counts by the 2-Hz clock pulses. A directional code, D_1, input from the Remote IC, will cause each register to advance or reverse its stepping sequence.

In operation, when any of the four functional commands, "Up", "Down", "C" and "T", is initiated, the "Control" terminal on the Remote IC has a logic 1 output. This condition permits D_1 through D_4 inputs to the Control IC to change only the 3 CTS codes, but not the BCD codes. As the "C" or "T" command is activated, the CTS 1 and CTS 2 turns on either the color register

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or the tint register respectively but disables the volume register. If either the "Up" or "Down" command is next initiated, the 2-Hz clock pulse will be gated in to clock the color or tint register output voltage every ½ second in 16 steps toward either the maximum voltage fed into HC or HT terminal, or the minimum voltage fed into LC or LT terminal on the converter IC. The directional code on D_1 line will be either logic 1 or 0 during the "Up" or "Down" operation.

Since the volume register is always on except during the "C", "T" or channel selection operation, pressing the "Up" or "Down" button without being preceded by the "C" or "T" command can only change the volume. Besides, the "Up" or "Down" command alone will not recall the display or activate the half-entry system.

All of the three registers are automatically set to their mid-counting positions when the AC power is initially applied to the DAP. However, subsequent counting position of each register as the set is turned on again will be the same as the last position when the set was turned off.

Transistors Q3101 through Q3109 are the buffer stages between the outputs of three registers and the inputs to the chroma and sound sections on the main chassis. These interface stages establish proper voltage ranges for the analog controlled stages.

VHF tuning operation

VHF tuning is accomplished by switching 12 properly pre-set AFT controlled tuning voltages, one at a time, to the VHF varactor tuner. In response to the BCD inputs, 0 through 4, from the Control IC, the VHF Select IC, U3401, determines which one of the 12 pre-set input voltages to be routed through an external control voltage amplifier, IC U3402, to the tuner (Fig. 4, left.) In addition, the VHF Select IC also develops proper band switching voltages for the high or low band switching in the tuner. However, the bandswitching system is disabled by a UHF logic from the UHF Units Select IC when a UHF channel is tuned in. This arrangement is made to convert the VHF tuner into an IF amplifier for extra gain during UHF reception.

A common AFT controlled voltage source from which both the VHF and UHF tuning voltages are derived is developed in the AFT Add Matrix, UR3108 (Fig. 3, bottom.) The controlled voltage source is obtained by adding the AFT correction voltage in proportion to the DC reference control voltage in a resistive network. The DC reference voltage is derived from the remote system power supply through a voltage regulator, U3107. On the other hand, the AFT correction voltage is obtained by combining the differential AFT input voltages from the IF module in the AFT differential amplifier located inside IC UR3108. Only the positive AFT output voltage is coupled to the AFT Add Matrix through the blocking diode CR8 and the AFT band switch. The amplified AFT correction voltage varies above and below a positive nominal value.

During the half-entry period, the positive half-entry voltage turns on CR9 as well as the AFT defeat stage. Since the AFT differential inputs are now shorted out by the AFT defeat stage, the AFT amplifier is disabled, and its output voltage is fixed at the nominal value.

The AFT defeat stage may also be activated by a manual switch. However, this manual switch is effective only during VHF reception. When the UHF tuning system is active, the UHF logic applied to the AFT Defeat Switch Disable stage causes diode CR7 to be reverse biased, effectively disabling the manual switch.

The amount of the AFT correction voltage to be added to the DC reference voltage depends on the band of tuning frequencies and the location of tuning frequency within each band. Due to the non-linear characteristics of varactor tuning, the changes in tuning voltage required to cause a given frequency change in the low VHF band (channels 2 through 6) is greater than that in the high VHF band (channels 7 through 13.) Furthermore, the required change in the tuning voltage is greater at the high frequency end than at the low frequency end within each band. It is therefore necessary to add more AFT correction voltage for the low VHF band than for the high VHF band and also to shift more AFT correction voltage toward high frequency channels in each band.

To accomplish the non-linear AFT injection, AFT band switches and the AFT ADD Matrix are used. When a low-band VHF channel is to be selected, the Lo V Logic from the VHF Select IC turns on the Low Band VHF AFT switch, adding more AFT correction voltage to the AFT ADD Matrix. On the other hand, when a high-band channel is to be tuned in, the Hi V Logic from the VHF Select IC will turn on the High Band AFT switch, adding the required amount of AFT correction voltage to the ADD Matrix.

Two unity-gain Top and Bottom amplifiers are used to couple different amounts of AFT controlled voltages, more for the higher channels in each selected band, to the VHF Tuning Matrix and Controls. The controls are factory preset for all 12 VHF channels, but provision is also made for field adjustments through front-panel accessibility to the 12 VHF offset potentiometers.

TABLE 2

CTS 1	CTS 2	FUNCTION	DISPLAY COLOR
0	0	Volume	Off or White
0	1	Color	Red
1	0	Tint	Green
1	1	Volume	White
D_1	Direction		
0	Down		
1	Up		

CTS and D_1 codes relative to color, tint, and volume controls. (Courtesy RCA Consumer Electronics)

UHF tuning operation

Tuning a UHF varactor tuner is not much different from tuning a VHF varactor tuner. The only difference in the RCA's system lies in the way the AFT controlled tuning voltage source is divided and preset for tuning each channel. Since there are 70 UHF channels, it would evidently be less practical to use 70 potentiometers, each tuned to one channel. RCA uses a two-stage tuning voltage dividing and switching system to tune all 70 UHF channels. In this system, a Ten's Divider with a Ten's Select IC and a Unit's Divider with a Unit's Select IC are used (Fig. 4, right.)

The Ten's Divider, consisting of Tens Resistor module, UR3304, and a series of trimmer potentiometers, is connected across the common AFT controlled voltage source. With proper adjustments of the Ten's trimmer

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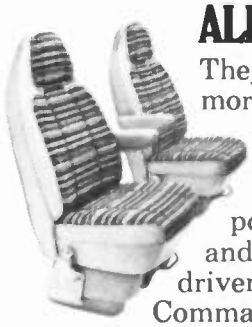

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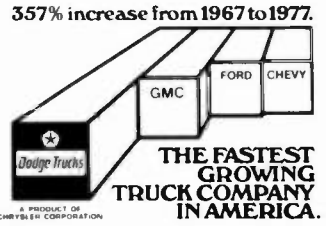

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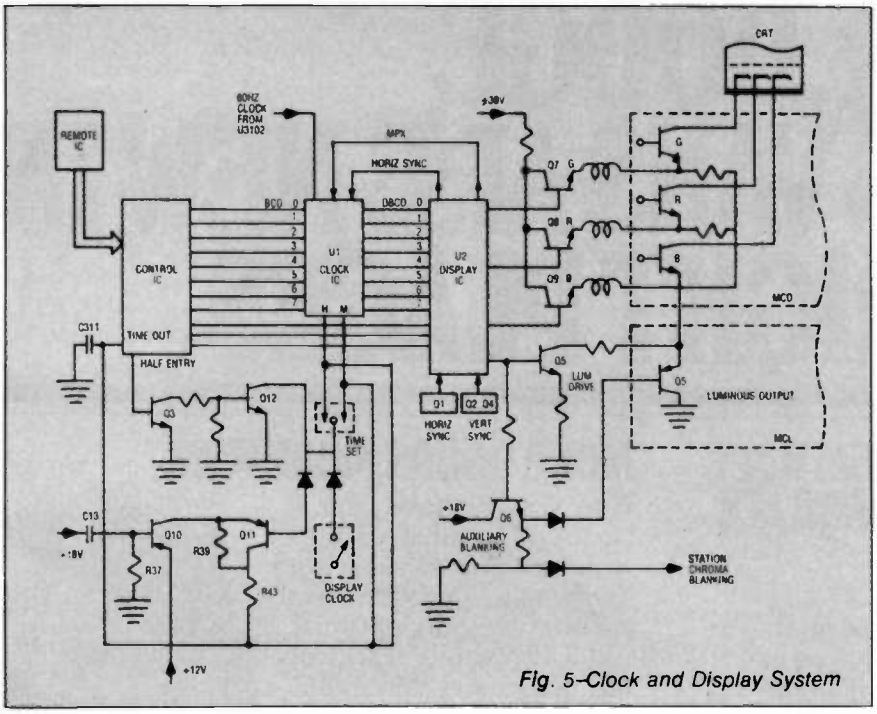


Fig. 5–Clock and Display System

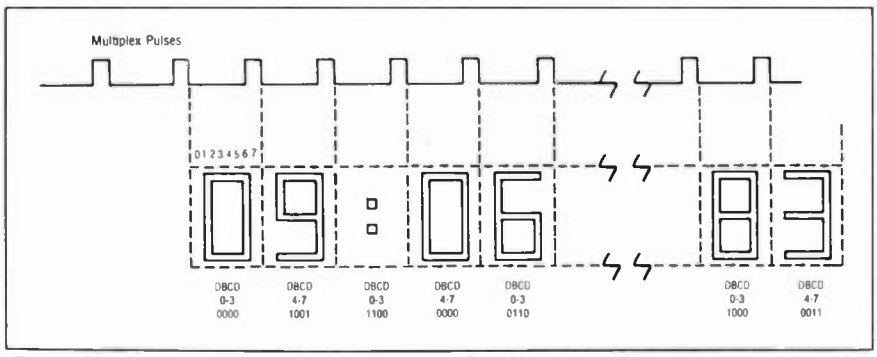


Fig. 6–Clock IC Outputs Relative to Character Display and Multiplex Pulses

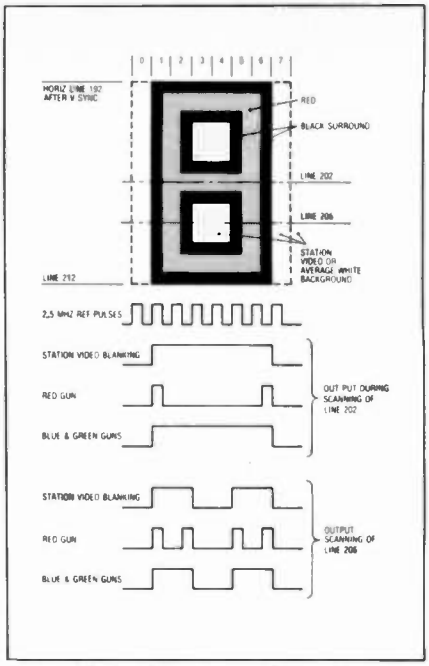


Fig. 7–Timing Diagrams of Video Output Waveforms for a Display of Red "8"

potentiometers, the AFT controlled voltage is divided into a number of different voltages, from the lowest to the highest potential. The potential from the wiper arm of one potentiometer to that of the next potentiometer represents a tuning voltage range for a number of consecutive channels.

The relationship between the tuning voltage and the tuning frequency of a UHF tuner is nearly linear from channel 14 up to channel 50. Above channel 50, the relationship becomes increasingly non-linear. It is therefore possible to preset the tuning voltage for every 10 consecutive channels up to channel 50 and for every 5 consecutive channels thereafter. The additional mid-point reference set at channel 55, 65 or 75 reduces the deviation between the linear system tuning approximation and the actual non-linear varactor tuning characteristics.

There is a total of 12 trimmer potentiometers used to cover the required voltage ranges for 70 UHF channels. These potentiometers are factory preset. Field adjustments of the potentiometers is generally not needed.

The ten's divided AFT controlled tuning voltages are applied to the Ten's Select IC, which in response to the BCD codes 4 through 7 from the Control IC, selects the preset tuning voltages at two or three consecutive set points (wipers of the trimmers) on the Ten's Divider. The voltages being selected from the upper, middle and lower consecutive points are then coupled to the Unit's Divider through the Top, Middle and Bottom unity-gain buffer amplifiers.

The voltage developed across the Unit's Divider, U3305, is divided into a number of individual tuning voltages, and each of the tuning voltages can be used to tune one channel. With the BCD codes 0 through 3 from the Control IC, the Unit's Select IC, U3302, selects one of those units divided tuning voltages and applies it to a tuning voltage amplifier inside U3303. The amplifier brings the selected tuning voltage up to a level suitable for use to tune the UHF tuner.

Each time a UHF channel is to be tuned in, the Unit's Select IC, in addition to selecting a required tuning voltage for the channel, also produces the positive UHF logic pulse which then turns on the NPN Logic Switch, Q3302. The conducting Logic Switch brings the UHF B+Switch, Q3301, out of cut-off, applying the B+ voltage to activate the UHF tuner.

UHF AFT range expansion

The tuning voltage range for the 70 UHF channels is comparable to that for the 12 VHF channels. Consequently, the AFT "pull-in" range is smaller for a UHF channel than for a VHF channel. It is desirable to expand slightly the AFT "capture" range during UHF reception. This desirable action is carried out by the UHF AFT Range Expander, Q3111 (Fig. 3, lower center.)

During the half-entry interval, the positive half-entry pulse turns on Q3111, placing resistor R3179 in parallel with the UHF Aging control R3145. As a result, the AFT control voltage at the wiper arm of the Aging control is decreased, and the smaller AFT controlled tuning voltage is produced at the output of the AFT ADD Matrix. This slightly lower tuning voltage decreases the UHF tuner local oscillator frequency even lower than the normal AFT "pull-in" range would allow.

As the second digit of the channel number is entered, the disabled half-entry system will cause Q3111 to be turned off. The capacitor C3119 under this condition begins to charge up, causing the AFT control voltage at the

wiper arm of the Aging control also to go up gradually. This action of decreasing the AFT control voltage at first and then allowing it to increase again effectively extends the AFT "pull-in" range.

The UHF AFT range expanding action does not affect the VHF AFT operation because the input to the VHF AFT band switches is taken directly from the AFT Differential Amplifier, not through the range expander circuit.

Clock and display operation

The major function of the clock and display system is to display the selected channel number as well as the time-of-day on the screen. Besides, the system establishes the color of the display and sets the amount of time for which the display will remain on the screen.

Referring to Figure 5, the Clock IC U_1 receives channel BCD codes from the Control IC and the 60-Hz clock pulses from the 60-Hz reference IC, U3102. In addition to maintaining the time-of-day, the Clock IC converts the time information and the channel BCD codes to the display BCD codes (DBCD) 0 through 7 for use by the Display IC. The Clock may be updated by shorting the Hours and Minutes terminals on the Clock IC through the Time-Set push-button switch and transistor Q12 to ground.

The DBCD codes from the Clock IC are divided into two groups, DBCD codes 0 through 3 and 4 through 7. Only one group of the 4-bit DBCD codes is read into the Display IC at a time for generating one character. By the application of a multiplex timing pulse train and the horizontal sync pulse to the Clock IC, those two groups of DBCD codes are arranged to be read into the Display IC alternately, resulting in characters generated one after the other (Fig. 6.) The multiplex pulses are derived from a 2.5-MHZ reference pulse train generated inside the Display IC.

Both the horizontal and vertical sync pulses from the chassis deflection circuits are applied to the Display IC through Q_1, Q_2 and Q_3. The vertical sync pulse establishes a reference for the vertical position of the characters (numeral, colon and dash) on the screen; while the 2.5-MHZ pulse train synchronized by the horizontal pulse establishes the horizontal position of the element of each character from one horizontal line to the next. The character generation begins on the 192nd horizontal line after the vertical sync and ends on the 212th horizontal line (Fig. 7.)

In response to the DBCD and CTS codes, the Display IC provides such functions as luminance drive through Q_5 for setting the display's saturation level; the proper series of color blanking through Q7, Q8 and Q9 for the display's color production; and the auxiliary luminance and chroma blanking through Q6 for blanking out the station video in the area on the screen where the character is displayed (Fig. 4, right.) Additional blanking is also applied to the leading and trailing edges of the character. The blanking causes a black area to surround the character. This black surrounding enhances the sharpness and visibility of the character.

TABLE 3

SYMPTOM	CAUSE	SOLUTION
Relay chatters on MCP001A power supply module.	Short on 12 VDC supply line.	Remove DAP modules one at a time until short is located.
Time-of-Day clock runs at twice normal rate.	Defective Master Clock divider U3104	Replace MCT001A Command module.
VHF reception on UHF	Defective UHF Select IC, U3301.	Replace MCU001A UHF Select module.
Intermittent or no control after warm-up.	Defective Master Clock divider, U3104.	Replace MCT001A Command module.
No color on UHF channels around Channel 30.	Misadjusted R3303 on UHF Select module MCU001A.	Carefully readjust R3303 to obtain normal picture.
Intermittent turn "on" or turn "off" with otherwise normal operation.	Defective MCZ001B post amplifier.	Replace post amp. module MCZ001B.
Clock display only distorted.	Defective Display IC U2.	Replace MCA001B Display module.
Loss of horizontal and vertical sync.	Defective sync Mute. driver Q14.	Replace MCA001B Display module.
No low VHF channel reception.	Defective Q3401	Replace MCV001A VHF Tuning module.
Bright red, blue, or green raster with retrace lines.	Shorted Q7, Q8, or Q9 on MCA001B Display module.	Replace MCA001B Display module.
Replacement modules do not solve problem.	Open copper pattern on MCM001A Master Assembly module.	Repair pattern break if possible or replace board.

Unusual symptoms, their causes and suggested solutions. (Courtesy RCA Consumer Electronics)

Display timing

The length of time the display remains on the screen is controlled by a display timer. The timer, mainly consisting of Q10, Q11, Q3, Q12, C3111, R43, R39, R37 and C13, provides 3 timing ranges depending on conduction states of the transistors (Fig. 5, lower left.) Under normal conditions, the display remains on the screen for approximately 4 seconds after release of the last button. This is the time for the capacitor C3111 connected at the Time-Out terminal on the Control IC to charge up from a near ground potential through R43 (both Q10 and Q11 are saturated) to a potential high enough to cause the Control IC to send a "Display Cut Off" command to the Display IC through CTS codes.

During the half entry, the display time is extended to 15 to 20 seconds to give the viewer enough time to enter the second digit before the display is cut off. The action is accomplished by forcing C3111 to charge through one extra resistor, R39, when Q11 is cut off by the half entry system through Q3 and Q12. The display time is also extended by about 10 seconds to allow the picture tube to warm up during initial turn on of the chassis power. Delaying the turn on of Q10 by the added R37-C13 charging network effectively achieves the time extension.

The display may be made to stay on the screen continuously by closing the

Continued on Page 61

Opto electronics

The basics

An enlightening trip into the fast growing field of light sensitive electronic devices.

By Bernard B. Daien

What does optoelectronics mean to you? It is said to be a combination of electronic and light technologies. Today the term is generally confined to solid state devices.

"Opto" is growing very rapidly, in many fields ... military, industrial, even entertainment. Yet many technicians remain largely unaware of the basics, buzz words, and potentials of opto. He knows it exists in the solar cells that power our satellites, our cameras that set exposure automatically ... and so on.

This article sets forth in simple terms, enough about the devices to understand them, and enough circuitry to get you started. Opto is both useful, and itriguing, to people in electronics. It is electronics at really high frequencies ... would you believe at one-thousand million megacycles?

Types of opto devices

Opto devices are divided into main categories ... light sources, and light detectors. Certain parameters are common to both, such as the range of light frequencies the device can handle in the ultraviolet-visible-infrared band. In electronics we would refer to this as the "frequency response," or, "bandwidth." In opto we refer to this as the "spectral response curve" for detectors, or the "spectral output frequency" for sources (emitters).

Of course other characteristics are different for sources or detectors. And within the categories of detectors and sources there are subdivisions ... different types. Let's look at the types of detectors first ... but, remembering that certain things are common to all, much of what we discover about detectors will be useful in examining sources ... and vice versa ... which makes the subject easier to absorb.

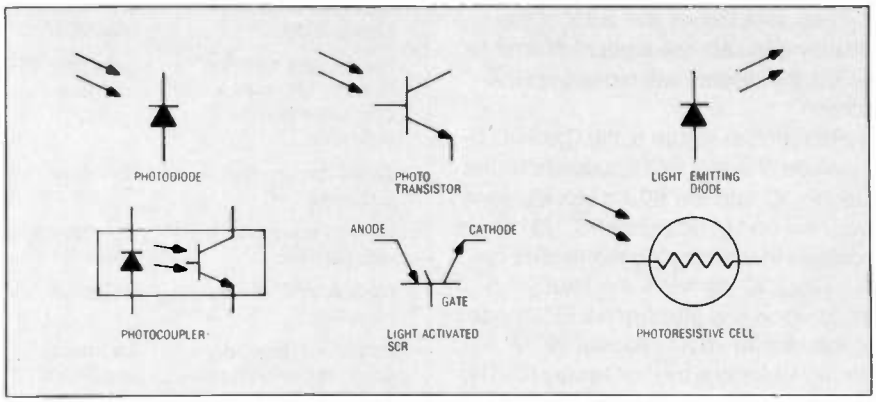


Fig. 1–Basic symbols

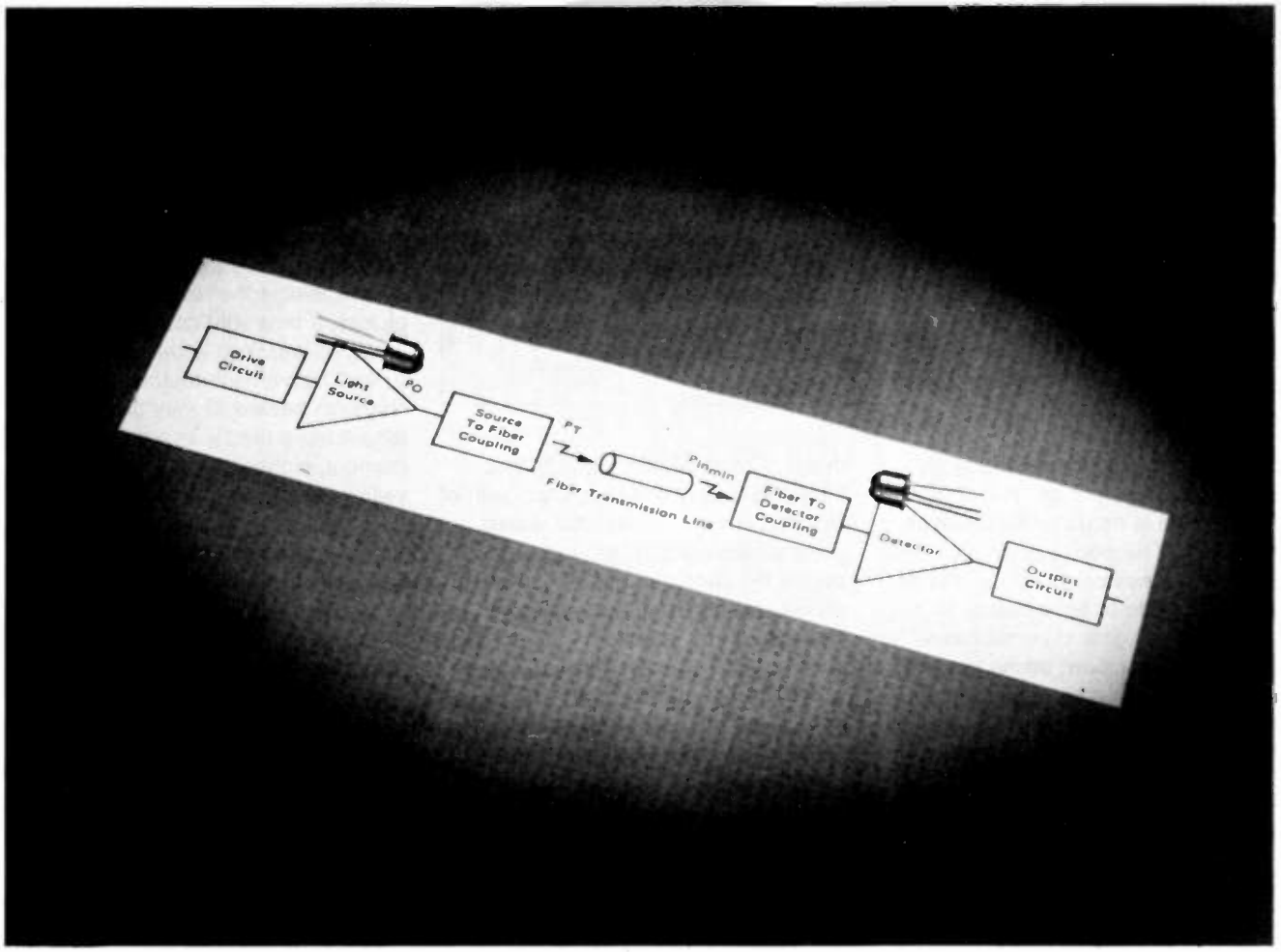
The use of the term "light" is not strictly correct here, since infrared and ultraviolet are not visible to the human eye, which is what we usually mean when we say "light." Many other living things do "see" these frequencies however, and they are also utilized by machines, therefore we refer to them as light. A more accurate term would be "radiant energy," with the frequency defined ... which leads us into the detectors.

There are four main types of photodetectors: Photovoltaic, photoemissive, photoconductive junctions, photoconductive bulk effect. Photoemissive types include photomultipliers ... they are vacuum tubes, and not covered here. Their main use is in night vision (snooperscopes), and TV cameras.

Voltage generators

Photovoltaic devices *generate* a voltage across their terminals, (or a current into a load), when illuminated. The commonest types are made of selenium or silicon. You may have noted that both have been used as rectifiers ... the old timers will recall the selenium plate rectifiers of the 1940's and 50's ... and of course you know about silicon rectifiers. Germanium, too makes a photovoltaic detector. By now you get the idea...a semi-conductor when exposed to radiant energy of a usable frequency generates an output voltage! (As a matter of fact, in the early days of plastic semiconductors clear plastic (transparent), was used, and it was soon discovered that light had a very strong effect on the current through the device.) *Let's make it plain though ... a semiconductor junction with no voltage applied, generates a voltage when struck by sufficient light.* This means the actual junction must be exposed to the light in order to absorb the radiant energy in the light.

When operated into a high impedance load as a voltage generator, the photovoltaic cell output is logarithmic (nonlinear) with linear increase in illumination ... that is, the output does not rise as rapidly as the light input. Since semiconductor junctions have capacitance, which increases as the voltage across the junction decreases, the capacitance of



the photocell is appreciable. When operated as a voltage generator into a high impedance load, the time constant becomes quite large ... or, stated another way, the response time is slowed.

If we use a low impedance load, the cell becomes a current generator, and the output versus input curve is *linear!* Operated this way we can use the cell to measure light output, as in photographic light meters, etc. Since the load is now a low impedance, the time constant becomes short, and the response time is improved. That's easy to follow, based on elementary electronics ... right? Of course, these photovoltaic cells can be, and usually are, quite large in order to generate a large current by exposing a large surface to capture light energy. Therefore they may have very large capacitances.

Photoconductive junctions

If we make a smaller junction, such as used in a signal diode or small signal transistor, the capacitance decreases, but so does the output current. We can get around this obstacle in applications where it is not necessary to *generate* voltage or current. In many uses we merely need to have an output signal that varies in accordance with the light input, and power can come from a battery or other source. In such use we employ a small semiconductor junction, exposed to light, *with an external reverse bias applied*. They are very fast, but have reduced sensitivity due to the small area of the device. The output current is linear with light input changes, the current being close to zero in darkness, increasing as the light level increases. Such a device is called a "photodiode" and is usually made of silicon, although germanium will work well too. If you happen to have some of the small glass covered signal diodes in your junk box, you will find that they work quite well in many applications. (If the diode seems to be made of opaque glass, scrape the surface, nail polish remover will take off most paint, there is often a paint baked on the glass surface to prevent photo effects.)

If a photodiode works, why not a phototransistor? Transistors have current gain, and provide more output for the same amount of light input. Again you can try any small transistor in a metal can. Remove the top of the can by filing or grinding the top edge till the top can be gently removed. A small piece of transparent plastic can be cemented on to protect the device, using Duco cement around the *outside* edge of the can. (Be careful not to touch, or contaminate the junction in any way! Some cements contain chemicals which are harmful to the junction, even in vapor form, so follow suggestions.) (Note. Some transistors will not work this way because the photo sensitive junction is on the bottom, and light cannot reach it. Others work well, depending upon construction.)

Since we now have a transistor, the usual transistor nonlinearities are in the circuit, and the output looks like the input-versus-output curve of a basic transistor amplifier. The device is slower than a photodiode, but the higher output enables us to obtain a useful signal at lower light levels, and thus ride over system noise.

Figure 1 shows the symbols, labeling, and connections for typical photovoltaic cells, photoconductive diodes, phototransistors, etc.

Bulk effect cells

Bulk effect photo cells consist of a thin layer of photo sensitive material, which changes resistance with light. There is no junction, the entire layer

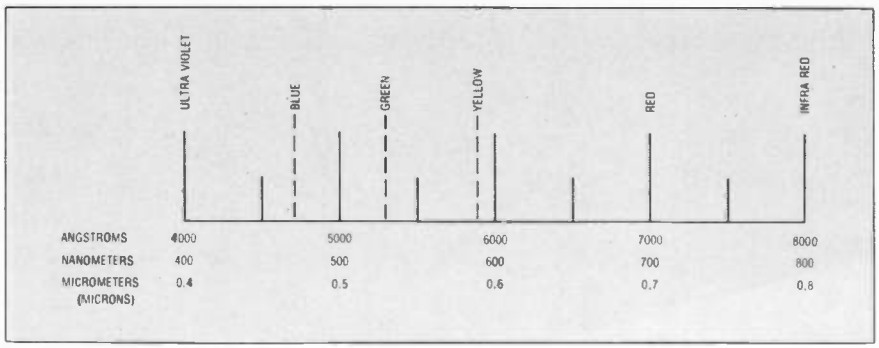


Fig. 2–The light spectrum in commonly used units

undergoes a change, consequently there is no "forward" or "reverse" bias ... and there is no generated voltage or current. The device is simply a light dependent resistor, therefore we can apply either dc or ac, which is an advantage in some circumstances. The cell is very slow, taking several milliseconds to operate, and under some conditions, with certain cells, even tenths of a second to stabilize.

In order to understand some of the terms used in optoelectronics, there is need to do a little defining.

Spectral Response. This is given in terms of wavelength instead of frequency. (For example: 500kHz can be stated as 600 meters.) Light frequencies are so high that the wavelength is given either in micrometers (millionths of a meter), or nanometers (thousandths of millionths of a meter). Just to confuse things, wavelength is often given in "Angstroms" ... an angstrom is a tenth of a nanometer. To put things in order, ten angstroms = one nanometer, and 1000 nanometers = 1 micrometer. In terms of frequency, visible light is one thousand million megahertz!

At this moment let's pause in our definitions to give you a better understanding of this light wavelength business, with the aid of Figure 2. Figure 2 is unique in that it has all three units of measurement, along with the light frequencies (colors) they define. Colors are merely different frequencies (wavelengths if you will) of radiated energy, the longest waves (lowest frequencies) being at the red end of the spectrum, and the shortest waves (highest frequencies) being the blue end of the spectrum. The spectrum is that seen in the rainbow ... red, orange, yellow, green, blue ... or the classic spectrum which occurs when a prism is used to break up daylight. Note that the different units are related the way picofarads, nanofarads and microfarads are related ... it's just that the terms would be confusing if you had no previous exposure to them. Also ... micrometers are sometimes called "microns," just to add to the confusion.

Here are some basic definitions to remember:

Dark Current ... The amount of leakage current through a photodetector, at a given applied voltage, when there is no radiation input.

Light Current ... Current output due to exposure to radiated energy.

Infrared. Invisible radiant energy at the long wave end of the light spectrum. It can be felt in the form of heat radiation.

Here comes "Kelvin"

Ultraviolet ... Invisible radiant energy at the short wave end of the light spectrum. Produces "sunburn" on human skin.

And we had better throw in another term ... "Kelvin Temperature." Those of you familiar with photography know that light sources in color photography are rated in degrees "Kelvin." This is necessary, since the color of the light source affects the results in the picture, a blue light casting blue tints on faces, etc. You know that *incandescent* light sources are merely filaments heated till they glow. A low temperature results in a dull red filament, higher temperatures yielding yellow light. Thus, as the temperature rises, the color output moves from the red, towards the blue. But, and this is a big "out," the color output of the lamp source is not a single color (frequency). Rather it has a fairly broad "bandwidth," and this is desireable for a general purpose light source. Who would want to use a reading lamp that emitted only blue (or red) light? Figure 3 relates the Kelvin temperature of the light source to the band of frequencies emitted. As you can see, most of the energy is at a wavelength longer than 800 nano meters, which is another way of saying heat (infrared). It's true that incandescent lamps are very inefficient light sources, which is why we use fluorescent lamps in modern installations.

Now I can just hear you groaning, "What's all this about Kelvin temperature?" As you know, centigrade is generally used for scientific temperature measurement purposes. It is based upon the points at which ice melts and water boils (at sea level) ... namely zero and one hundred degrees centigrade respectively. But 0° Kelvin is the point at which *molecular motion ceases*, just under minus 273° centigrade. Kelvin starts at that point. Thus 0°K = −273°C. Simple, centigrade + 273° = Kelvin. To get a little "feeling" for these figures, a 120 volt 6W pilot lamp filament is about 3,860° fahrenheit, which equals about 2,250° centigrade, or about 2,520° Kelvin. You can take your pick, but in photo work they generally use Kelvin. And, as usual, just to put a kink in things, it has become popular to refer to centigrade as "celsius" lately. They are the same. Physicists, astronomers, electronic researchers, and others have been using Kelvin for years now ... so you might as well get used to thinking inter-changeably. As a matter of fact, one of the reasons you have been finding it difficult to follow some

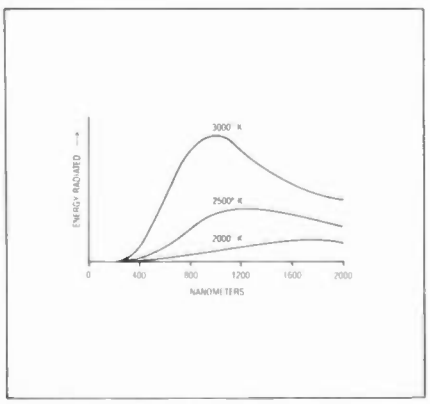


Fig. 3–The radiated spectrum for incandescent light sources

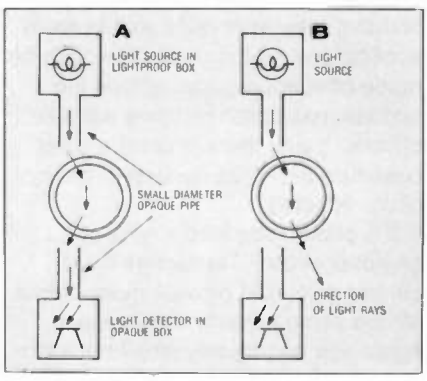


Fig. 4–A) Empty transparent pipe made of glass or plastic. B) Pipe filled with transparent liquid.

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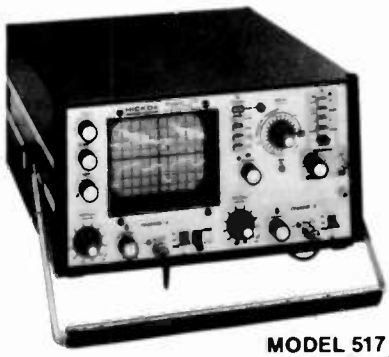

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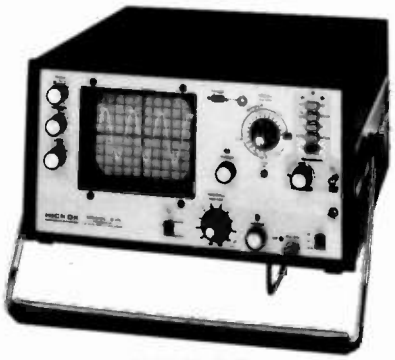

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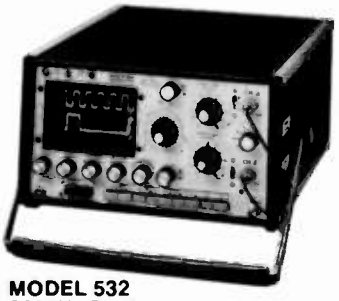

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technical articles is that the same thing is referred to by different names ... and if someone isn't handy to straighten things out, it can get to be downright confusing!

Well, we have deliberately wandered from the main subject, but as is self evident, the words were not wasted, since they will be frequently encountered in the electronics field.

Light sources

There are many "light sources" in common use; incandescent lamps, fluorescent lamps, neon lamps, arc lamps, etc. Some emit ultraviolet radiation (UV), others infrared (IR) ... some are broad band for general purpose lighting, others emit a very narrow band of frequencies and are thus good for communications and special applications other than lighting. We are not interested in devices for general lighting (reading, photography) ... rather we will confine ourselves to the solid state devices. It is necessary, however, that we look at some of the basics common to all light sources.

You have already noted the spectral response curve ... and you know that incandescent lamps are broad band devices which waste most of their energy in the form of heat. Light Emitting Diodes (LEDs) have narrow spectrums, green at 560 nanometers (nm), amber at 600 nm, and red at 660 nm. (There are also IR leds at around 950 nm.) They are very efficient, wasting little energy, and thus are often called, "cold light." In the past cold light was looked upon as a curiosity, because light was always associated with some form of heat ... fire, hot filaments, etc., and, in fact, it was a byproduct of heat.

Mercury arc lamps put out *a series of narrow bands* ... three lying between 350 and 450 nm, and two more between 530 and 580 nm. Fluorescent lamps put out a broadband low level pattern between 400 and 700 nm, plus several large narrow peaks. We need to define some units commonly used in working with light *sources*. Again, some of these will be useful in discussing detectors later on.

Candle: The original international light source was a candle, used as a standard. It is now replaced with the term "Candela" which is one sixtieth the *luminous intensity* of a piece of platinum one square centimeter in area, at the temperature at which it turns solid from the molten state (2,046°K). The candela has just about the same output as the original candle, but is reproducible with accuracy. *Luminous intensity* is given in candlepower (visible light only.)

Footcandle: A unit of illumination. Since the illumination falls off as the square of the distance, we must include distance in the definition. Thus

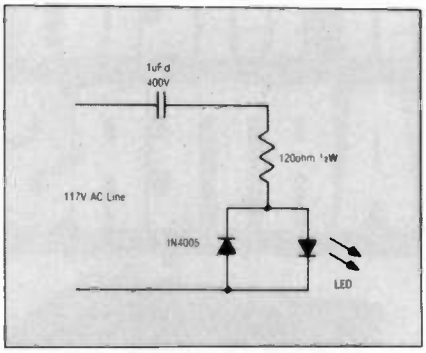

Fig. 5–This pilot light is in actuality a low power, long life, voltage sensor.

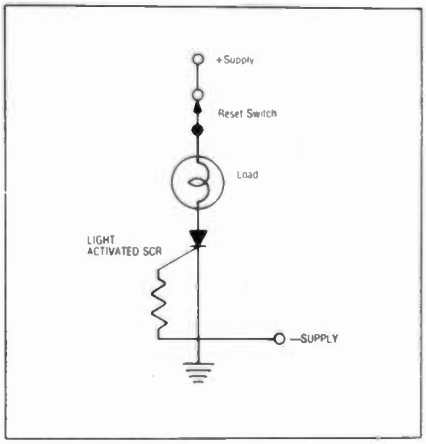

Fig. 6–A light sensitive latching relay

... Footcandles = $\frac{\text{Candlepower}}{(\text{distance in feet})^2}$, or, the more foot candles, the more illumination ... the more distance, the less illumination. Makes sense. (Full sunlight = 10,000 footcandles. Full moonlight = 0.03 footcandles, for reference use.)

Brightness defined

So far we have talked about a light source with luminous intensity (candles), and the resulting illumination falling on a distant object (footcandles). But what if light from a source falls on an object, illuminating it, and that object now appears bright due to the light reflected off it? That's what happens when you see an object in daylight ... the object appears bright due to the daylight reflected. The object itself generates no light. We call this "brightness," and one unit commonly used to measure brightness is the "Foot Lambert." An object has a brightness of one foot lambert when it reflects 100% of the light falling on it, when illuminated by one foot candle. You can see that brightness depends upon the illumination falling on the object, and how much light is reflected from the object. If the object is black velvet cloth, there is little brightness, regardless of how many footcandles fall upon it. If one footcandle illuminates a surface with only 50% reflectance, the brightness of the surface would be 0.5 footlamberts.

Another term, Lumen, is a unit of luminous flux, or the time rate of flow of light energy. It is significant because it is what the human eye experiences ... you call it "visual sensation." To give you a frame of reference for it, one candela (candle) produces a total luminous flux of slightly over 12.5 lumens. One footcandle equals one lumen per square foot.

This might be the appropriate time to reveal that we have been dealing with "Photometry" ... which is defined as the measurement of light in terms of the effect produced upon an observer ... a very confusing subject to most students ... so if you have been following us, give yourself a pat on the back! That's why we have been reminding you, by adding the words, "visible light." But what if the radiation is ultraviolet, or infrared, and not visible? In that case we measure the *radiation* flux in watts per square centimeter, or milliwatts/sq cm, or microwatts/sq cm.

Opto characteristics

Cadmium Sulfide light dependent resistors take fractions of a second to stabilize at dark current, and light current. The time to stabilize is also affected by the previous state, light or dark. It is also dependent to some extent upon ambient temperature. Cadmium Selenide is about ten times faster, but is much more temperature dependent. Light dependent resistors have light to dark current ratios which can exceed 1,000,000 to 1. They must be well sealed, since moisture will destroy their usefulness. They come in a variety of spectral response curves, for various purposes.

Photovoltaic silicon cells generate about 0.6 volts open circuit, the voltage falling as a load is placed upon the cell. Working into a very low resistance, the cell looks like a current generator, with an internal resistance depending upon the area of the cell. A cell with one square centimeter of area has a resistance of about 5 ohms

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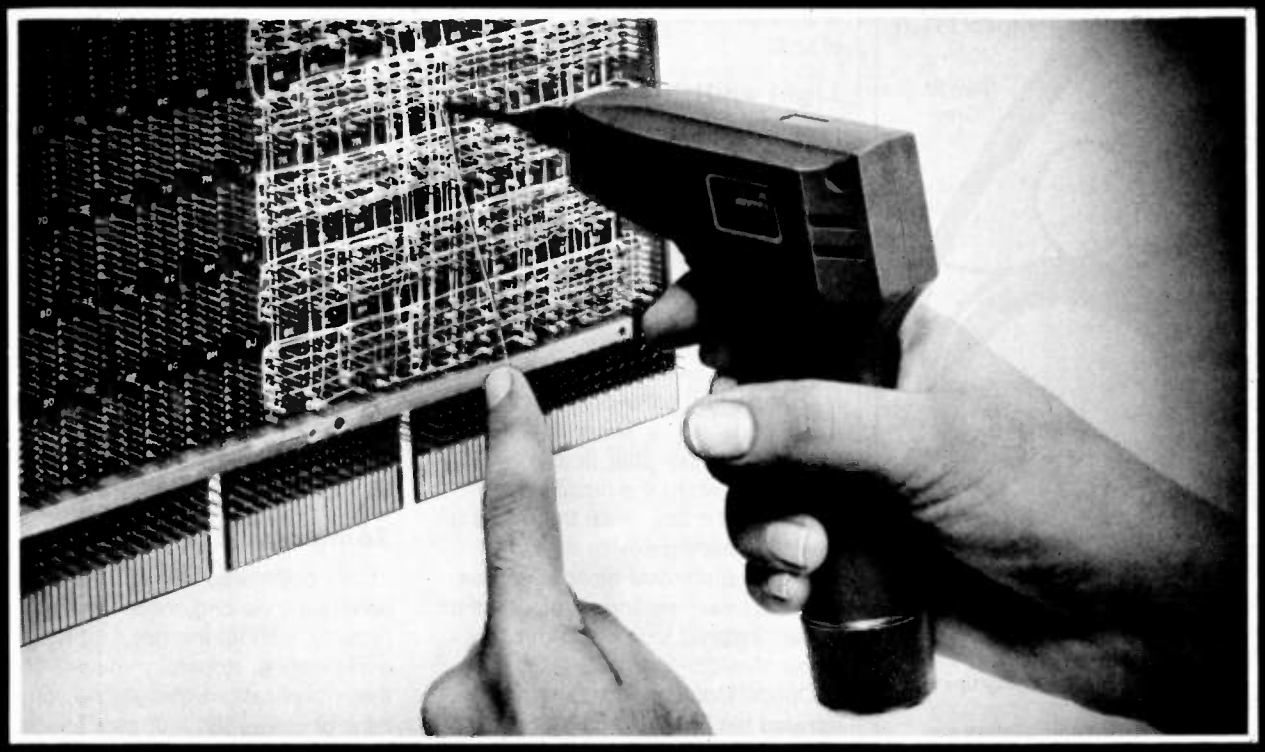

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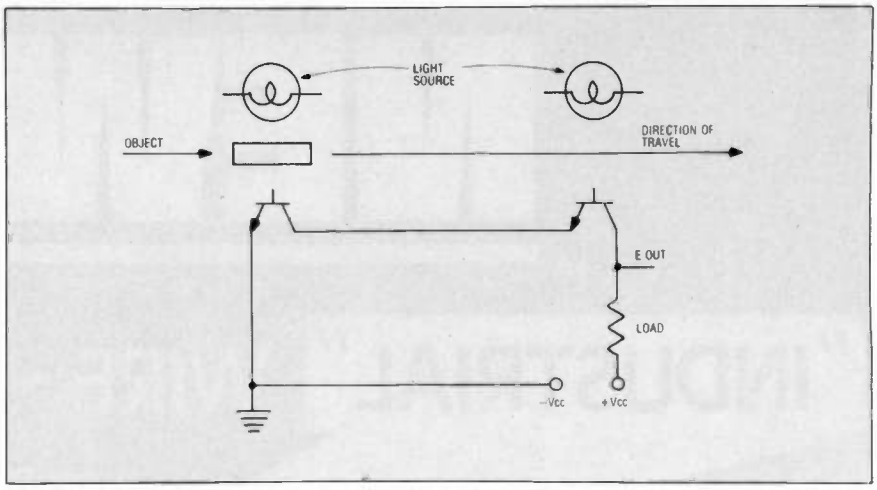

Fig. 7–A system for measuring velocity with light sensitive devices

at an illumination intensity of ten footcandles. Cells may be connected in series for increased voltage, parallel for greater current, or series-parallel. Photovoltaic cells are often loaded for maximum *power* output, which is somewhere between open and short circuit, depending upon the load requirements and the size and number of cells.

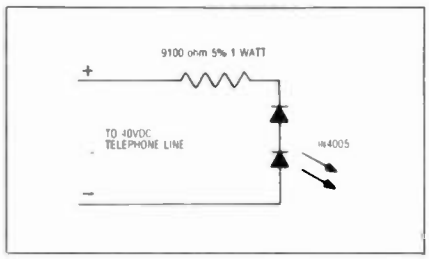

Fig. 8–A telephone "blinker"

Light emitting diodes

Light emitting diodes are operated with a forward bias, drawing typically, 20 milliamperes at under 2 volts for red, under 3 volts for amber, and under 4 volts for yellow or green devices used as indicator lights. Leds are low power devices, but by operating them in a pulsed mode, high *peak* power can be obtained, and this is useful when other opto devices are used as detectors. Unfortunately, pulsing does not offer much advantage when the human eye perceives the led, since the eye is an *average* reading device for rapid changes. Electronic devices can be used as *peak* reading detectors, thus pulsed infrared leds are commonly encountered.

Optical Couplers combine an infrared led emitter, and a photo transistor in one package, physically separated, but optically coupled, thus the only connection is via the light beam. The input and output are isolated from each other, and can operate at different voltage levels, *and do not require a common ground*. The frequency response is in hundreds of kilocycles. Sometimes a darlington configuration is used with the phototransistor, resulting in higher output current for the same light input, but the frequency response drops off by a factor of ten or so. When speed, rather than high output, is required, the phototransistor is often connected as a diode, using the base/collector junction only, in which case the frequency response is increased by a factor of about ten, into the megacycle range.

A device less frequently encountered is the Light Activated SCR, which functions in the same way as a conventional SCR, except that it is triggered on by light, instead of a gate pulse ... but some LASCRs feature dual triggering capability, with either a gate voltage pulse or light.

Some applications

At this point, with some of the basics behind us, we can show some circuitry, without the need for lengthy explanations. Hopefully you will find these applications stimulating you to think of others for your own special interests in both hobby and business.

Figure 4 is a detector for the presence or absence of colorless (transparent) liquids in a pipe or container. The liquid flows through a transparent piece of pipe. A light source provides parallel light rays, passed through a small diameter piece of opaque tubing, which pass through the pipe and its contents, and upon leaving the pipe the light rays pass through another piece of small diameter tubing and impinge upon a light detector.

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light rays are deflected differently if the pipe is empty, or full, due to the index of refraction of the liquid. If the setup is made so that the light rays pass through the pipe and onto the detector when the pipe is empty, then they will miss the detector when the pipe is filled ... and vice versa. The arrows indicate the direction of the light rays. A shorter assembly can be made if lenses are used instead of the pieces of small diameter tubing. Of course, the entire system should be placed inside of a light proof box in order to prevent external light sources interfering with proper operation. This system works well with liquid level indicators, flow meters, etc. Of course, we now understand that the light source used must have an output spectrum suitable for the detector, and that the radiation must be capable of passing through the pipe and the liquid. (Some glass, and certain liquids, do not pass ultraviolet, or infrared, and so forth.)

Other uses

Figure 5 is a low power line voltage monitor that can be added to any equipment lacking a pilot light. The led consumes little power, and unlike 117 volt pilot lights, has an indefinite life. The circuit produces no heat, needs no transformer, takes little space, and the leds come in several colors.

Figure 6 is a latching relay. Once struck by light, the circuit stays on until reset. When powered by a dc source, an SCR will stay on as long as the load current is greater than the holding current. To turn off the SCR, the load current must be reduced to zero (or close to it). The normally closed switch is used to reset the circuit by manually opening the circuit. The load can be a device other than a lamp, of course. Used as an intruder alarm, the circuit will turn on lights, gongs, sirens, etc., when struck by light ... and intruders need light to see by!

Figure 7 is a simple velocity measuring system. Normally both phototransistors are turned on and there is an output voltage across the load. When the light source is interrupted, the detector turns off, thus the output voltage drops. This happens twice (as the moving object passes each detector in turn) ... since the detectors are in series. The pulses can be used to start and stop the pulses from a generator feeding a counter, by means of logic gates. If the pulse generator runs at 1 megacycle, the resolution will be 1 microsecond, as an example. Knowing how far apart the sensors are, and the number of pulses counted, the speed can be determined. Thus if the sensors are ten feet apart, using a 1 megacycle generator, and counting 10,000 pulses, we would have traveled ten feet in 10,000 microseconds, or 1000 feet per second velocity. Actually, ordinary daylight can be used instead of the two light sources. For faster speeds, photo diodes can be used.

Security applications

We have already mentioned the fact that some leds and photodetectors operate at infrared wavelengths (invisible radiation). These are ideal for security system use. The detector usually has a piece of material in front of it, used as a filter, to remove radiation at other than the led frequency. Since the infrared cannot be seen, an intruder is unaware that he has broken the beam until the alarm sounds. If the current through the led is modulated by an audio amplifier, the output of the detector will contain the modulation information (communication on an infra red beam).

Figure 8 shows an interesting telephone application for leds, using the normal rotary dialer. As shown, the led draws no current from the line when the phone is not in use, but flashes when the phone rings, as a "silent call indicator." If the two input connections are reversed however, the led will glow at a low level when the phone is not in use. When any phone on the line (extension phones included) is activated, the led illumination drops almost to extinction. If any phone on the line is dialed, the led flashes the number dialed, one flash for "1", nine flashes for "9", etc. Interesting? ET/D

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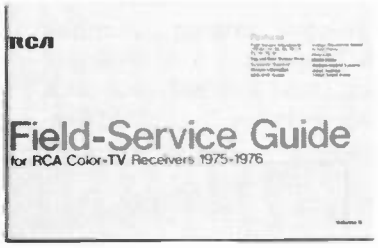

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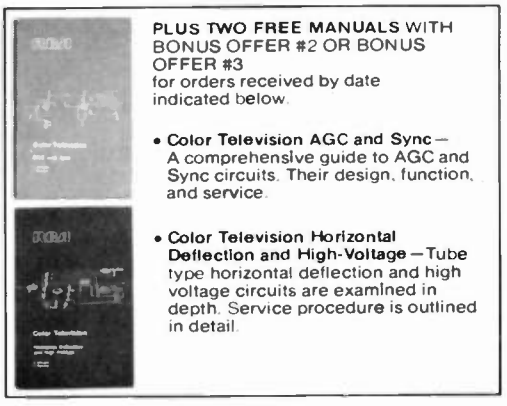

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Davis Antenna Company has issued a new dealer price list covering installation of UHF/VHF/FM antennas. Prices for work done by the company include a 25% commission to the dealer. Contact *Davis Antenna Company*, RT. 4 Box 335, Waldorf, MD 20601.

David Clark Company's Series 3400 communications system described in a free catalog now available from the company. The series 3400 amplified communications system is a self-contained system for applications where background noise or distance makes communicating difficult, as on construction sites, crane operations, large manufacturing facilities and sporting events. For copies of the catalog, contact *David Clark Company*, Communications Division, 374 Franklin St. Worcester, MA 01604.

Russell Industries, Inc., has announced the immediate availability of two new universal scanner, telescoping replacement antennas. Each covers all scanner frequencies, the manufacturer reports. One mounts to the real panel via a right angle Motorola plug and the other via a Motorola plug which is on a right angle to the telescoping antenna. Russell Industries says literature on the replacement antennas is available by writing *Russell Industries, Inc.*, 3069 Lawson Blvd., Oceanside, N.Y., 11572

OK Machine & Tool's latest catalog describes the company's line of wire wrapping tools, electronic tools, bins, pre-stripped wire and rolls, cable assemblies, and PCB kits and accessories. Copies of catalog 62C-1978 are available from *OK Machine & Tool*, 3455 Conner St., Bronx, NY 10475.

"Understanding Digital Electronics" the first of a planned "Understanding Series" of books from **Texas Instruments,** explains how the digital system, electronic devices and circuits work. "Understanding Calculator Math"

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Publication Date: September 1, 1978-Orders will be fulfilled within 60 days of the publication date or within 60 days of the date of order, if received after publication date.

covers information, formulas, facts and mathematical tools needed to use a calculator more efficiently. The soft-cover books are $3.95 each and may be ordered from *Texas Instruments*, P.O. Box 3640, MS 84, Dallas, TX 75285.

Meg-O-Volt Insulation Testers Models 510, 520 and 530 from Sperry Instruments are fully described in a new product data sheet. The data sheet contains detailed product descriptions, features, ranges and specifications. The Meg-O-Volt series features test voltages of 500 and 1,000 VDC, two separate low ohms scales and one AC voltage scale. For copies of the data sheet, contact David L. Weissman, *Sperry Instruments*, 245 Marcus Blvd., Hauppauge, NY 11787.

A new Semiconductor Guide is now available from Sylvania. The 1978 Sylvania ECG Semiconductor Industrial MRO Replacement Guide and Catalog has been recently announced by General Telephone and Electronics Corporation. According to the publisher listings in the 164 page guide have been increased from 35,000 to about 60,000 industry part numbers used in industrial and MRO applications with all part numbers cross-referenced in alphanumeric order to appropriate Sylvania replacements. The catalog contains 72 pages of technical data for listed types, including logic diagrams, pinouts and package drawings and information on new types added since the last edition and an expanded digital integrated circuit section describing 340 types in CMOS, TTL, DTL, HTL and RTL logic modes. Copies are available from authorized distributors of *Sylvania* electronic components.

The latest issue of T**he Hewlett-Packard Personal Calculator Digest** contains an article 'Engineering for the Cold, Cruel World,' which describes how HP calculators have survived falling into a fire, falling off a speeding motorcycle and being buried in frozen mud. It contains other articles about the advantages of RPN language, the Personal Programmers Club and an introductory article about programming. In includes letters to the editor, a question and answer section, a collection of unusual case histories, and an extensive catalog section describing and comparing the functions, specifications and software of each product in the HP calculator family.

Charts aid the reader's comparison of models. Publication #5953-1911D may be obtained free from *Inquiries Manager, Hewlett-Packard Company,* 1507 Page Mill Road, Palo Alto, CA 94304.

Electronic components, test equipment, hardware and tools are listed with prices in a newly released 104 page catalog. This catalog contains over 10,000 items including expanded lines of capacitors, resistors, trimmer potentiomters, semiconductors, switches, transformers and test equipment, at it is claimed, very competitive prices. This catalog is free from: Catalog, *Mouser Electronics,* 11511 Woodside Ave., Lakeside, CA 92040.

A "RF Interference Handbook" is now available from Sony. It gives detailed instructions for combating 25 different types of interference, from CB radio and broadcast stations, to video games and ignition systems. Sony claims corrective action for each of the 25 types is covered separately and completely, requiring no reference to other sections of the book. The handbook is available for $5 a copy from *Sony,* Technical Publications Dept., 47-47 Van Dam St., Long Island City, NY 11101

"Sounding Off About Rentals" is the title of an eight page brochure recently published by Perma Power Electronics Inc. Subtitled, "A Guide to Profitable Rental of Sound Equipment," it is designed for two distinct categories of readers, the operator of a rental company who needs advice about sound equipment, and the distributor or dealer in sound equipment who needs advice about rentals, according to Perma Power. They state also that it covers the market for rented sound equipment, the basic considerations for being in business, setting rates, selecting equipment, training personnel, handling rental transactions, maintenance, advertising and promotion, and charts on the types of portable public address equipment chosen by renters, reasons why renters do not buy, suggested inventory of basic types of equipment for rental operators, rental forms and sample advertising and promotional pieces. Perma Power Electronics claims to be the nation's largest manufacturer of portable sound systems, offering floor lecterns, table top rostrums, electronic megaphones and mobile units, as well as suitcase and attache case systems. The brochure is

free from *Perma Power Electronics Inc.* 5615 West Howard St., Chicago, IL 60648.

Four new modular power supplies are highlighted in Wall Industries new short form catalog. The two-page reference guide offers specifications and prices of Wall's new DC/DC Series L regulated converters, DC/DC Series B miniconverters, AC/DC Series T regulated miniature power supplies and DC/DC Series D high efficiency single output converters. Wall's standard AC/DC Series W regulated power supplies and DC/DC Series H proportional high voltage power supplies also are featured. Free copies of the short form catalog are available from *Wall Industries*, 175 Middlesex Turnpike, Bedford, MA 01730.

Complete with model numbers, specifications, PC layouts, mounting information and hardware, C&K Components' SFC 678 catalog describes the companie's subminiature and microminiature toggle, rocker, push-button and power switches. The 16-page catalog is available from *C&K Components*, 103 Morse St., Watertown, MA 02172.

The 48-page BK-79 catalog from Dynascan is the largest ever offered by the company and features a broad range of test instruments including oscilloscopes, frequency counters, digital and analog multimeters, function and RF signal generators, capacitance meter, digital probe, semiconductor testers, power supplies, and two-way radio and television test instruments. Each product description includes a detailed specification section and suggested applications. Also included in the catalog is a complete line of instrument probes, connecting cables and other accessories. Catalog BK-79 is available free from *B&K Precision, Dynascan Corp.*, 6460 W. Cortland Ave., Chicago, IL 60635.

Capitol Radio Engineering Institute has published a new course catalog for home study programs in electronic engineering technology. The 58-page booklet describes the CREI programs in general as well as providing detailed information on each at-home study course. Included in the new catalog is a new minicomputer and microprocessor technology program which includes a microprocessor laboratory. Copies of the catalog are available from *CREI*, 3939 Wisconsin Ave., NE, Washington, DC 20016.

Free literature describing its line of communications accessories for Motorola, General Electric, RCA and other radios is now available from Unex Laboratories. The literature covers security kits, wireless induction earphones and transducers, noise cancelling microphones, palm microphones and earphones and Flexicom headsets. Contact Thomas H. Murphy. *Unex Laboratories*, Hathorne (Danvers) MA 01937.

A new four-page brochure describes the broad line of liquid crystal display products available from LADCOR. In addition to the line of displays which LADCOR supplies to the watch and clock industry the brochure also describes their line of displays which are available for applications that require displays capable of being multiplexed. Since many LCD programs require custom displays, the brochure makes a strong point regarding the custom design and production capability of LADCOR. LADCOR, a wholly owned subsidiary of the Lausanne Organization S.A., may be contacted by writing Donald B. Rogers, vice president, marketing, *LADCOR*, 348 E. Middlefield, Mountain View, Calif. 94304. ET/D

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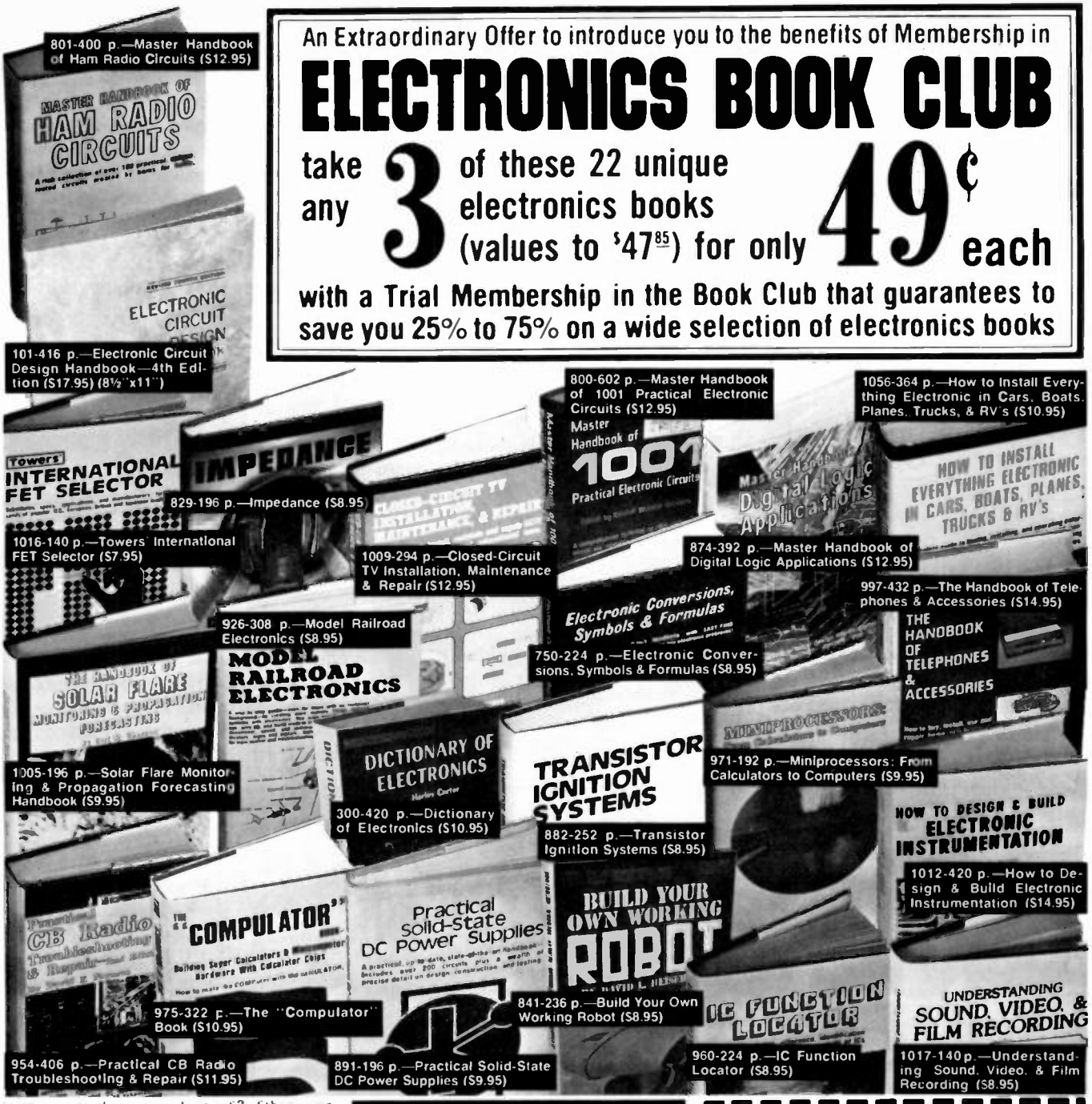

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Circle No. 116 on Reader Inquiry Card

DEALER'S SHOWCASE

Disco Film

Circle No. 154 on Reader Inquiry Card

Disco Film, a film-forming solution that peels off when dry to remove dirt and grime from record grooves has been introduced by *Empire Scientific Corp.* A water-soluble solution that is harmless to vinyl, Disco Film is sponged over the record surface with a built-in applicator. When dry, a flexible film is formed, which is peeled off with Scotch tape. One container of Disco Film, with suggested resale price of $29.95, will clean up to 70 vinyl LP record sides.

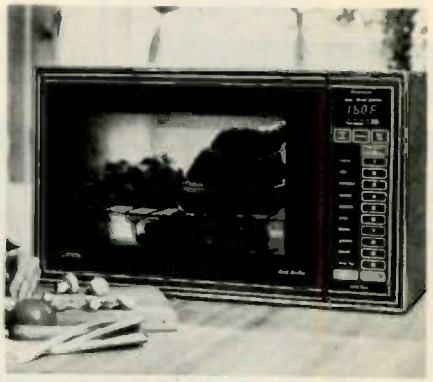
AM/FM/CB Combo

Circle No. 155 on Reader Inquiry Card

An in-dash AM/FM/MPX pushbotton radio/CB transceiver has been added to the autosound products offered by *RCA Distributor and Special Products Division.* The 40-channel CB portion of the Model 14T405 features phaselock-loop frequency synthesizer, LED channel readout, delta tune, built-in ANL, lighted S/RF meter and detachable microphone. A CB monitor switch allows CB transmissions to break in on AM or FM radio. The AM/FM/MPX portion of the radio includes five pushbuttons for any combination of AM and FM stations, slidebar control for AM/FM selection, fader and balance controls, built-in AFC, FM stereo indicator light and AM antenna trimmer. The unit can be hooked-up as a two-speaker or four-speaker system. Suggested list price is $259.95.

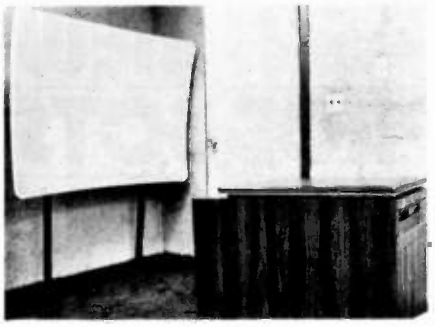
Microwave Oven

Circle No. 156 on Reader Inquiry Card



Litton Model 560 microwave oven now offers several new features. In addition to its Meal-In-One feature by which it can cook a three course meal all at once, it now offers pre-programmed settings to cook or reheat 47 frequently prepared

foods and many complete meals, stated William George of *Litton*. He said also, another new feature called Defrost II cuts defrosting time by 20 to 40 percent, that a pound of hamburger can be defrosted and ready to cook in only five minutes. This is made possible by the automatic adjustment of power levels during defrosting. The Defrost II system begins operation with a high power setting. As the ice crystals begin to melt, the power level is reduced to keep the surface of the food from cooking. Other features include the ability to automatically switch from cooking by time to cooking by temperature, a beep to indicate time to turn, stir or add an ingredient halfway thru the cooking cycle, variable power oven control, automatic temperature control, a 1.5 cu. ft. interior, a 99-minute timer and a new cookbook. It retails for $629.



Projection TV System

Circle No. 157 on Reader Inquiry Card

Sharp Electronics Corporation has just released information on their new large screen projection color television system. According to Sharp the system uses three projection tubes, a tri-potential electrostatic focus coil and a comb filter circuit, which along with a high performance screen produces a very bright and clear picture. It has a "setting string" and a built-in cross-line pattern generator for each setup, touch electronic channel selector and an ultrasonic remote control for channel change, off-on and volume. The system consists of a 72 inch, diagonal, screen (XO-720 SC) and a projector (XV-7200). The retail price is under $4000.

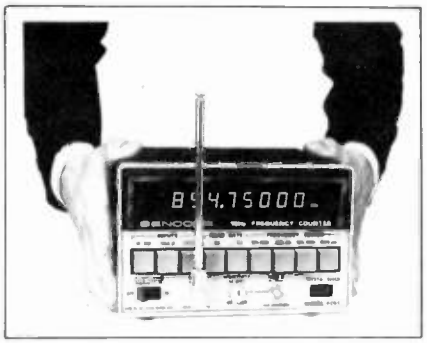
40-Channel Converter

Circle No. 158 on Reader Inquiry Card

The Sylvania 4041, a programmable 40-channel converter utilizing a microcomputer to allow cable television subscribers to store up to 10 channels in the unit's memory systems and recall them sequentially, is now available from *GTE Sylvania*. The converter's hand-held remote control unit has a 12-button, sealed keyboard and LED channel indicator. It connects to an RF processor at the television receiver with a plug-in 25-

foot interconnect cable. The unit employs a crystal-controlled frequency synthesizer which the company says eliminates fine tuning circuitry and converter drift. The programmable converter is available with optional on/off remote action and one-, two- or three-channel descrambling module for pay television applications. Optional extension cords for the interconnect cable also are available. ETD

NEW PRODUCTS



1 GHz Counter

Circle No. 159 on Reader Inquiry Card

The model FC51, a 1 GHz, direct-reading pushbutton frequency counter has been introduced by *Sencore* for measurements in the 806-947 MHz business communication and police band. It features .5 parts per million accuracy to enable testing to FCC specification in the 902-928 MHz medical electronics and industrial scientific band, the 470-806 MHz UHF TV band and the 947-952 MHz broadcast band. A 50 ohm input is provided for communications measurements from 10 MHz to 1GHz at an average sensitivity of 100 millivolts. A separate 1 megohm high sensitivity jack is provided for direct connections to digital circuitry, PLL feedback circuitry and control pulse circuitry to 10 millivolts. A built-in sensitivity control is used when measuring complex waveforms to reduce sensitivity so that only the frequency component with the greatest amplitude reads. The FC51 is powered by 115 VAC or plugs into a 12 volt cigar lighter for remote checks. Price is $975.

Germanium Small-Signal Devices

Circle No. 160 on Reader Inquiry Card

Three germanium small-signal devices from *Germanium Power Devices* now meet MIL-S-19599/126C specifications. The 3 MHz, 5 MHz and 10 Mhz devices

all are rated to 150 mw, with BVCEO at 25V. All are PNP types with applications in military communications and computer equipment.

New Amplifiers

Circle No. 161 on Reader Inquiry Card

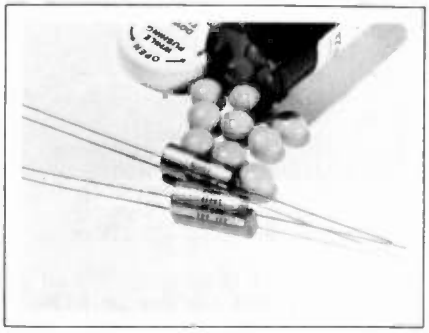
The Maximizer Series 5000, a new line of TV-FM antenna amplifiers, has been introduced by *TACO/Jerrold Distributor Sales Division*. According to TACO/

Jerrold, the seven new Maximizer models offer high gain and low noise figures to improve picture quality and permit signal reception even in the most difficult reception areas. Each Maximizer system includes a high gain preamplifier and an indoor power supply with TV set outlets, in addition to a built-in FM option to provide FM band interference suppression, supplemented by a tuneable trap for full amplification of the FM band. An all-weather housing seals the input and output terminals, and a single universal mounting bracket allows for mounting directly to the terminals of most square boom antennas or to the mast of other antenna installations.

Polycarbonate Capacitors

Circle No. 162 on Reader Inquiry Card

TRW Capacitors has introduced a new series of metalized polycarbonate capacitors described as the smallest hermetically-sealed units available. TRW Types X482 and X483 capacitors



are available in metal-enclosed cases as small as .175 inches × 9/16 inches with capacitance values from .001 mfd to 10.0 mfd. Rated from 50 VDC to 400 VDC, the units have tolerances to ±1% and a dissipation factor of less than

0.3% when measured at or referred to 1000 Hz, ±20. Operating temperature range is -55 C to +125 C.

Six digit Counter

Circle No. 163 on Reader Inquiry Card

The Mini-Max, a small, inexpensive frequency counter with 50 MHz guaranteed performance, is now available from *Continental Specialties Corporation*. The 3 '' × 6 '' × 1½ '' calculator-styled counter features a six-digit magnified

LED display with 100 Hz resolution and 10 times per second update. A UHF FET preamplifier provides good weak signal performance and also permits the Mini-Max to be driven directly from a optional whip antenna. The unit uses a standard TV color burst crystal for its timebase and is rated at ±3 ppm accuracy. Power consumption is less than 70 mA. Suggested resale price of the Mini-Max counter is $89.95. Available options and accessories include whip antenna, input cables, carrying cases and AC and automotive battery eliminators.

IC Inserters

Circle No. 164 on Reader Inquiry Card

Techni-Tool has expanded its Little Dipper line of DIP inserters to four models, and now offers the units for 8-10, 14-16, 28 and 40 pin DIP configurations. Called the fastest manual inserters available, the Little Dipper inserters feature non-wearing construction and self-aligning characteristics, adjustable center spacing, no-stress insertion and static control for handling MOS and CMOS devices.

Small Mobile Radio

Circle No. 165 on Reader Inquiry Card

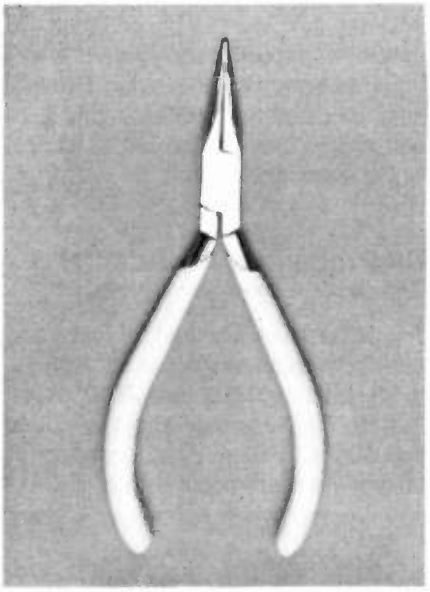
Motorola has introduced a new under-dash FM two-way mobile radio, The MAXAR-80. This radio offers considerable power for its size and price the manufacturer states. It is 2½ inches high by 6½ inches wide by 10½ inches long and is rated at 55 watts low band, 25 and 50 watts high band, and 30 watts UHF. Motorola also claims increased selectivity, sensitivity and intermodulation protection for top performance in congested urban areas. Accessories include "Private Line" and "Digital Private Line" tone squelch, and "Extender" noise re-

duction circuit options. The MAXAR-80 can be used as a base station, a control station in the UHF model and as a base station to contact up to 100 personnel equipped with Motorola tone or tone and voice pagers. MAXAR prices begin at $675.

Chain Nose Plier

Circle No. 166 on Reader Inquiry Card

A new miniature chain nose plier for extra fine bending, forming or holding of delicate parts has been added to the *Hunter Tool* line. Designated No. 20145, the new plier features a plastic dipped handle, color coded for identification. The new tool is made of chrome vanadium steel, and comes complete with



coil spring that returns the plier to an open position. The 20145 is 4½ inches long and has a narrow jaw for reaching into tight spots. It has radiused edges and a smooth gripping surface for delicate assemblies.

Solder Cream in Tubes

Circle No. 167 on Reader Inquiry Card

A series of solder creams packaged in dispenser tubes and blister packed on display cards is now available from *Multicore Solders*. The cream is a mixture of

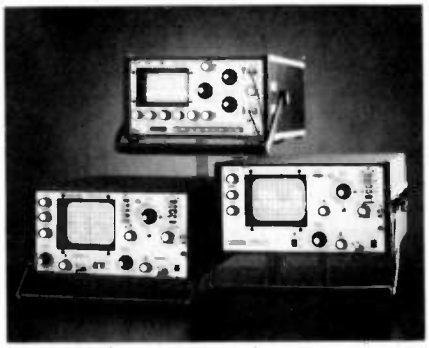
Circle No. 122 on Reader Inquiry Card

solder and flux that can be placed prior to heat application. Because the material is tacky, it will hold parts in place until the solder is melted, thus eliminating the need for clamps, jigs or a second pair of hands. The cream is available in three formulations for electrical soldering, all-purpose metal joining and lead-free, non-toxic alloy for stainless steel, houseware and jewelry applications.

New Oscilloscopes

Circle No. 168 on Reader Inquiry Card

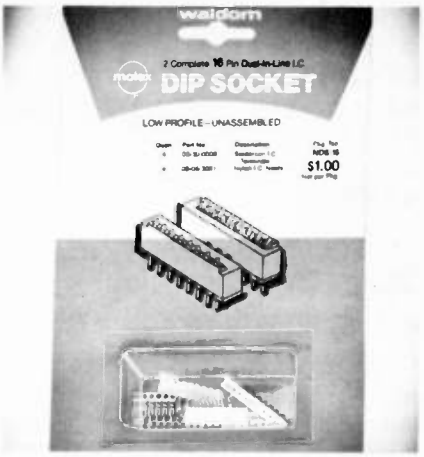
Three low-priced oscilloscopes for commercial, industrial and consumer products service, featuring automatic triggering, have been introduced by *Hickok Electrical Instruments*. The Model 532 ($995 including probes) is a dual trace 30 MHz scope with 11.7 nanosecond risetime and a built-in delay line for leading edge viewing of fast risetime pulses. A full time 4x expansion allows any portion of a pulse train up to 40 full divisions long to be viewed without a multiplier and the unit is capable of testing most digital logic circuits, including microprocessors. The Model 517 ($695 including probes) is a dual trace 15 MHz scope with 5 mV/cm sensitivity and triggering up to 30 MHz. It features automatic selection of chopped or alternate operation in dual trace mode depending on sweep speed selected, algebraic sum and difference capability and TV line and frame sync circuits. The Model 515 ($495 including probes) is a single trace version of the Model 517. TV sync separators are built in for easy locking to TV video wave forms at any sweep speed, and it provides x-y operation for vectorscope measurements.



IC DIP Sockets

Circle No. 169 on Reader Inquiry Card

A new line of unassembled Molex 14-pin and 16-pin dual-in-line IC DIP sockets has been developed by *Waldom Electronics*. The assembly parts to make two complete 14-pin sockets sell for 95 cents, 16-pin sockets sell for $1. Each



display card package includes 4 solder-con IC terminal carrier strips and 4 nylon IC nests. Assembled, they make 2 complete 14-pin or 16-pin dual-in-line IC sockets. Terminals are made of 70/30spring tempered tin plated brass. To assemble, the user simply inserts the IC terminal strip into the nylon housing nest, and then the nest assembly is inserted into the printed circuit board, which the user furnishes.

RF Probe and AC Adapter

Circle No. 170 on Reader Inquiry Card

Triplett has introduced an RF probe and an AC clamp-on adapter as accessories to its Models 3300 and 3000 digital VOMs. The RF probe is said to extend the VOM's frequency response for AC voltage measurements with a range of

50 KHz to 200 MHz. Set selector switch voltage is from 2-200 volts, with 35 VAC maximum for the probe. In addition to measuring RF voltage, the probe with the tester may be used as a signal tracer and gain analyzer. The AC clamp-on ammeter adapter will measure AC current from a single conductor of the circuit, reading out directly as AC amperes. Accuracy is ±5% from 5-200 amperes. Below 5 amperes, Triplett says that accuracy can be maintained by looping two

or more turns of the conductor through the clamp and dividing the reading obtained by the number of loops. The RF probe, Model 79-411, is priced at $16; the Model 10-D-clamp-on ammeter adapter sells for $30.

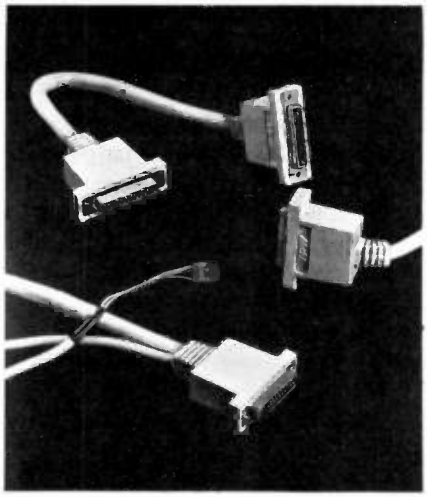
Miniature pliers

Circle No. 171 on Reader Inquiry Card

Designed for holding, bending and cutting fine wire, *Xcelite* offers 13 new miniature electronic pliers from 4 " to 6 " long with coil spring openers, blue plastic-coated cushion grips and polished heads. Available carded or in bulk, the types include chain and needle nose, looping, tip and diagnonal cutters, and a special stainless steel pliers for trimming circuit boards and continuous snap cutting of component wire.

Molded Cable Line

Circle No. 172 on Reader Inquiry Card



A line of molded cable assemblies said to feature fully functional strain relief and an external covering to withstand user abuse is now available from *TRW Holyoke Wire & Cable*. Available in any length, shielded or unshielded, the assemblies are available in 9-, 15-, 25-, 37-, or 50-position D-subminiature connectors. All 25-position cable assemblies meet the requirements of EIA Specification RS232, and 9- and 37-position assemblies meet EIA Specification RS449. In addition, all cables have UL approval. The cables are furnished in EIA color-coded 22-ga. wire, and other sizes and types can be provided. Custom features, including supplying the assemblies with one end stripped and tinned, with special connectors or special colors, also are available.

TVI Filters

Circle No. 173 on Reader Inquiry Card

Two new low pass TVI filters, the XLP-150 and the XLP-500, have been announced by *Telco Products*. The XLP-150 is said to handle more than 150

watts AM and 300 watts PEP SSB, suppressing all harmonics above 41 MHz by more than 75 dB. The XLP-500 is said to handle more than 500 watts AM and 1,000 watts PEP SSB, suppressing all

harmonics above 38 MHz by more than 95 dB. Both units are installed in the coax transmission line with standard PL-259-type connectors with no input-output polarity necessary. Suggested resale price of the XLP-150 is $14.50; for the XLP-500, $24.50.

High Voltage Resistor

Circle No. 174 on Reader Inquiry Card

Six sizes of T-series carbon film resistors for high voltage and high impedance applications are now available from *American Components, Inc.* Standard resistance values range from 1 megohm

to 1 terohm with resistance tolerance range of ±5%, ±10%, ±15% and ±20% and ratings to 3 watts, 15kV. All T-series resistors are supplied with mylar protective sleeves.

High-Speed Logic Troubleshooter

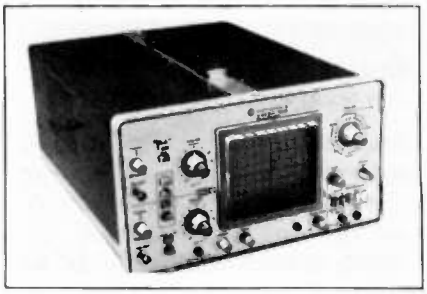
Circle No. 175 on Reader Inquiry Card

The Model 5700B Scanmaster from *Information Scan Technology* enables rapid pushbutton probe of IC module pins without counting and without making an individual connection to the pin. A panel switch allows user selection of logic thresholds for testing CMOS, TTL, HTL, RTL and DTL. The Scanmaster simultaneously interfaces the signal on the pin under test to an external oscilloscope, counter or other test instrument while probing and features a built-in dual-threshold high speed logic state analyzer, a 3½ digit voltmeter and a universal logic pulser. The unit is priced at $1,295.

Oscilloscope

Circle No. 176 on Reader Inquiry Card

A five-inch, dual-trace oscilloscope, described as a simplified portable unit with features usually found only in lab mod-

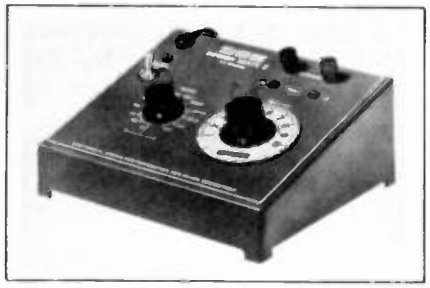


els, is now available from *Motorola, Inc., Communications Division*. The R-1004A is a 15 MHz bandwidth scope featuring 5 MV/cm vertical sensitivity, 20 calibrated sweep steps, with sweep down to 40 nanosec/ cm. The R-1004A includes three horizontal time base presets for servicing closed circuit or cable television receivers, automatic trigger circuits to provide a base line display in the absence of signal and automatic selecting between the chopped or alternate display mode. In addition, the unit may be used as a calibrated horizontal amplifier for X-Y displays of any signal.

Nulling Bridge

Circle No. 177 on Reader Inquiry Card

A nulling R/C bridge priced at $74.95, is now available from *Continental Specialties*. The Design Mate-3 features two LEDs with high/low markings to perform as a null detector with better than 5% accuracy, the company says, and can

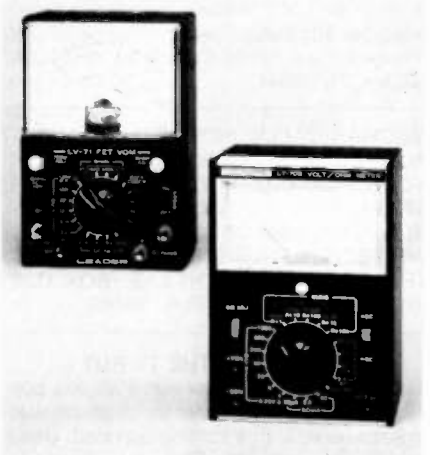


measure resistances between 10 ohms and 10 megohms in six ranges and capacitances between 10 pFd and 1.0 pFd. The unit's package, including a built-in 117 VAC 60 Hz power supply, weight 2 lb. It comes completely wired and calibrated and includes instructions covering applications and unit's operational theory.

Analog Multimeters

Circle No. 178 on Reader Inquiry Card

A battery operated VOM which reads as low as 0.75 volts and 50 microamps, full scale, and a solid state FET VOM which has 12 voltage ranges and four current ranges are now available from *Leader Instruments*. Protected against overload

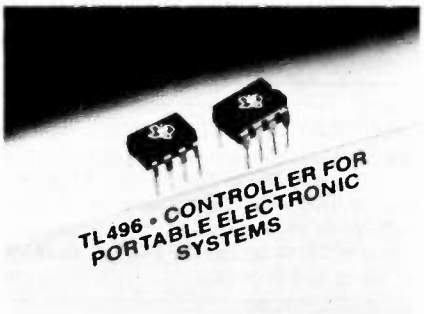


and polarity reversal, the LT-70B VOM operates on two AA batteries. Voltage ranges are from 0.25 volts to 1,000 volts DC and 2.5 volts to 250 volts AC. There are four current ranges: 50 microamps, 2.5 and 50 milliamps DC and 0 to 2.5 amps AC. Diode leakage testing is from 0.75 milliamps to 75 milliamps. Price of the LT-70B is $42.50. The LV-71 VOM features dual FET amplifier circuitry, a polarity reversal switch, battery condition checkout and diode overload meter protection. This new analog multimeter is priced at $69.95.

Power Supply Controller IC

Circle No. 179 on Reader Inquiry Card

The TL496C power supply controller IC, designed for portable electronic systems, is now available from *Texas Instruments*. The controller can provide a 9-volt regulated system supply from a transformer-coupled AC input or a two-



cell battery standby source. It also allows batteries to be recharged through one external diode when operating on the transformer-coupled source. A new monolithic IC, the TL496C is operable from 1.7 to 3.7 volts and contains voltage reference, pulse generator and timing circuitry, error amplifier, blocking diode and an output switching transistor. Other functions onboard the chip are rectifier diodes, a series pass regulator for operation from transformer-coupled AC input and the catch diode required to provide the battery charging function. Pricing in 100-piece quantities is $0.66 each.

Desoldering Tool

Circle No. 180 on Reader Inquiry Card

Chemtronics' new D5 desoldering tool features an effective desoldering wick in a refillable dispenser tool to aid in more efficient desodering while economizing on wick use. The pocketsized tool consists of a 1 in. plastic cylinder which

holds five feet of desoldering wick in either .06 in. or .10 in. diameters. The braided wick is fed through a Teflon probe which allows the user to shape the wick to provide maximum absorbancy. The copper braid meets all military specifications and NASA publications requirements and uses a rosin flux which is non-activated and free from halogens and corrosive chlorides. The D5 desoldering tool is available by itself or as part of Chemtronics' SD5 system.

RCA

continued from page 35

Display Lock switch. When this condition prevails, the potential at the Time-Out terminal never goes up because the closed switch shorts the terminal to ground through Q12.

Troubleshooting

Troubleshooting the DA system is not much different from servicing any modular chassis. The preliminary troubleshooting procedure calls for functional analysis of trouble symptoms and isolation of troubles to sub-systems or individual modules. Common techniques used in locating the defective module or even defective individual components include inspection of module connectors and cabling, resistance and voltage measurements, signal tracing, module reinsertion and module substitution.

Certain precautionary measures must be taken in handling the modules during the troubleshooting of the DA system. First, the receiver must be unplugged from the AC outlet before attempting any module removal; second, static electricity or any residual DC potential associated with human body, off-chassis components or modules, or even troubleshooting tools, must be discharged by touching the associated agent to the receiver main chassis before proceeding; and third, the removed or replacement module must be handled only by its metal frame. The practices cited above are necessary for a safeguard against possible damage to the delicate MOS IC's mounted on various modules.

It should be noted a number of unusual symptoms have been noticed through field experience. The causes for these symptoms may not be immediately clear even after functional analysis. Case studies in the field have contributed to the understanding of these unusual symptoms. Table 3 lists some of the unusual symptoms along with possible causes and their suggested solutions. ETD

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104MP	1.94	3.20	168	1.40	2.25	233	.68	1.02
105	2.76	4.22	169	1.98	3.05	234	.65	1.00
106	.60	.95	170	3.05	4.95	235	4.25	6.30
107	.81	1.35	171	1.30	2.15	236	7.57	10.40
108	.96	1.53	172	.56	.90	237	5.62	8.10
109	.26	.33	173BP	4.76	6.54	238	11.50	15.75
110MP	.35	.54	175	1.52	2.25	239	2.75	3.63
112	.69	.87	176	2.39	3.94	241	1.55	2.29
113	.30	.60	177	.56	.90	242	1.75	2.52
114	.30	.60	178MP	.60	.95	243	2.04	2.69
116	.36	.66	179	5.69	8.88	244	2.75	3.63
117	.39	.60	180	5.35	8.84	245	3.33	4.40
118	1.54	2.95	181	4.65	7.50	246	4.39	5.80
120	.56	.90	182	3.05	4.40	247	3.61	4.77
121	1.96	3.18	183	3.30	5.00	248	4.85	6.42
121MP	3.92	6.36	184	1.25	1.99	249	6.34	8.38
122	1.95	3.30	185	1.55	2.29	250	6.42	8.50
123	.66	1.05	186	1.42	2.29	251	6.34	8.38
123A	.89	1.32	187	1.60	2.50	252	6.42	8.50
124	1.40	2.30	188	1.45	2.20	253	1.56	2.06
125	.55	.79	189	1.65	2.50	254	1.83	2.41
126	1.16	1.85	190	2.05	3.10	261	1.62	1.95
127	4.60	7.50	191	2.30	3.80	262	1.80	2.16
128	1.25	1.75	192	1.13	1.80	263	1.62	1.95
129	1.35	1.85	193	1.20	1.86	264	2.44	2.93
130	2.30	3.80	194	.63	1.05	274	2.12	2.80
130MP	4.60	7.60	195A	2.67	3.95	280	4.60	6.30
131	1.88	2.84	196	1.88	2.70	281	6.00	8.20
131MP	3.76	5.68	197	1.75	2.52	282	4.71	6.45
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154	2.13	3.30	218	3.42	5.25	287	.63	.86
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156	.85	1.30	220	1.57	2.50	289	.80	1.10
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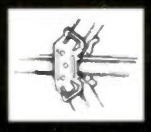

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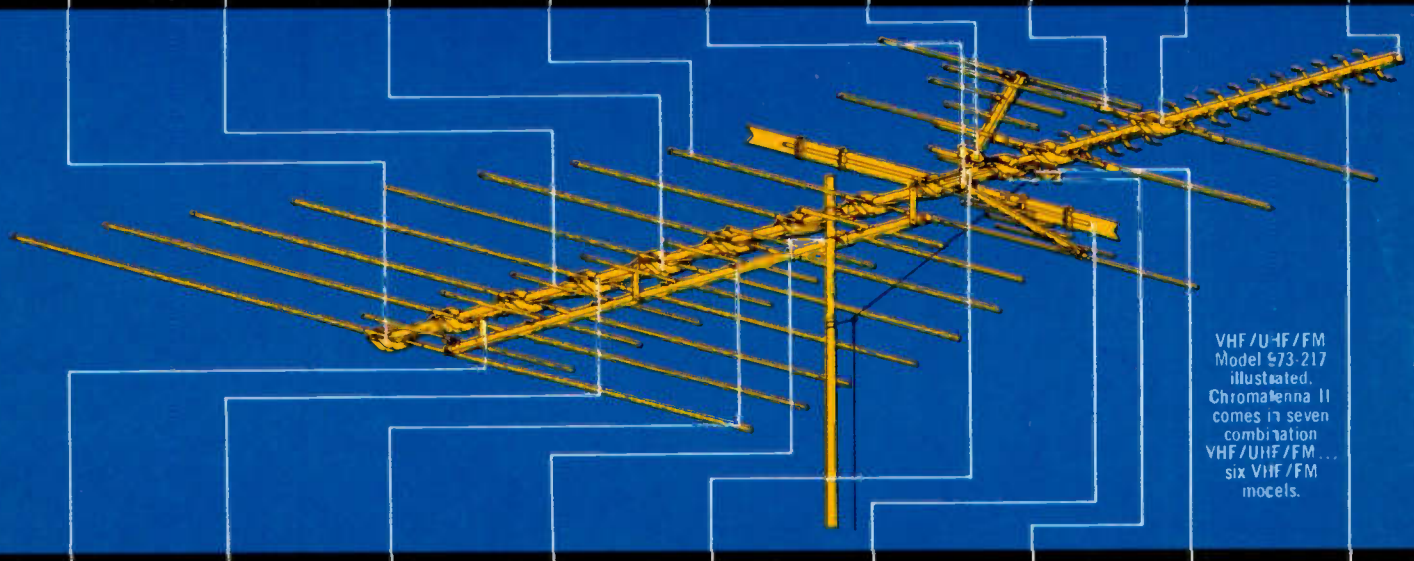

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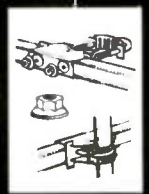

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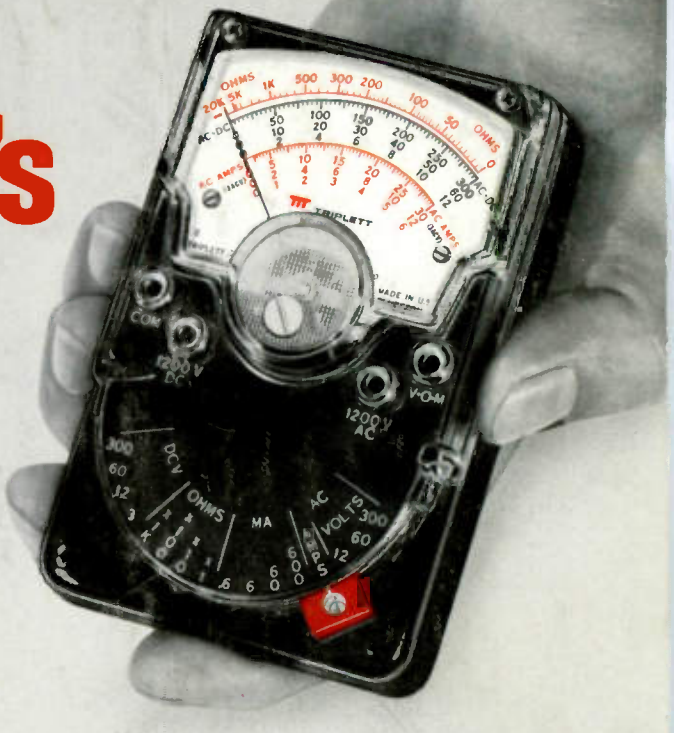

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