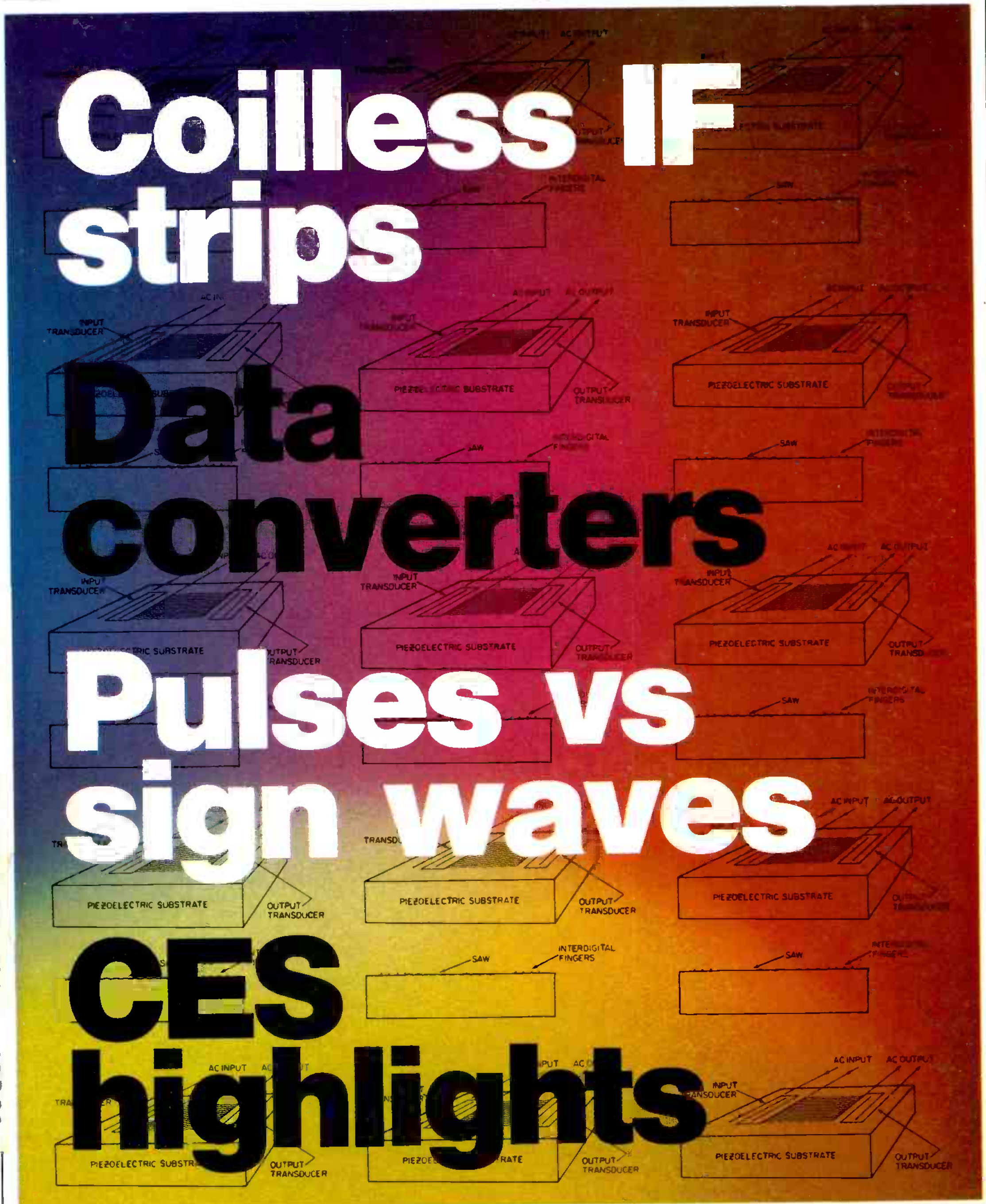
# ET/D

AUGUST 1979 • $1.00

**ELECTRONIC TECHNICIAN/DEALER**

LEADING THE CONSUMER AND INDUSTRIAL SERVICE MARKETS




## Coilless IF strips

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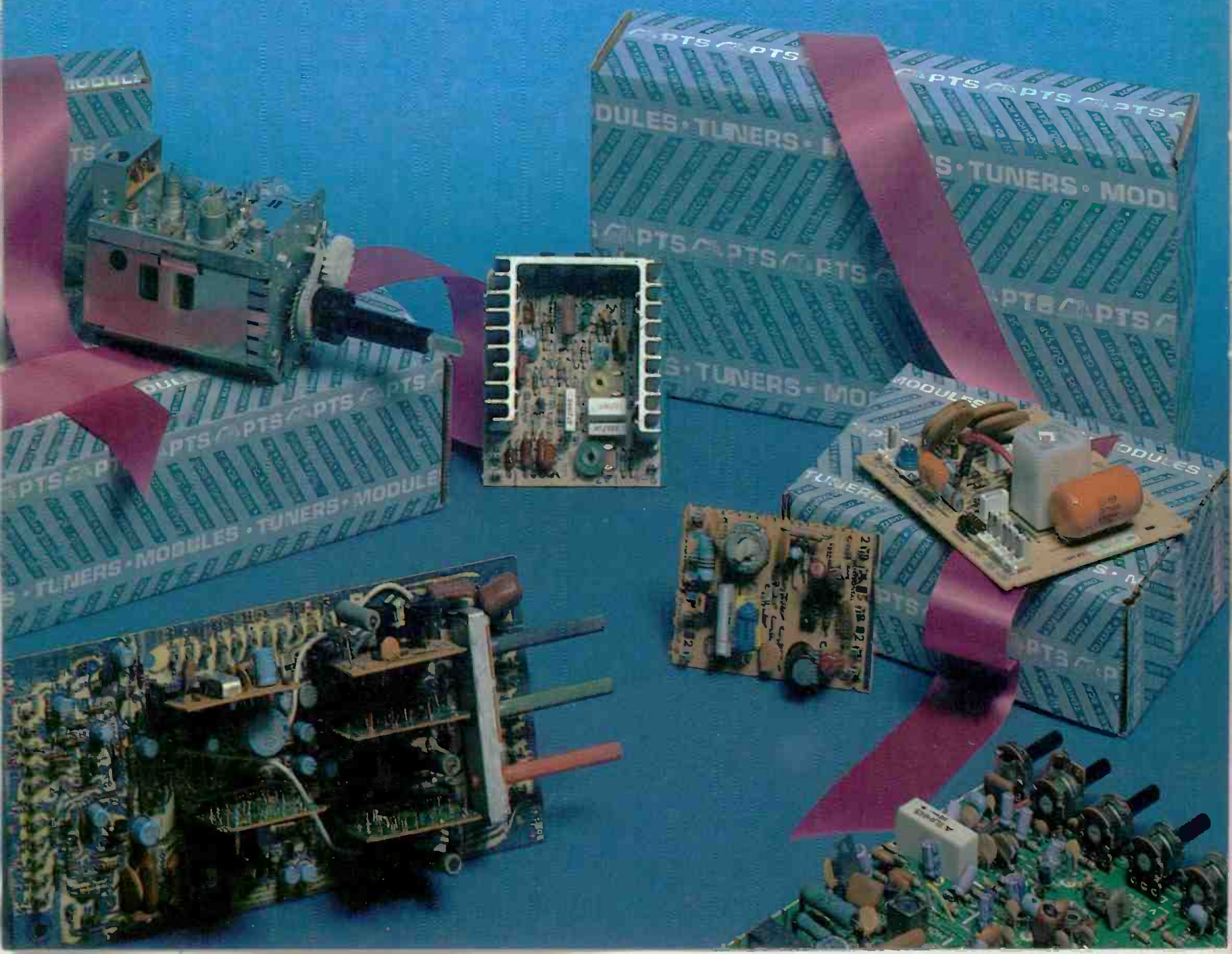

# INDUSTRY REPORT

## Microelectronics Forges Substantial Change, says EIA

Microcomputers and microelectronics in general are forging large and significant changes on American business, Americans in general, and the economy as a whole.

According to a report in the Electronic Industries Association's 1979 *Market Data Book,* recent advances in hardware now permit microcomputers to handle the higher level language software packages until recently used only in conjunction with large computers.

The EIA report said:

"Microcomputers are introducing many changes in the prevailing structures in business and in the economy as a whole. Beyond the effects within the electronic industries, the adoption of microcomputers is initiating extensive changes in other important manufacturing industries. Employment patterns in manufacturing as well as service industries are also being significantly affected ... "

"The effect of microelectronics developments on consumers has social implications that extend beyond economics. One significant consequence is that highly sophisticated products that have previously been available only to institutional buyers are becoming available to, and perhaps indispensible to, the individual, private consumer. Information and communication tools, previously restricted to use by government and large corporation, are becoming more and more accessible to the individual citizen."

## Industrial Electronics Market Surges

Although the (factory) sales of all electronic equipment and systems totaled some $65 billion last year for a 14.9 per cent growth rate compared to 1977, only the industrial market segment exceeded that average.

According to statistics compiled by the Electronic Industries Association, of the four components comprising the electronics marketplace, three of the industry groups—consumer, components, and communications, all showed negative growth rates in 1978 compared to their growth rates a year earlier.

The consumer segment, which comprised 14.4 per cent of the total market in 1977, last year dropped to 14.3 per cent. Similarly the components segment dropped from 17.7 per cent to 17.5 per cent; and communication receded from 31.3 per cent to 30.5 per cent.

Only industrial, with factory sales of some $25.5 billion (an 18 per cent increase over 1977), showed an increase advancing from 36.6 per cent of the total market to 37.7 per cent.

One significant milestone was reached in the television marketplace, according to EIA. The number of color sets in use surpassed the number of black and white for the first time in history.

Moreover, EIA adds, the "modern color set is becoming more than a broadcast receiver" as it is now being used in conjunction with video games, home computers, pay and cable TV, and video discs and tape cassettes. The name "television" itself may be obsolete, EIA said, since it means viewing at a distance.

## NESDA Transported to Texas

In an unexpected action, the executive council of the National Electronic Service Dealers Association (NESDA) has moved the administrative headquarters from Indianapolis to Ft. Worth, Tex.

In the latest episode in the continuing saga, begun early this year with the resignation of Charles Porter as executive director, it was announced that Texas Electronics Association (TEA) executive director J.W. Williams will take over as chief administrator of NESDA and ISCET.

According to a NESDA statement, the action was taken with the concurrance of NESDA President Bob Villont and ISCET Acting Chairman Forest Belt.

W. S. (Bob) Harrison, editor of *ServiceShop* magazine has been retained as publications editor, it was announced, and the magazine will immediately begin publishing on a six, instead of 12, times a year basis. Marti McPherson, interim NESDA administrator following the resignation of Porter, will continue as editor of the association's annual yearbook in Indianapolis, the statement said.

William said the physical relocation of the office began June 3 and was completed by the 30th of the month. All association functions were continued without interruption, he said, including the organization's annual convention in Tucson, Az.

Williams said he considered his main priority to "improve upon NESDA's ability to communicate and respond to the membership."

The organization's new address is 2708 W. Berry St., Fort Worth, Tex., 76109. NESDA's phone number is 921-9061 and ISCET's is 921-9101. Both area codes are 817.

## Philips to Make Scopes in U.S.

Dominick Protomastro, president of Philips Electronic Instruments, Inc., has announced that Philips plans to manufacture oscilloscopes in the U.S.

"We expect to have the American-

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ELECTRONIC TECHNICIAN/DEALER
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AUGUST 1979, VOL. 101, NO. 8



## FEATURES



**Coilless IF strips**
**Data converters**
**Pulses vs sign waves**
**CES highlights**

**On the cover:** The Surface Acoustic Wave filter could well replace IF bandpass tuning in TV receivers very soon. This month's cover background's repeating pattern emphasises its potential importance.

## DEPARTMENTS



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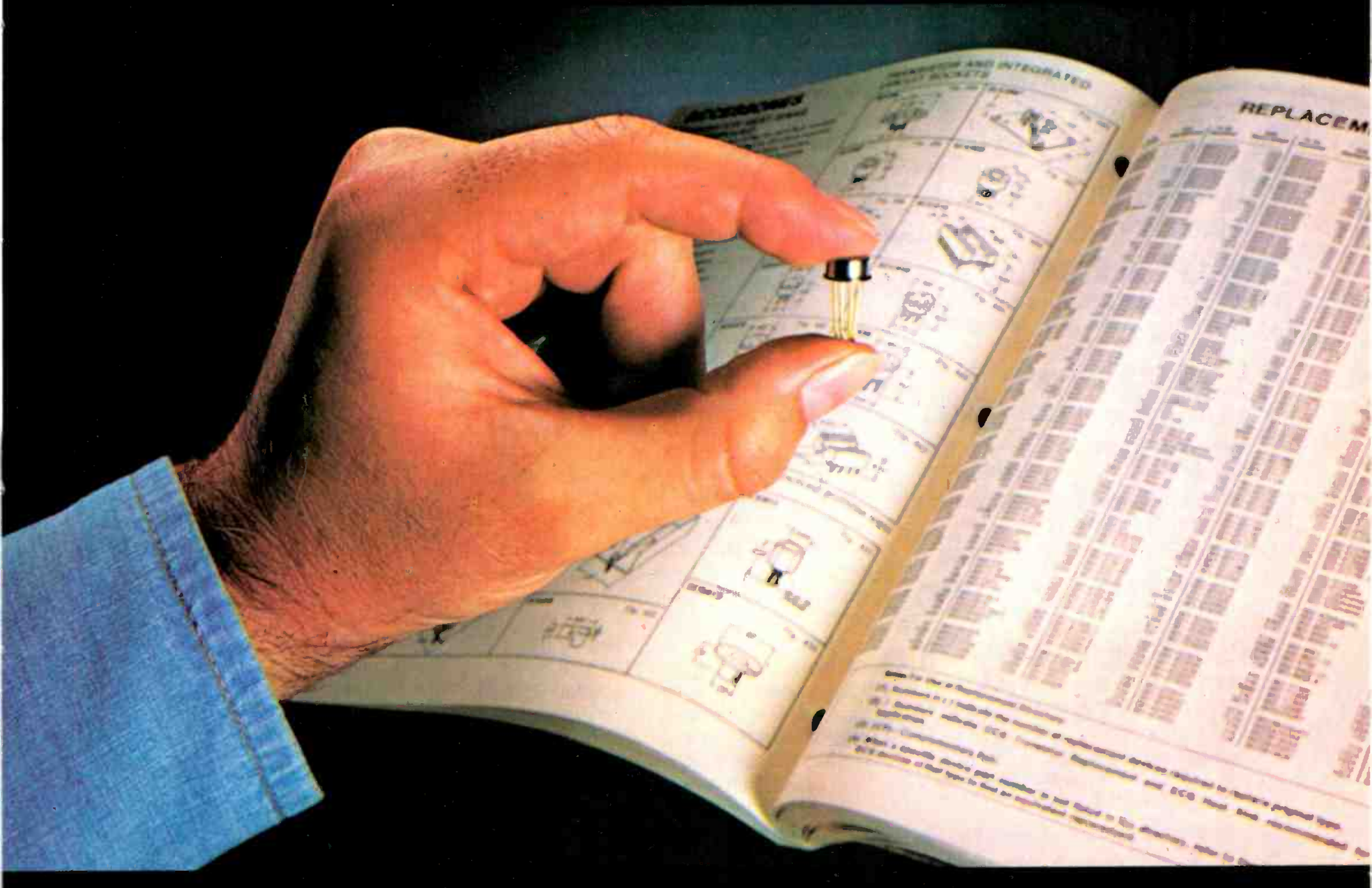

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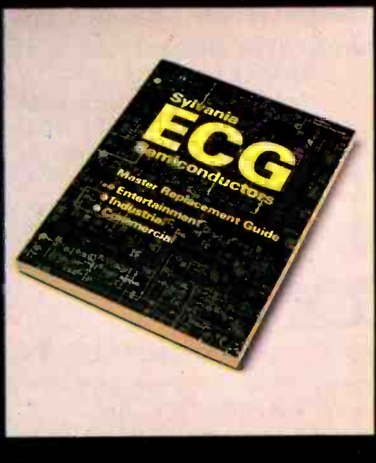

made Philips oscilloscopes ready for delivery in this country by the last quarter of this year."

Protomastro said the manufacturing facility will be located at the present U.S. headquarters site at Mahwah, N.J. Burgeoning demand for scopes in the U.S. has necessitated the action, he added.

While scopes will comprise the U.S. manufacturing capability for Philips for the next year or so, eventually plans call for Philips to make in the U.S."a very significant portion" of all equipment sold by Philips Test and Measuring Instruments.

### VLSI Technology Advancing Rapidly

The 1979 Electronic Industries *Market Data Book*, published by the Electronic Industries Association (EIA), reports that very large scale integration (VLSI) is among the most notable technological achievements currently impacting electronics.

"The development of large scale integration (LSI) has made it possible to combine tens of thousands of transistors into a tiny, quarter-inch chip of silicon. With the more recent advent of very large-scale integration, it is widely estimated that by 1980 it will be possible to concentrate more than a million transistors onto a single chip," EIA said.

In efforts to fit more information onto a chip, researchers are looking to new methods for etching smaller circuitry, including electron beam methods. An alternative to electron beams are x-rays, EIA reports, and more powerful x-ray sources are currently being sought.

Among the applications of VLSI will be large computer memories, imaging devices, and even possibly "pocket sized computers."

As the density of circuitry continues to increase, scientists are also looking for ways to develop higher speed semiconductors. One method, EIA reports, that could lead to a new generation of semiconductor devices is the use of gallium arsenide (GaAs) in place of silicon.

In describing this new method, EIA said current semiconductors are flat and their electrons flow in the positive zone, it leaves behind a positively charged spot." These positive charges, however, act as obstacles to the current and slow its flow.

"To overcome this obstruction, scientists are experimenting with ... several thin layers of GaAs. Alternate layers of the GaAs do not contain the impurities that would create separation into positive and negative regions, which enables them to absorb the obstructing positive charges left in the layers where electron current flows."

This design, at least in theory, allows electrons to flow at speeds several times previously achieved speeds, and of course, results in faster semiconductor device response times. ET/D


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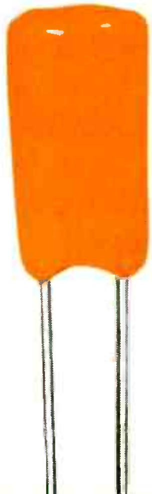

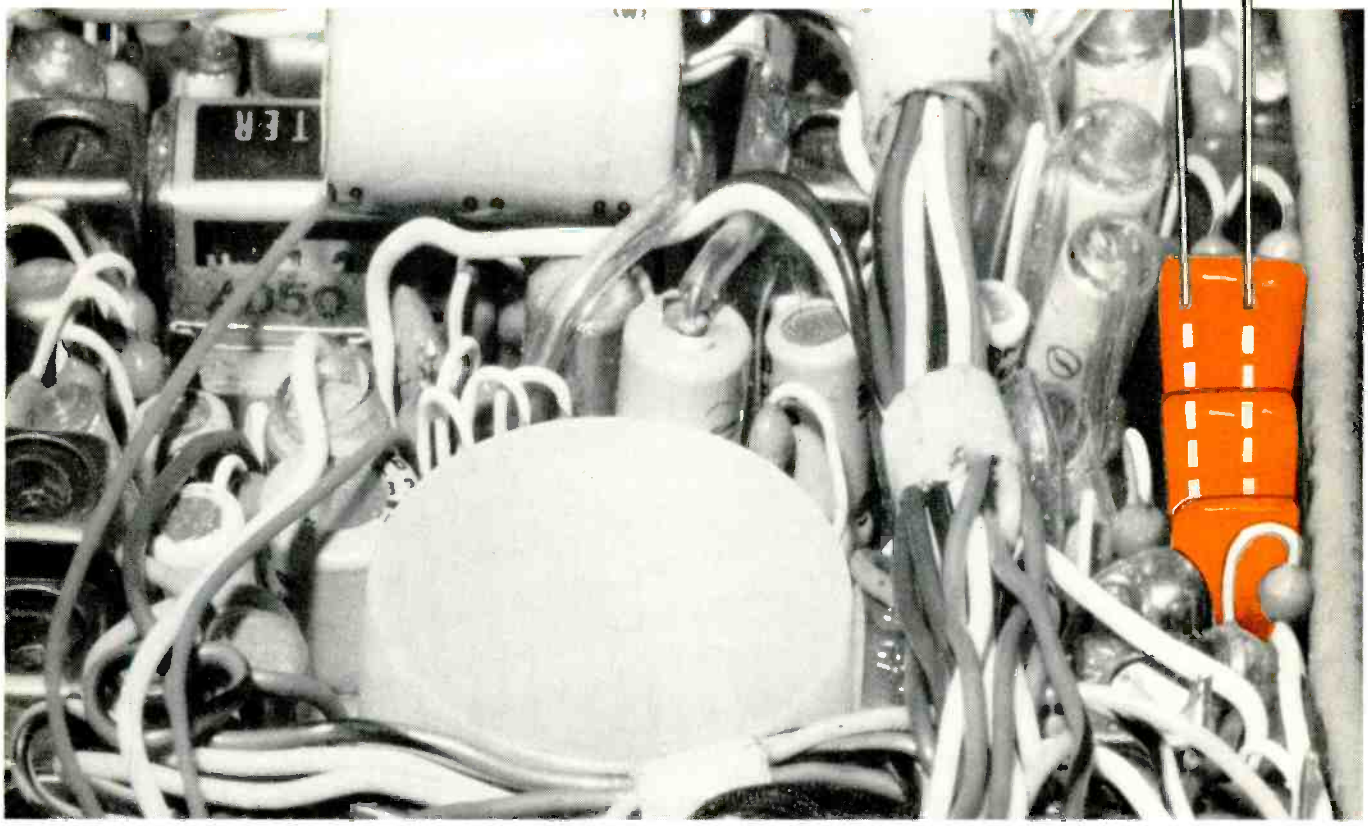

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# FROM THE EDITOR'S DESK

Quite often we are able to gain new insight and perspective into our own consumer and home electronic industry by taking a moment to look at what is going on in some of the more closely allied environments around us.

Recently such an opportunity presented itself to me. I, along with a group of editors from other industrial and consumer publications, was invited to Minneapolis to investigate and learn about some of the philosophies, technologies and products which are being considered by the residential, (home, office, and apartment environmental controls) division of what is also one of America's major computer makers—Honeywell, Inc.

It was indeed an enlightening experience.

Not only were we given a glimpse of what is "really going on" in at least one high technology profit making industry, but in so doing we are able to gain glimpses of the kinds and types of utensils and systems and—even the test gear—that will make up our real world in the near future.

I can say this unequivocally. Industry already knows the microelectronics, microprocessor, computer (call it what you will) revolution is here.

The message I want to convey is that unless you, as an electronics serviceshop owner, manager, or professional technician realize this—NOW—you will not be around much longer.

Consider this. Honeywell currently designs and develops its own microelectronic chips in Minnesota. It has acquired another semiconductor manufacturing facility in Texas, and is building two new facilities for chip designs and development at, as yet, unannounced sites.

Obviously, the future of electronics design, application or repair work, lies in *understanding* the microprocessor. I underline the word understand.

For instance, by the mid 1980s, VLSI will permit (it is estimated) the placement of one million transistors on a single chip.

Yet, as one Honeywell scientists put it: "It's nothing more than a piece of sand unless you know how to use it."

Truer words were never spoken. And to think that this microelectronics revolution will escape the home entertainment and consumer electronics marketplace is—at best wishful thinking—and more practically, just plain stupidity.

One of Honeywell's purposes in inviting editors to tour its Minneapolis area facilities was to unveil a newly developed prototype of a home or office environmental control system based on microprocessor logic control. This system "senses" outdoor weather conditions, indoor load conditions, wall temperatures, etc., and compares real time conditions to user desired conditions to control the amount of heat redistribution.

Compatible with this advanced heat distribution system is Honeywell's microprocessor based W89 diagnostic device. In other words, I saw a glimpse of the test equipment of the future.

Via simple one-plug hookup to the Advanced Heat Pump Control system, this (portable) piece of gear routinely runs through its various test algorithyms, eventually displaying on a 5-inch CRT the specific malfunctioning component, such as a coil, compressor, relay, etc.

I mention this simply by way of saying that to think these systems, this type of "computerized" error detection and fault description, will escape consumer electronics is highly unrealistic.

If you haven't already pondered the larger question of what the consumer electronics service industry of the future will resemble—it is high time you did.

And, without question, the key to understanding the future of electronics service is first to understand the microprocessor, its functions and applications in modern society.

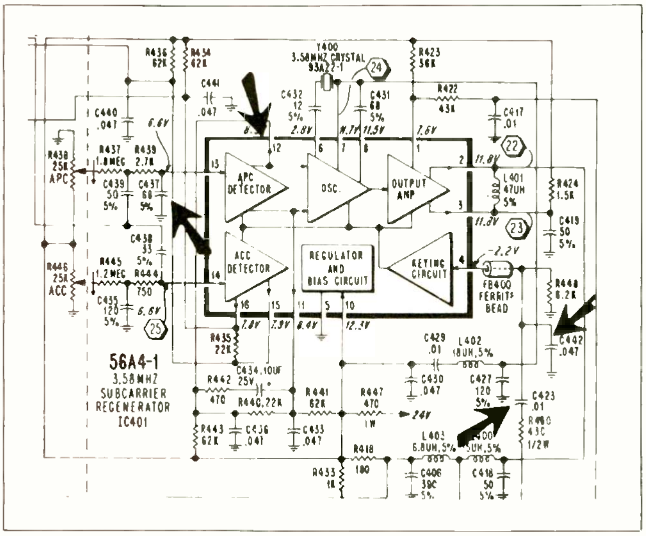
As Robert Stenstrom, Honeywell's manager of technology assessment remarked: "The semiconductor industry has a close parrallel to the cement industry ... both add value to sand."

Understanding the *value* is the key.

Richard M. Lay

# SERVICE SEMINAR

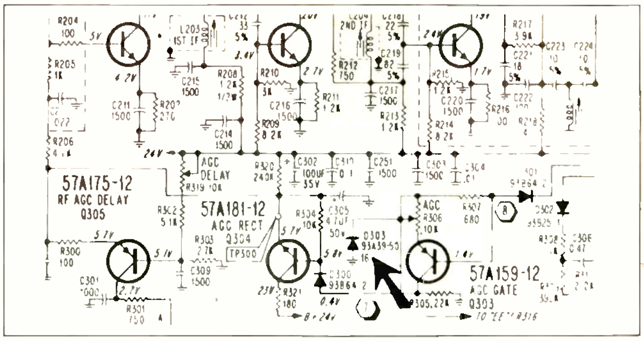
## ADMIRAL




**Color TV Chassis M55—Color bars** across screen and possible loss of color sync. Possible Cause: Defective IC401, C423, C437, and/or C442. Note: A horz. keying pulse from the HOT should be present at pin 4 of IC401.

**Touchy vert. sync.** Possible Cause: Defective C801.

**AGC overload with severe horz. tearing.** Ok when set warms up. Possible Cause: Defective Zener (D303).



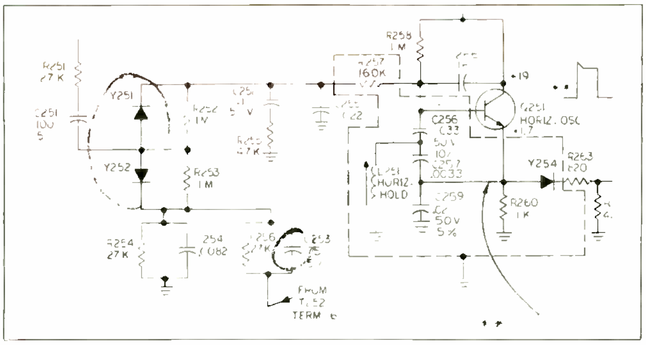

## GENERAL ELECTRIC

**Color TV Chassis MA/MB/MB-2/MB-75, MC/MC2, YM Horizontal output transistor replacement.** Failure to use the correct part will cause the following problems: When using an EP15X45 to replace an EP15X28, the device will not switch fast enough and will overheat; when using an EP15X28 to replace an EP15X45, the device does not have sufficient gain and will overheat. Use an EP15X28 in chassis numbers MA/MB/MB-2/MB-75 and an EP15X45 in chassis numbers MC/MC-2, YM. Universal replacements can cause problems. Use the authorized replacements.

**Color TV Chassis XA-2, weak or no horizontal sync,** arc causes failure of Y251 and Y252.

Repair: 1. Check C253. If it is bad, replace it with an ES18X69 and go to step No. 4.

2. If C253 checks good but has a tan color, replace it anyway and go to step No 4.



3. If C253 checks good and has a brown color, proceed to step No 4.

4. Now replace Y251 and Y252 (ES16X27).

5. Then check the resistance from the common connection of Y251 and Y252 to the cathode of each device. This resistance must be at least 450K measured on the board. If resistance is lower, locate the cause before going on to the next step.

6. Check the location of the green wire going to the CRT printed board. If it is connected to the W-3 hole, perform the following modification:

a. Cut green wire (W3) flush at CRT circuit board and strip ⅜'' of the insulation off the end.

b. Wrap and solder the green lead to the end of R131 which is standing off the circuit board. Keep the connection about ⅛'' away from resistor body.

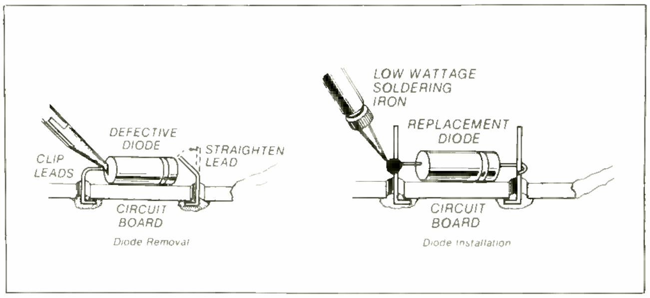
c. Cut the section of the resistor lead between the new solder connection and the board and remove it.

d. Dress R131 with green lead now attached away from board and other wires, etc.

## RCA

**Color TV Chassis CTC93. 150 Volt bridge rectifier failure.** The 150 volt bridge rectifier in the CTC 93 chassis consists of CR 600, CR 601, CR 602 and CR 603. It has been determined some small percentage of these diodes suffered a degradation of reliability during the chassis assembly process. The cause was identified and corrective action taken on instruments where the first four digits of the serial number are 9031 or higher. In order to ensure continuing reliability, customer satisfaction and to prevent callbacks, when one diode failure in the 150 volt bridge is encountered, change all four diodes (Stock No. 141489, 4 required). Since the CTC 93 Components Kit (Stock No. 199060) containes three 141489 diodes, the prepared technician should carry additional quantities.

To change the diodes proceed as follows: 1. Remove each diode by clipping leads as close to body as possible, then bend remaining leads perpendicular to the printed circuit board. 2. Clip replacement diode leads to one-half length. Observing polarity, wrap each lead of the new diode around an original lead, then crimp securely and solder. Note: *This technique is recommended where applicable in this chassis.* ET/D



WARNER ENTERS HOME VIDEO MARKET. Warner Communications has entered the consumer video tape and disc markets, a move that should significantly impact these emerging areas. According to Warner Board Chairman Steven Ross, a new division of the entertainment conglomerate will develop and market software for both VCR and video disc owners. The impact of Warner's entry into software production can be better gaged when you consider some of its subsidiaries, including Warner Brothers Records; Warner Brothers Pictures; Warner Brothers Television; Warner Cable; plus Atari, Inc., which is in electronic games and computers.

ISCET-TECH LIBRARY MOVED TO CHICAGO. Henry Golden who established this library of service data, and who has been operating it for the past half-dozen years, in Kansas City, MO, has suffered a series of strokes and a heart attack recently and has asked to be relieved of the obligation. Responsibility for the library has been assumed by George Sopocko at 5631 West Irving Park Rd., Chicago, IL 60634. (312-545-3622). George states that he is reorganizing the library and should be in operation by October. Meanwhile he will accept donations of material and can give a tax deductible receipt for fair value.

HITACHI OPENS NEW HEADQUARTERS. Hitachi has opened up its new national headquarters and eastern regional offices in New York City. According to a spokesman, the new 11,000 square foot facility is part of a seven-region system, each with its own warehouse and engineering facility. The addition was needed, Hitachi said, to accommodate "rapid expansion in the U.S. video market."

PREDICT $22 BILLION COMPUTER MARKET. A market research firm-- Frost and Sullivan -- says it conservatively estimates that $22 billion worth of "small business computer systems" will be sold during the next 10 years. The firm stated decreasing price and software availability are the major factors influencing small business computers. A micro based system priced at $12,000 today will cost $9,000 in 1987, the firm predicted. "Microcomputer based systems have resulted in fundamental changes in the computer marketplace; small unsophisticated users having minimal background are now becoming involved in data processing," the firm contends.

IFH PLANS INDUSTRY POW-WOW. The institute of High Fidelity (IHF) has announced it is planning a special conference for industry leaders to evaluate major problems peculiar to them. Scheduled for October 2 at New York's Statler Hilton, the major thrust will be to examine new markets, the impact of advanced technology, changing merchandising patterns, reordering of financial priorities, and the impact of the Federal government.

INDUSTRY STATISTICS EXCHANGE ANNOUNCED. In a related action, the IHF said an industry-wide confidential sales data figure exchange has been created with the help of Price Waterhouse. A similar project attempted in the mid 1960s failed for lack of participation, according to IHF. However, modern management methods now require manufacturers to have accurate data on the size of markets and specific product categories, IHF said, and this project is intended to fill that need.

# STRICTLY BUSINESS

When you have "NOT HOME" calls, you are watching your money drain away, like sand in an hour glass. Instead of productive time for the technician, we are faced with lost time, wasted time.

What might this wasted time be worth to you? Well, if you get one of these calls, say, once each day per man, with a three-man crew this might be costing over $3000 per year. If you want to figure your own cost, count the number of "not homes" in a month's time, and multiply it by the average labor income per call.

If you find that you do have a problem, there are a number of ways to go about correcting it. One of the best ways occurs at the time you are taking the service call. If the customer has no idea when during the day the technician is going to arrive, and if the customer sometime during the day has something she wants to do, she is apt to go out and do it. Inevitably, that is when the technician arrives, and you have a "not home.' If you can narrow down the time when the tech is going to arrive, the customer will be more patient. Many service firms find no difficulty in scheduling calls either AM or PM. In the General Electric Company factory operations, the day is divided into three parts . . . morning, mid-day, and afternoon. Further, GE allows the customer to choose the period when the technician is going to come. If she has selected the time herself, she is much more apt to be home at that time.

For those doing one-call-at-a-time dispatching, the procedure includes calling the customer's home. The dispatcher calls the customer. If she is at home, she is told that the technician will be there shortly. Then the tech is contacted and dispatched to the home. If the customer does not answer, that job is temporarily set aside and another customer is called instead. Note is made of the time of the phone call. Later in the day, the customer is called again, and if reached, the call is dispatched. If the customer is not reached all day, there is a written record of the attempts that are made to reach her, as she will surely say, "I was only out for a minute."

If the technician reaches the home and cannot gain entry, the tech should contact the dispatcher who will then make a phone call. This accomplishes two things. One, of course, is that the dispatcher has a written record of the fact that two attempts were made to gain entry and it is definitely established that, indeed, the customer was not home. It is also strange . . . but true . . . that many times the customer is home but just does not answer the door. But few people can resist answering the phone, at which time they are told that the technician is standing on their door step and would they please go and let him in.

There is one final technique that is used by some firms. Charge the customer for the call. Or at least, establish a charge for the call, even if it is never paid. This establishes the high cost of the missed call in the customer's mind.

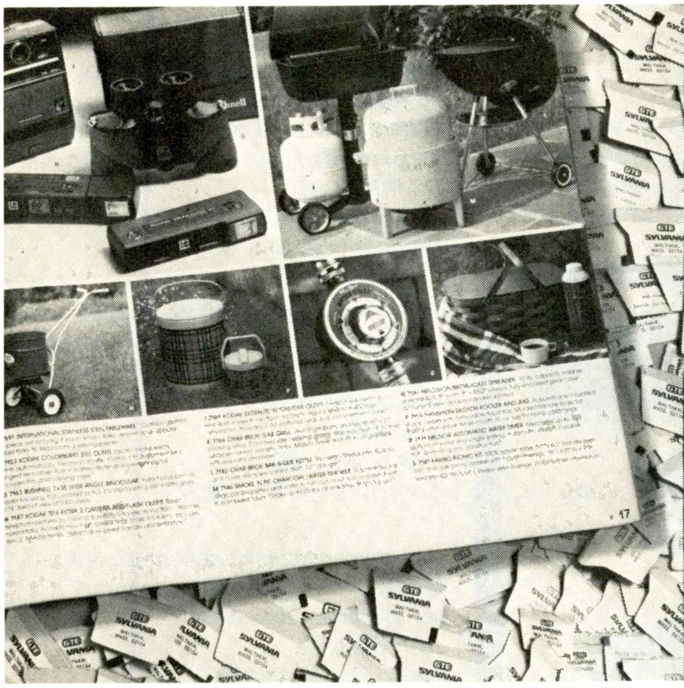
Results from the computerized NARDA Service Data System program indicate that on average, service firms encounter two per cent of all calls as "not homes." With diligence, this can be lowered to less than one per cent.

"Not home" calls result in poor productivity, loss of profit, and poor customer relations. LET'S STAMP OUT "NOT HOMES."

John Dooley

Mgr., NARDA's Service Division

# ENTER THE SYLVANIA TABS 'N' TRAVEL SWEEPSTAKES



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There's no limit to the number of Sweepstakes entries you can submit, so keep those Inventory Control Tabs rolling in to increase your chance of winning extra tabs, or a great trip.

* If you haven't started saving Sylvania receiving tube tabs, what better time? Ask your Sylvania distributor salesman for full details and your Supertab '79 Awards Catalogue.


Sweepstakes open September 1, close midnight October 31, 1979.

The Sylvania Supertab '79 program is available only to dealers and service technicians. Employees of General Telephone & Electronics, GTE Sylvania, their subsidiaries, affiliates, authorized distributors, or their advertising agencies are not eligible to participate. No purchase required. Void in Missouri, Utah and where prohibited by law.

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ET2066

# LETTERS

TEKFAX FOR SALE!
*I have the original series of TEKFAX plus 101, 103, 104, 107, and 113. These are for sale to anyone who wishes to make an offer.*
*M. L. Chapin*
*53811 Franklin*
*Utica, MI 48087*

EDITOR: By original series we assume that the TV TECH/MATICS series was meant. These covered, in eight volumes, 1965 thru 1968 U.S. B&W and color TV production.

*Having retired from business, I have for sale TEKFAX volumes 103, 105, 109, and 113.*
*Roman Grall*
*Box 95*
*Whitelaw, WI 54247*

HELP WANTED:
*This is in reference to a mini-TV set Model TPS 5050, a solid state unit manufactured in 1969. Our problem is a broken neck on the CRT which is a 3 inch diagonal measurement. Symphonic Electronic Corp. is no longer in business. We wonder if someone might have such a tube laying around and would like to sell it. The tube number is 06407.*
*Delta Electronics*
*500 Stambaugh Ave.*
*Farrell, PA 16121*

*I've been a subscriber to ET/D for over 25 years. Can you list my request in your Letters column? I need a schematic for a Bradford 9 inch b-w Model D-MAT55988*
*M. Ascencio, Jr. 22874 N. Brookside Dr.*
*Dearborn Heights, MI 48125*

*I need a vertical output transformer for a Conar Custom 70 TV receiver (#TR47). It can be new or used. I will gladly pay a reasonable price.*
*L. N. Canale*
*118 S. Main St.*
*Spring Valley, NY 10977*

*Can anyone furnish a schematic of AKAI Model 8 reel-to-reel tape recorder? It is not available from AKAI.*
*Jake Santine*
*Jake's Repair Service*
*2400 NE Greenfield Place*
*Mounds View, MN 55432*

*I need a schematic and operating instructions for a Heath Kit oscilloscope Model IO-12, Series 752-1012A.*
*John Bell*
*195 Silleck St.*
*Cliffton, NJ 07013*

*I am looking for a source of parts for the old wind-up Victrolas. Any help would be greatly appreciated.*
*Thomas P. Falks*
*Friendly TV Services*
*P.O. Box 662*
*Hot Springs, VA 24445*

*Friden is out of business. I would like to contact anyone else trying to repair a Friden (Singer) Model EC1114 electronic desk calculator. I have some schematics and data and would share and exchange info.*
*Robert Miller*
*Rt. 1*
*Anadarko, OK 73005*

*I need information on a Bradford Model 1004B30*
*John Williams*
*35043 Altos Ct.*
*Grisson AFB, IN 46901*

*I need a schematic and parts list for a bass guitar amplifier. Brand name Kay, Model K-830 by Valco. The manufacturer using the Kay name says it was manufactured prior to their purchase of the name and they cannot help me.*
*David J. Lamb*
*P.O. Box 104*
*Cairo, IL 62914*

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

*I need information for substituting a Sears flyback #299755. Sears says it is not made anymore. It has a Toshiba part Number AZ-9976.*
*W.J. Crow*
*321 E 63rd St.*
*Hialeah, FL 33013*

*I need a remote control kit for a Heath/Kit TV, Model GR9000. Can anyone help me?*
*Jim Nicks*
*10219 N. 23rd St.*
*Tampa, FL 33612*

*I need a schematic or any information on a RCA CB Model M1, No. 555489.*
*Janty Shurdon*
*National Electronics*
*222 Belmont Ave.*
*Haledon, NJ 07508*

TEKFAX WANTED:
*Somehow I missed out on TEKFAX 113. If any of the readers out there has a duplicate I would be glad to trade a 114 for it.*
*E. J. Alderman*
*RFD 2, Box 83*
*Madison, NC 27025*

*We have a copy of TEKFAX 112 and would like to purchase numbers 110, 111 and 113. Do any of your readers have copies they wish to sell?*
*W.M. Simpson*
*Carson Valley TV*
*Box 1866*
*Gardnerville, NV 89410*

*I would appreciate any help in obtaining the following TEKFAX-Numbers 102, 109, 110, 111, 112, 113.*
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*1317 Hampton St.*
*Richmond, VA 23220* ET/D

# Consumer Electronics Show Highlights

## High technology in the home

**This year's summer Consumer Electronics Show in Chicago was the biggest ever from the standpoint of attendance. From a technology point of view, it proved without question that the microprocessor is king.**

**By Richard W. Lay**

Manual is dead; all doubts have been eliminated by the high technology products shown at the 13th Annual Consumer Electronics Show (CES) this past June, in Chicago. The microprocessor has become the marketing star of "the new consumer electronics."

Replacing the old manual controls with the functional diversity permitted through the programmable microprocessor, America's consumer and home entertainment electronics' manufacturers have finally completed the circle — in effect, bringing to the consumer marketplace those innovations and technologies developed in this country during America's space research age of a decade ago.

There were micros in TVs (RCA's), micros in tape decks and stereo tuners; micros in language translators (Quasar); micros in VCRs; in home computers, of course; everywhere!!! The summer CES was a tremendously significant show because when it came right down to it, it provided an insight into the future of consumer electronics. From the technological and servicing point of view it was astounding.

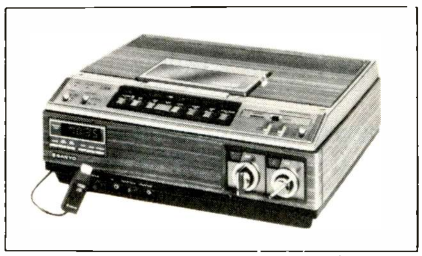

*Fig. 1 – Thr 4½ hour Sanyo Model VCR5000*

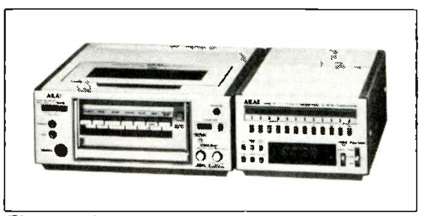

*Fig. 2 – Among the host of new portables shown at CES was Akai's first video tape recording entry, ActVideo*

Like all CE shows of recent years, this one was absolutely mind boggling from the standpoint of sheer size. There was only one difference between this and others ... this one was the biggest ever. Almost 61,000 attendees pushed through aisles jammed shoulder to shoulder in Chicago's McCormick Place and two overflow hotels for a glimpse at the 938 exhibitor's products.

Actually, the CES is a somewhat unusual show. It is run, in fact, on three different levels. One being popularity, a second from a marketing standpoint, and thirdly, from a purely technological point of view.

### The winners

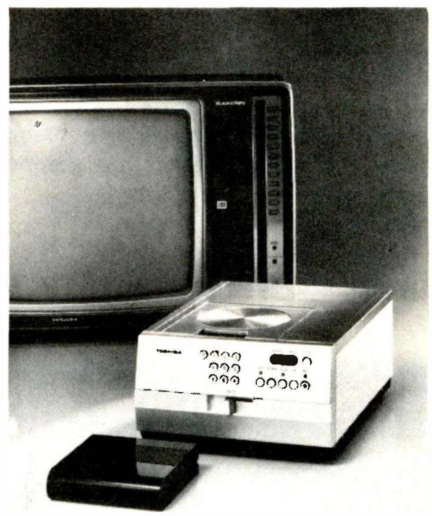

*Fig. 3 – Toshiba's revolutionary high speed, fixed head video tape recorder prototype model*

From the popularity standpoint, CES had two clear cut winners, Magnavox's video disc player and Texas Instruments' candidate in the home or personal computer field. From a marketing standpoint, among the products that retailers showed most interest in were, again Magnavox's disc system and third generation video cassette recorders, which are now in the portable phase. (What they've done is take the traditional recorder and chop off the tuner, leaving the record mechanism available for portable use with camera.) Thirdly, the technological prizes have to go to Toshiba's fixed head video tape recorder and Ohio Scientific's computerized home security system.

The former represents a tremendous advance in size reduction, the number of components used, and

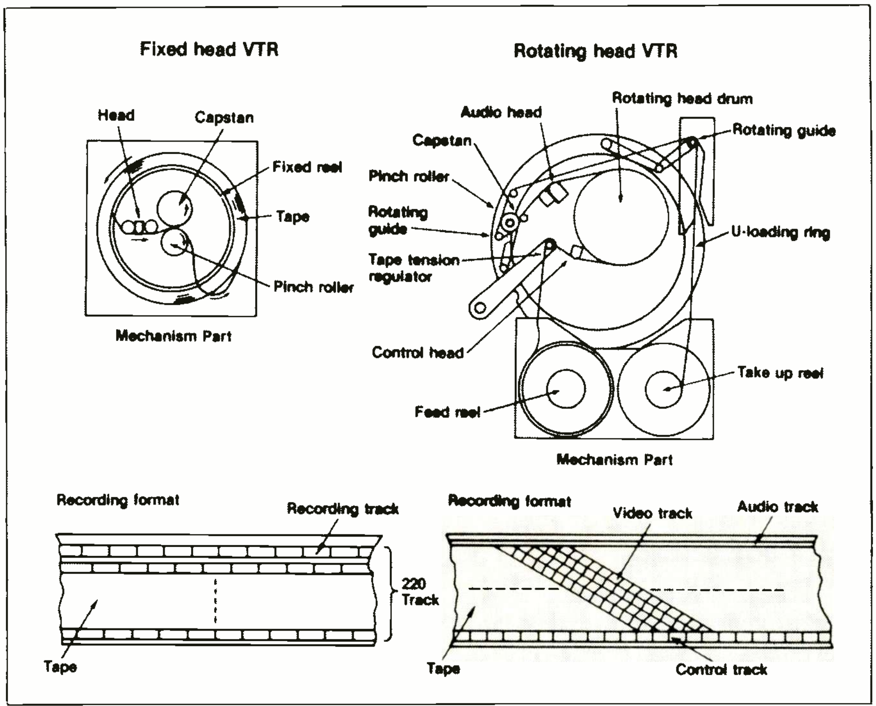


*Fig. 4 – Comparison of the new fixed head and traditional rotating head VTR systems.*

*Fig. 5 – RCA's new programmable CTC101 chassis with comb filter.*

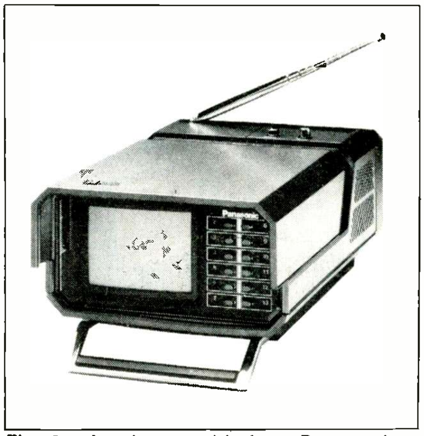


*Fig. 6 – A color portable from Panasonic featuring the "multiplexed," one-gun picture tube.*

in potential uses (if it ever gets out of the engineering lab), while the latter is an amazing state of the art advancement in home security, though admittedly with its $5,000 price tag it is more in harmony with the commercial building and industrial marketplace.

On the stereo front, pulse code modulation continues to be the talk of the day — but that's all, just talk — because you can't buy it yet.

## New VCRs

In VCR developments Matsushita Electric, through Panasonic, Quasar, and RCA, among others, showed its new 6-hour VHS system ... up from the current 4-hour playing time. Sanyo introduced its new 4-½ hour Beta format VCR, the Betacord III Model VCR5000 (see Figure 1).

The Sanyo unit, with a suggested retail price of $1,095, permits up to 50 per cent more playing time on a standard Beta three-hour cassette. Also, (in the extended play mode) pressing a pause button will instantly stop the tape, freezing the action on the screen for more detailed study.

ALSO showing new VCRs were Sharp, with a programmable two and six hour VHS system; Toshiba with a five-hour programmable Beta format; Akai's first VCR entry — "Activideo" — (see Figure 2). The timer can be programmed to record two programs per day for up to seven days. It also has an automatic battery recharger. Suggested retail, though, is $1,495.

Toshiba showed its new five-hour, programmable VCR. This unit, with a suggested retail of about $1,400 carries a "freeze frame" feature together with a fast scan capability.

## Toshiba's LVR

However, without question the major attraction in VCRs this year was the display of Toshiba's prototype fixed head, endless loop, tape recorder — the LVR (Longitudinal Video Recorder).

The work of Dr. Norikazu Sawazaki, the inventor of the helical scan system, the new LVR system (see Figures 3 and 4) crams an astounding 220 recording tracks on a 100-meter long endless loop tape. According to Toshiba, this model eliminates about two-thirds of the mechanical components now used, and is therefore much smaller in size and potentially cheaper.

The 220 recording tracks are accessed by the "fixed" head's ability to move up or down in relation to the width of the one-half inch tape. Tape motion is at high speed so that each track provides about 17 seconds playing time, or some 62-1/3 minutes (220 x 17) in total. A microprocessor controls positioning of the head and stepping to the next rack when the end of the current track is reached.

Toshiba says the "interesting" aspect is the random access of any selected track within a few seconds, just the time required to reposition the head. This provides virtually "instant" playback of recorded material.

Potential uses of this system when developed, Toshiba says, are data memory, video file, product explanation, surveillance and others.

## Programmable TV

On the television side of things, RCA is out with its fully programmable home security system television chassis (Figure 5). While I won't go into the circuitry involved at this time (since this will be part of ET/D's annual review of new TV chassis this September), RCA is adding to some of its ColorTrak receivers a 7-day programmer. A digital clock when not displaying channel information, this AutoProgrammer controls set turn on and off and permits channel changes and schedules to be "ordered," up to seven days in advance.

Additionally, the programming instructions can be accessed and read by the set user for editing or schedule changes as desired. An AC plug on the set is included so that a lamp can be scheduled to turn on and off at various intervals while the owners are away.

Incidentally, RCA is the first manufacturer we've heard about to follow Magnavox's suit of adding a high picture resolution comb filter to its circuitry (see ET/D, Sept. '78).

About the only other real innovation insofar as television is concerned, was the introduction, by Panasonic, of Matsushita's new one-gun color CRT which uses only 60 per cent of the power of a comparable CRT (see ET/D, March, p. 27). Panasonic is using this tube in its new battery-operated (nine "D" cells) portable (see figure 6).

This unit, the CT-1010, has a 4.5 inch screen, weighs 10 pounds and features pushbutton channel selection.

### Home computers

While most of the computer manufacturers seemed to toss in the towel on the so-called "home" or "personal" computer market — and direct their efforts toward "small" business applications — at least one company went in the opposite direction — Texas Instruments.

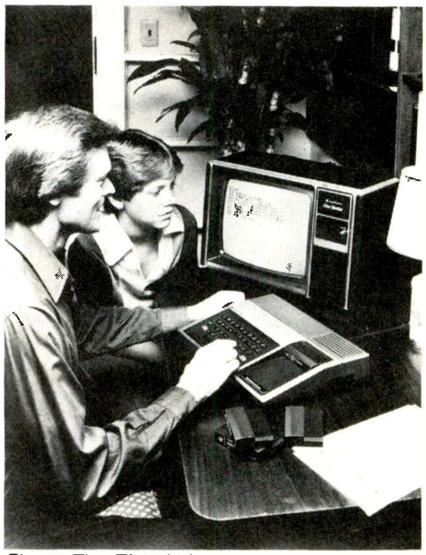

*Fig. 7–The TI-99/4 home computer system, including 13-inch color monitor, retails for about $1,150*

With the majority of the personal computer people opting for the National Computer Conference (run simultaneously with CES) in New York — TI came up with what in my opinion is the most user oriented personal computer on the market. From the standpoint of ease of operation and available software, TI's 99/4 home computer system (complete with 13-inch video monitor manufactured by Zenith) is really — in this writer's opinion — the first small computer system that can really be called a "home" system.

The key to TI's approach is its solid state software packages, which will range in price from $20 to $70. These are solid state, pre-programmed ROMs which when inserted into the console permit up to 72K bytes of RAM and ROM (combined).

Features of the TI-99/4 are 16 colors for graphics, music and sound effects generator, built in equation calculator, and 13 digit floating point BASIC. Solid state software packages include games, including football and chess, investment analysis, personal record keeping, graphics, and educational packages such as statistics, grammar, reading, etc.

Scheduled for late summer or fall introduction, the system will retail for about $1,150.

### Computerized security

Ohio Scientific, another of the high technology companies that is strung midway between the "home" and "small business" computer environments, showed its amazing $5,000 C8P DF "home computer of

*continued on page 47*

*Fig. 8–Ohio Scientific's computerized home security system and personal computer combination. It carries a $5,000 pricetag.*

# Surface acoustic wave filters

## Their impact on consumer electronics grows

First Zenith, now Toshiba, and soon others are sure to follow with these special passband filters for truly "alignment free" television.

**By Paul Shih**

Surface-acoustic-wave (SAW) devices have been used for several decades to provide a number of specific signal processing functions in industrial and military communications.However, the use of SAW filters in television receivers has been realized for only a few years. It is anticipated that wide-spread use of SAW devices by the TV industry will follow that of dgital tuners which has gradually become commonplace.

This article attempts to describe the basic theory and operation of the SAW filter and presents a practical example in which a SAW filter is used in the IF section of a TV receiver.

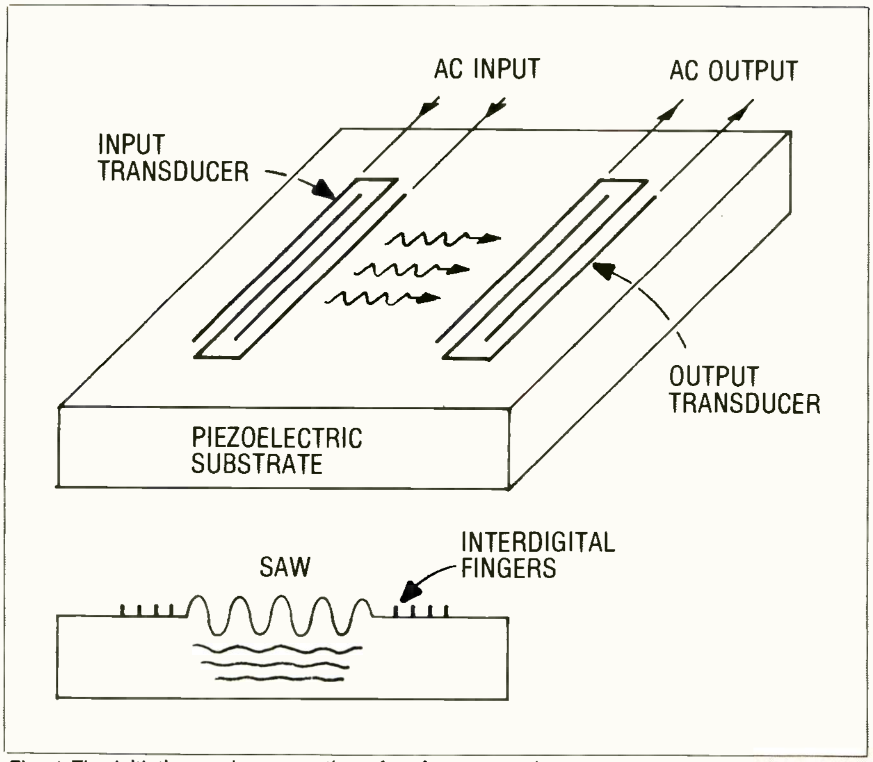


*Fig. 1-The initiation and propagation of surface acoustic waves.*

### Piezoelectric effect

The operation of SAW devices is primarily based on the principle of piezoelectricity. Nearly a century ago, Pierre and Jacques Curie discovered an inherent property, called piezoelectric effect, in certain natural crystals, such as rochelle salt, quartz, and sodium chlorate. The piezoelectric effect is exhibited by the deformation of piezoelectric materials through pressure, tension or shear. It is accompanied by the appearance of an electrical potential across particular surfaces, or the application of a potential difference across the surfaces is transformed into a mechanical strain or stress in the materials. Some 60 years after the first discovery of piezoelectricity, it was recognized that piezoelectricity can also occur in certain materials other than single natural crystals, and the effect was demonstrated in high polymers and some synthetic materials. The most widely used piezoelectric materials nowadays for SAW components are lithium niobate, bismuth silicon oxide, lithium tantalate and thin-film zinc oxide.

### Surface acoustic waves

The fundamental physics of acoustic, or Rayleish, waves which propogate on the surface of solids was first described by Lord Rayleigh in 1895. Basically, the acoustic waves are launched on a solid surface by a thin metal transducer deposited on the surface of a piezoeletric substance.

Tha AC electrical signal applied to the transducer electrodes causes the substrate material between the electrodes to be distorted due to the piezoelectric effect. This periodic strain spreads on the surface for some distance, but decays expoentially into the solid within a very short distance from the surface. The mechanical deformation on the surface manifests itself as acoustic surface waves propagating from the input transducer to an output transducer. The basic setup for generating surface waves is shown in Fig. 1.

Detection of the SAWs by the output transducer transforms the surface periodic strain back to the corresponding periodic electrical signal which appears across the output terminals of the SAW device.

The SAW can also be generated and detected on the surface of a non-piezoelectric substrate. This process can be accomplished by employing structures which are composed of zinc oxide piezoelectric film layers overlying interdigital metal electrodes (Fig. 2). Application of an electrical signal to the electrodes which are sandwiched between the oxide film and the non-piezoelectric substrate will cause the mechanical strain in the film to be transferred onto the non-piezoelectric surface. This transfer process causes SAWs to be generated on the non-piezoelectric surface. Upon receiving the SAWs, an output transducer converts the acoustic waves back to an electrical signal by a reverse piezoelectric process.

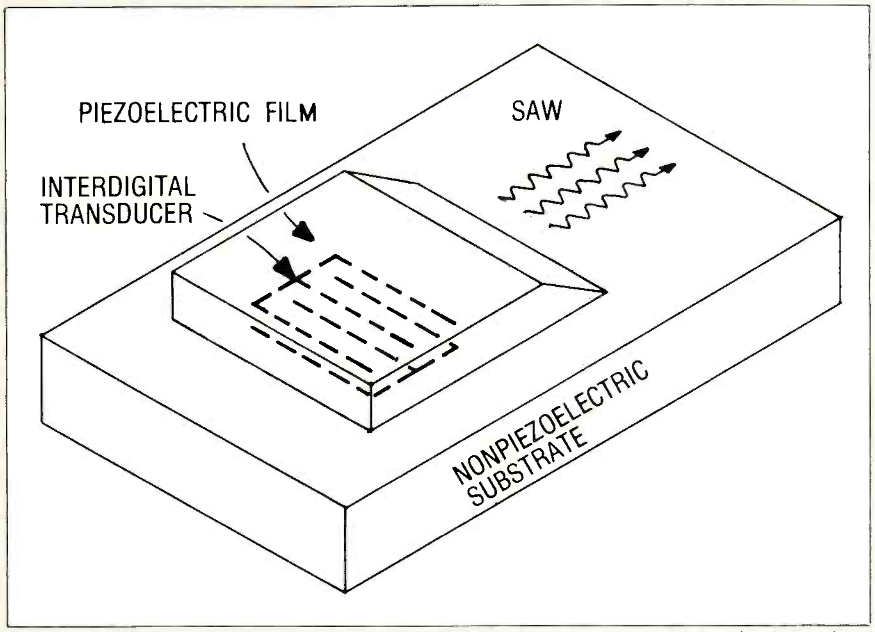


*Fig. 2-A look at the physical layout of the interdigital transducer on a non-piezoelectric substrate.*

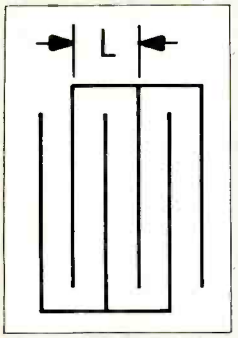


*Fig. 3-An interdigital transducer with uniform fingers.*

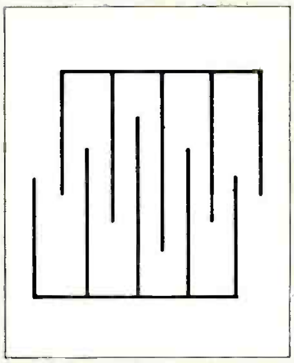

*Fig.4-The weighted finger array.*

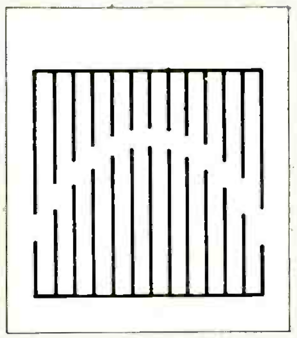

*Fig. 5-This "dummy-finger" array provides better phase response.*

## Interdigital transducers

For most surface acoustic wave (SAW) filters, the interdigital transducer is the prime component. It consists mainly of a periodic structure of film-coated metal electrodes deposited on the surface of a piezoelectric substrate by a photolithographic process. The geometic structure of the transducer determines the bandwidth and the frequency characteristics of the SAW filter. High-frequency SAWs are generated or received at that part of electrode array (or comb) which has electrodes (fingers) close together; whereas low-frequency SAWs are generated or received where the fingers are further apart.

A structure with uniform fingers responds best to one frequency whose wavelength equals the periodic distance L of the fingers (Fig. 3). A uniform array with only a few fingers has broad frequency responses above and below the fundamental frequency. This characteristic makes the array suitable for broad-band operation as a receiving transducer. If a large number of uniform fingers is used, the frequency response of the array is sharpened, resulting in limited bandwidth operation.

For control of specific frequency response with sharp cutoffs, the fingers are amplitude "weighted" during the design process by varying the amount of overlapping of electrodes in certain parts of the array (Fig. 4). One drawback, however, for the non-uniform finger overlapping is phase distortion caused by different propagation velocity as the SAWs travel through each pair of overlapped fingers. One geometic structure that can provide specific frequency response and has very little phase distortion is an array of dummy fingers as shown in Fig. 5. With this latter structure, the propagation velocity of the waves is not altered because the SAWs "see" the same amount of "metal" as they propagate through each pair of now-overlapped (dummy) electrodes. Other methods employed to decrease the undesirable spurious response include use of split fingers and slant electrode arrays.

## Multistrap coupler

Distortion in SAW transmission can also be caused by spurious bulk-wave signal reflection. This undesirable source for distortion can be suppressed considerably by the use of a multistrap coupler (MSC). The coupler, consisting of parallel metallic straps deposited on a substrate, can transfer acoustic energy from one acoustic track to another (Fig. 6).

The bulk waves which are generated along with the SAWs by an interdigital transducer become prominent as the number of finger pairs is reduced to provide broadband operation. Most of the bulk-wave energy penetrates into the solid, but the bottom surface of the solid substrate may reflect the energy back to the top surface. The reflected bulk waves may cause interference to SAW operation. If this kind of interference is allowed to go unchecked in filtering operation, it can degrade the stop-band performance and cause spurious response. The use of MSC in an arrangement shown in Fig. 6 can keep most of the reflected bulk waves off the SAW propagation path, thereby reducing the bulk-wave interference. Due to this desirable characteristic, the MSC may be used to couple a "weighted" finger array to a uniform array with only a few fingers for wideband operation.

Another way to suppress the bulk-wave interference involves treatments of the substrate bottom surface, such as cutting oblique grooves or drilling blind holes. Certain substrate materials have a property of retarding the bulk-wave propagation; therefore, a simple treatment of the substrate bottom surface as mentioned above is adequate to control the bulk-wave interference without having to use the MSC.

Coupler design generally involves choice of the strap length and the optimum strap repeat distance. For specific bandwidth response, the repeat distance of straps is critical. With proper design, transmission and reflection response for an MSC can approach almost 100% transfer from one track to another with very little or no loss.

## Transit response

Triple transit response refers to SAW reflection along the propation path between the input and output transducers. This phenomenon occurs when part of the SAWs is first reflected off the receiving or output transducer and later reflected back to the output transducer by the input transducer. These double-reflected waves take three times as long to produce an output at the receiving transducer as do the original waves after leaving the transmitting or input transducer. This kind of time delay in a video transmission can cause multiple images or "ghosts" in the reproduced picture.

Triple-transit echoes can be suppressed by using undirectional transmission in which two mismatched transducers are employed to cancel out waves traveling opposite to the forward propagating direction. One disadvantage, however, for such unidirectional transmission is high signal loss due to cancellation of energy.

Another way to reduce the triple-transit response is to use a split-finger array as a receiving transducer. Waves reflected by the split fingers are twice as high in frequency as the original waves, and therefore they are too far away from the passband to cause any further interference.

## SAW IF filters

Basically, all SAW components are in one way or another bandpass structures, and bandpass filters are among the most fully developed SAW devices. Traditionally, SAW devices are used exclusively for signal processing in industrial or military communications and radar systems. However, potentially large-scale application of the SAW components in consumer electronics is possible due to research and development in manufacturing technology and cost reduction.

The greatest potential for SAW filters in consumer products is probably in television receivers. Typically, in a conventional TV IF section, a number of LC circuits or traps need to be tuned or adjusted individually for specific frequency response during production assembly and occasionally during field servicing. Conversely, a single SAW filter in place of those LC tuned circuits needs no tuning because its specific frequency response band is established during the design and manufacturing process. In addition, the SAW filter is more stable in operation. Once it works in the circuit, one can expect it to function that way for a long time without any attention.

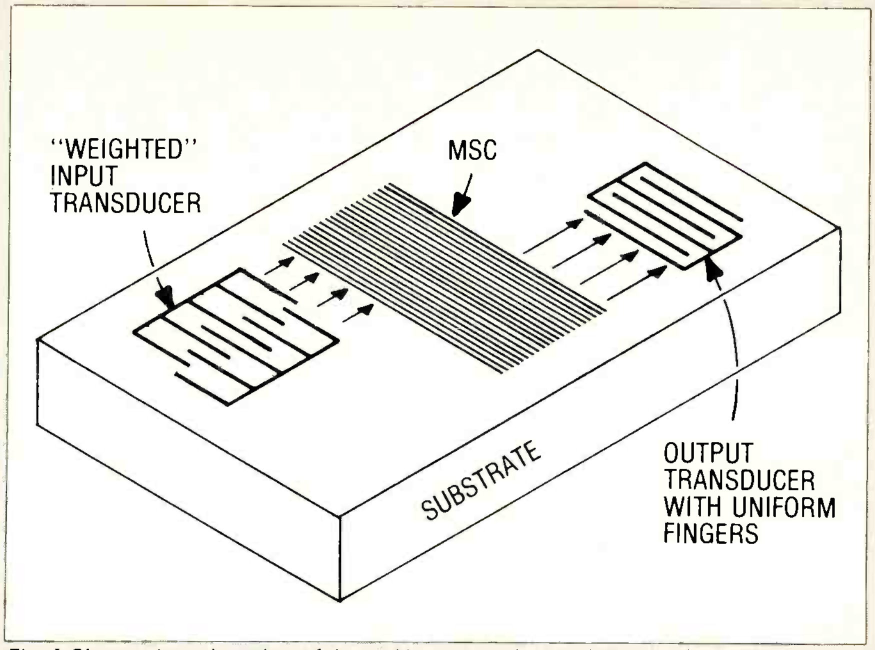


*Fig. 6-Shown above is a view of the multistrap coupler used as a track changer.*

About 10 years ago, DeVries and his co-workers at Zenith Radio Corporation first demonstrated three cascaded SAW filters for use in the TV IF section. The filters, built on lead-zirco-nate-titanate substrate, had a low loss at 44 MHz, a bandwidth of 3.6 MHz and a 50-dB trap attenuation within 1 MHz of the IF passband. However, due to high production costs and technical problems of bulk or spurious reflection, use of the SAW components never went beyond the laboratory *at that time*. Subsequent research solved the technical problems and found ways to cut the production cost. The result has been the development of SAW filters as practical components and they have been used in some of Zenith's color chassis for several years.

Besides Zenith's pioneer work, a number of industrial laboratories and TV manufacturers have also launched their researches in SAW devices for use in TV circuits. Mullard Research Laboratories, Redhill, England, demonstrated TV IF SAW filters which are built on bismuth silicon oxide substrate. It is claimed that the substrate being used has better bulk-wave suppression properties than lithium niobate, the most widely used substrate material for SAW filters. As a result, a simple treatment of the substrate bottom surface is enough to check the bulk-wave interference without using a multistrap coupler. Another advantage bismuth silicon oxide has, in addition to its low material cost, is better velocity properties which permit the filter to be built smaller and results in lower production costs. Nevertheless, bismuth silicon oxide does have lower acoustic coupling efficiency which causes more wave-propagation loss than with more expensive lithium niobate.

Toshiba Electric Company of Japan has begun to use SAW devices as IF filters for their 14- and 18-inch color chassis. The filter is fabricated with three sets (input, shield, output) of interdigital aluminum electrodes on lithium tantalate crystal material. The substrate material has good temperature stability and low spurious response and the crystal can be grown in air, instead of in a protective gas environment. This results in low production costs.

## Zenith's SWIF

The earlier work on the SAW filter done by Zenith, as previously mentioned, provided the foundation for the development of the current Surface Wave Integrated Filter, called SWIF. The filter is composed of input and output interdigital transducers built along with a miltistrap coupler of 100 metal lines on a 1/2 by 3/16 inch lithium-niobate substrate similar in

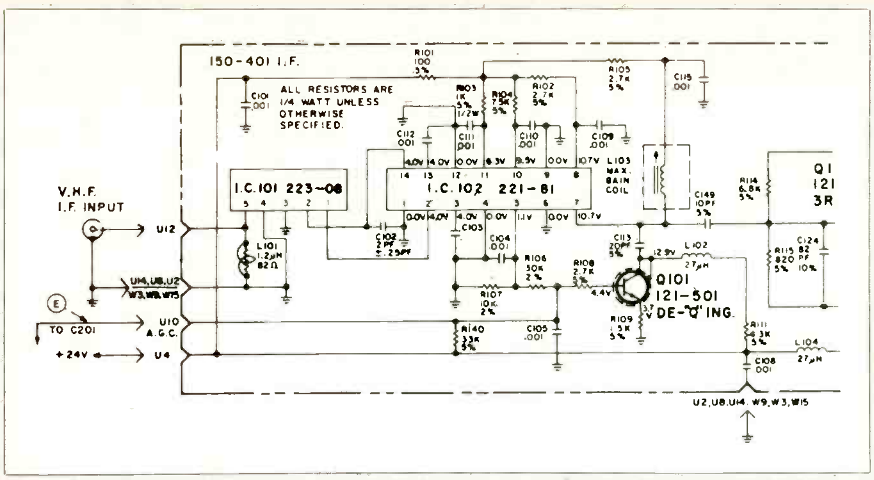


*Fig. 7-The simplified schematic of a SWIF IF section used in Zenith's 19GC45Z/50Z chassis.*

arrangement to the one shown in Fig. 6. The input transducer is amplitude "weighted" to provide the required frequency selectivity for the IF section. The typical responses of the input transducer include low signal loss for the 44-MHz I.F. passband, some attenuation for the sound carrier at 41.25 MHz, large attenuation of the signals outside the passband, and sharp trapping action at 39.75 MHz and 47.25 MHz for the adjacent picture and sound carriers.

The receiver or output transducer is intended for broad-band response with its fewer uniform interdigital fingers. Coupling between the two different transducers is carried out by the multistrap coupler that also helps to reduce unwanted reflection of bulk or spurious waves.

The substrate wafer is mounted with epoxy on a thin conductive coating which is deposited on the inside bottom of a ceramic package which in turn is connected to ground in the circuitry. Four terminals for the two transducers are brought out of the package with wire-bonding, and a ceramic lid is used to seal the package with epoxy.

The SWIF (IC 101) has been used in a number of Zenith's color chassis. A simplified schematic of an IF section using a SWIF as found in Chassis 19GC45Z/50Z is shown in Fig. 7.

## Wideband tuner

A wideband tuner with a bandwidth of 10 MHz is used with the SWIF IF section. The input from the tuner is coupled through a 75-ohm IF cable to pins 4 and 5 on IC 101, the SWIF. L101 terminates the cable in the IF module to provide proper impedance matching to the SWIF. The output from the SWIF at pins 1 and 2 is coupled to pins 2 and 14 on IC 102, a 3-stage IF amplifier. The conductive coating on the bottom of the SWIF is connected to the ground through pin 3 on IC 101.

Several capacitors associated with IC 102 help to stabilize the operation of the amplifier; C102 at pin 14 provides neutralization, and C112 and C103 at pins 3 and 13 respectively decouple the DC feedback network which is used to establish the DC operating point for the amplifier.

An internal zener reference source of 6.3 volts at pin 11 is obtained from a 24-Volt external source at U4 on the IF module. The IF AGC control voltage from IC 401 on the AGC module is coupled through U10 to pins 10 and 5 on IC 102 and also to the base of Q101, the de-"Q"ing transistor.

The amplified IF output is taken across the Max Gain coil, L103, between pin 7 on IC102 and the ground. L103, being the load for the IC amplifier, is the only tuned component before the 3rd IF amplifier.

Transistor Q101 is connected in parallel with the gain coil L103. As the received composite video signal increases in magnitude, so does the AGC control voltage. This action causes Q101 to conduct more current, partially shorting out L103. The result is that Q of the coil is decreased and the IF output at pin 7 is reduced as well. With less signal input to the receiver, the opposite action takes place to increase the gain of the amplifier for more IF output at pin 7. The de-"Q"ing network, functioning as a variable damping resistor for the gain coil L103, helps to maintain the constant video and sound output under varying signal strength conditions.

## Conclusion

The earliest applications of surface-acoustic-wave filters were

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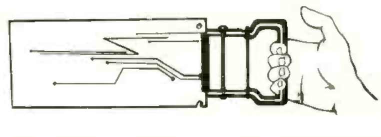
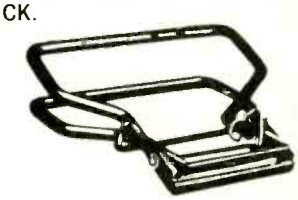






# Intro to data converters

The real world is analog.

Most of the new test instrumentation, as well as many of today's consumer products for the home, display information in digital readout form. For a general look at how these circuits function, read on.

**By Joseph J. Carr, CET**

A large portion of modern industrial, scientific, medical and military instrumentation uses *digital* circuits which may or may not involve a digital computer. Most *transducers* which are used to sense physical parameters such as position, force, pressure, temperature, etc., however, are *analog* devices. They produce an output voltage or current that is proportional to the parameter being measured.

Similarly, strip chart recorders (used to make permanent records of waveforms and other pertinent analog data), and control system components such as motors, require digital interface circuitry in order to put out an analog signal. The circuits which are used as communicators between the analog and digital worlds are called *analog-to-digital converters* (ADC) and *digital-to-analog converters* (DAC).

## DAC circuits

It is the usual practice to introduce the DAC first, because several of the more popular ADC circuits use a DAC in a negative feedback circuit. The DAC is a circuit that will produce an output voltage or current that is proportional to both a reference voltage (or current) and the digital binary word applied to its inputs. The most common DAC technique is the *registor ladder*, of which two types exist: *binary weighted* and *R-2R* (see Fig. 1).

The binary word at the input will be made of *bits* that are represented by two voltage levels; 0 volts for logical-0 and some positive or negative voltage for logical-1. These bits, or "binary digits," are represented in Fig. 1 as switches that connect to ground to produce the logical-0 state and *E*1 for logical-1.

The binary weighted ladder circuit is shown in Fig. 1A, and is essentially a multiple-input inverting follower op-amp circuit. Binary numbers are weighted by position, similar to the more familiar decimal numbers (see ET/D, Nov. 1977).

In Fig. 1A each input resistor represents a different weight, with B1 being the most significant bit, and $B_n$ being the least significant bit. From Ohm's law, and the basic rules governing op-amps, we know that output voltage $E_o$ is given by

$$E_o = E1 \times \frac{B1}{R} + \frac{B2}{2R} + \frac{B3}{4R} + \ldots + \frac{B_n}{nR}$$

Where B1 through $B_n$ are either "1" or "O" depending upon the actual binary word being represented.

The problem with the binary ladder, however, is that resistor values become unreasonably large or small if more than a few bits are represented. In an ordinary eight bit system, popular in microcomputer applications, if R is 10 Kohms, then the resistor at B8 will be 1.28 megohms. In a twelve bit system, even higher values are needed.

## The R-2R ladder

The solution to this problem is to use the R-2R resistor ladder (Fig. 1B). In this circuit all resistors, with the exception of load resistor $R_L$, have one or two possible values, R or 2R (i.e. 50 Kohm and 100 Kohm are popuar). The load resistor should have a value that is as high as possible.

It is the circuit of Fig. 1B that forms the basis for most commercial DACs. An example of a commercial DAC is shown in Fig. 2. This particular model is the DAC-08 by Precision Monolithics, Inc., and is an example of a *current* output DAC (i.e. no load resistor). The switches in Fig. 1B are now shown as transistors. The output current will be

$$I_o = I_{ref} \quad \frac{B1}{2} + \frac{B2}{4} + \frac{B3}{8} + \ldots + \frac{B8}{256}$$

Fig. 2B shows a voltage output circuit using the DAC-08 connected to an external load resistor and op-amp buffer. Also shown are the outputs expected for various input words. Note that $I_{ref}$ is created from $V_{ref}$ and a 5.00 Kohm resistor.

The output of a DAC rises or falls in *steps,* and this produces a staircase ramp as in Fig. 3. The value of each step is also the amount of change caused by the least significant bit (LSB), which is given by $V_{ref}/2n$ (where n is the number of bits). In our popular eight bit system, then, the minimum step is $V_{ref}/256$. If $V_{ref}$ is 10.00 volts, as is often the case, then each step is approximately 40 mV.

If the DAC is designed to operate only with positive outputs, then zero volts (or zero mA), is represented by 00000000, but in *bipolar* DACs, 00000000 represents the maximum *negative* output. Since this is a digital system, we find that zero volts actually lies between two of the possible binary states (i.e. 10000000 and 01111111). Examine the chart in Fig. 2B. This phenomenon creates the notion of "plus and minus zero." In the eight bit system with a 10.00 volt reference potential, the nearest we can get to zero is 40 mV.

## ADC circuits

Although quite a few different ADC circuits exist, we are going to consider

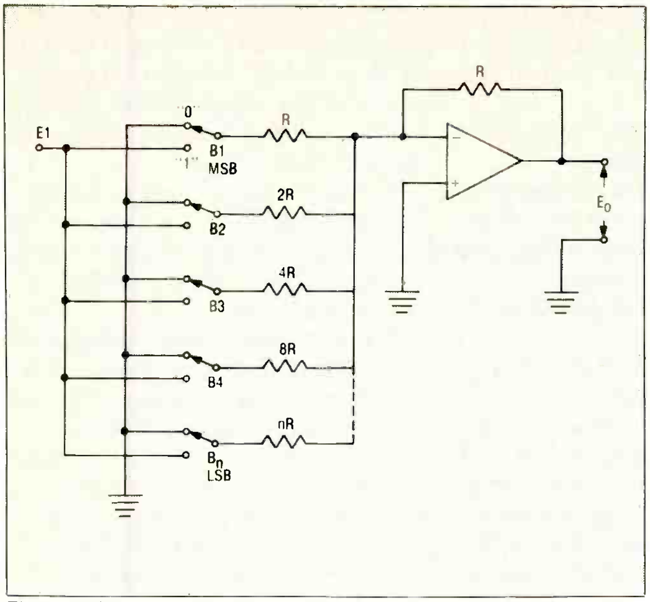



*Fig. 1A-Binary weighted resistor ladder DAC circuit*

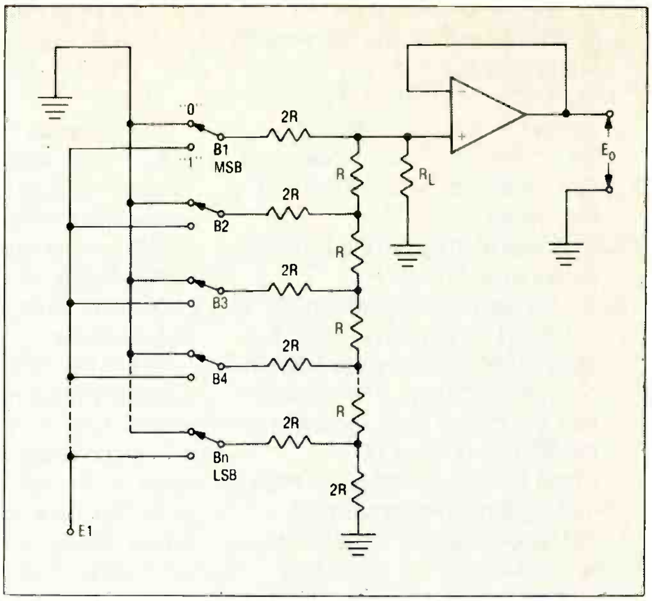



*Fig. 1B-R-2R resistor ladder DAC circuit*

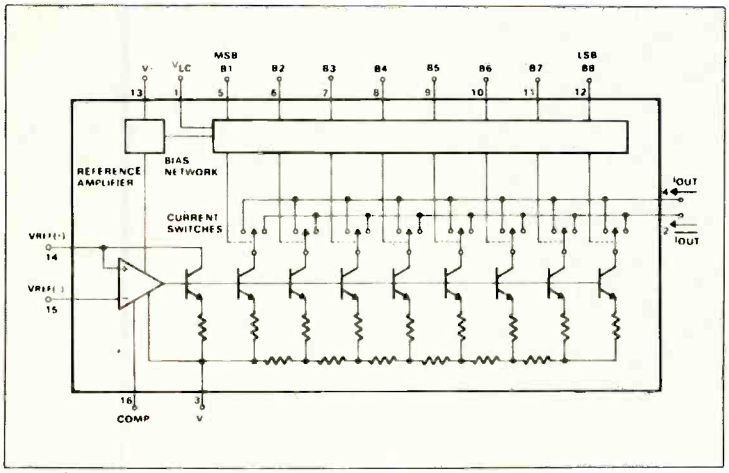
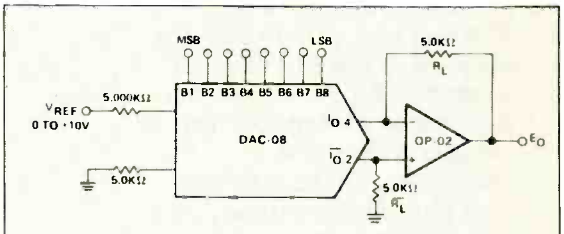



*Fig. 2A-Block diagram and pin-outs for a DAC-08 eight bit IC DAC.*




IF $R_L = \overline{R_L}$ WITHIN ±.05%, OUTPUT IS SYMMETRICAL ABOUT GROUND

| | B1 | B2 | B3 | B4 | B5 | B6 | B7 | B8 | $I_O$ mA | $\overline{I_O}$ mA | $E_O$(V) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| POS. FULL SCALE | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1.992 | .000 | +9.96 |
| POS. FULL SCALE -LSB | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1.984 | .008 | +9.88 |
| (+) ZERO SCALE | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1.000 | .992 | +.040 |
| (-) ZERO SCALE | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | .992 | 1.000 | -.040 |
| NEG. FULL SCALE +LSB | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | .008 | 1.984 | -9.88 |
| NEG. FULL SCALE | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | .000 | 1.992 | -9.96 |

*Fig. 2B-Voltage output, bipolar, connection, with table showing output voltage level for various input states.*

only the *ramp, successive approximation, and dual-slope integrator*. Those readers who desire more information may be interested in my book *"How to Design & Build Electronic Instrumentation,"* TAB Books Cat. no. 1012.

The block diagram for a ramp type of ADC circuit is shown in Fig. 4. Note that this circuit is also called the binary counter ADC or the servo ADC. The principle sections of the circuit are a binary counter, a DAC, a voltage comparator, and a control logic section.

When a *start* pulse is applied, the control logic section resets the binary counter to zero, making the DAC output also zero. Since the DAC output $E_o$ is less than $E_{in}$ the comparator output is HIGH. This output level remains HIGH until $E_o = E_{in}$.

A clock causes the binary counter to increment once for each clock pulse, so the DAC output voltage will ramp upwards (see Fig. 4B), changing one step for each pulse. When $E_o = E_{in}$, then the comparator output drops LOW, shutting off the counter, and issues an *end-of-conversion* (EOC) pulse. The binary number on the output of the counter when the comparator stopped the action is latched, and represents the analog input voltage $E_{in}$. In an eight-bit, unipolar, ADC 00000000 usually represents 0 volts, and 11111111 represents fullscale, in our example 10 volts.

The ramp-type ADC is used where moderate operating speeds are needed. The conversion time for a fullscale input is 2n clock pulses, where n is the number of bits. Suppose, for example, that we have an eight bit ADC using a 100 kHz (i.e. 10 µS period) clock. The fullscale conversion time would be ($2^8$) 10 µS), or 2560 µS (2.56 mS).

The successive approximation ADC circuit of Fib. 5A operates at a much higher speed, and can complete a conversion in (n + 1) clock pulses. For our hypothetical eight bit system using a 100 kHz clock, the conversion time would be (8 + 1) (10µS) = (9) (10 µS) = 90 µS, which is 28 times faster than the ramp type ADC operating at the same clock frequency. The principle components are the DAC, voltage comparator, and a special *successive approximation register* (SAR).

The SAR previously was constructed of discrete digital logic components in the past, but now some semiconductor manufacturers offer SAR integrated circuits. An SAR, whether discrete or integrated, consists of some control logic, output latches, and a shift register (i.e. array of cascaded flip-flops). The output latches are connected to the digital inputs of the DAC.

## ADC circuit operation

When the *start* pulse is received, the control logic clears the SAR, setting all shift registers and output latches to "0." The operation is as follows (assume that

$E_{in}$ = 6 volts in this example):

1. On the first clock pulse following the start pulse (i.e. t1 in Fig. 5B), B1, the MSB, is set HIGH. The word applied to the DAC, then, is 10000000. This word produces a DAC output $E_0$ of 5 volts dc (i.e. half-scale).
2. $E_0$ is less than $E_{in}$, so the SAR sets output latch B1 HIGH.
3. On the next clock pulse (t2), B2 is set HIGH, producing an output word 11000000. $E_0$ is now 7.5 volts, so is greater than $E_{in}$. This situation tells the control logic section to set the B2 output latch LOW.
4. At the time t3, bit B3 is set HIGH, making the new output word 10100000. $E_0$, then, is 6.25 volts so is greater than $E_{in}$. Again, the control logic section sets the output latch LOW, leaving the w000.
5. At time t4, bit B4 is set HIGH, giving an output word of 10010000. The value of $E_0$ is now 5.63 volts, so $E_0$ is less than $E_{in}$. In this case, then, the output latch is set HIGH, leaving the word at 10010000.
6. This process continues for four more trials. At each trial the output latch is set LOW if $E_0$ is greater than $E_{in}$, in set HIGH if $E_0$ is less than $E_{in}$. An EOC pulse is issued following the ninth clock pulse, or when $E_0$ = $E_{in}$.

The successive approximation type of ADC is used where high speed is required. Although most are designed for use with clocks between 500 Khz and 2.5 Mhz, some circuits exist using clocks as fast as 13 Mhz, resulting in conversion times of less than 700 nanoseconds.

One of the slowest ADC circuits is the dualslope integrator. But what it lacks in speed, it makes up in operation. The dual-slope integrator is more immune to noise on the signal than are the other types. The dual-slope integrator, then, is almost ideally suited for use in digital voltmeters. In fact, most DVMs use this type of ADC.

The block diagram of the dual-slope integrator is shown in Fig. 6. It consists of an operational amplifier integrator (A1), a voltage comparator (A2) a binary counter, and a control logic section. The operation is as follows:

1. A *start* pulse at time $t_0$ causes the electronic switch S1 to connect the input of the integrator to the analog input signal, and to reset the counter to zero.
2. The integrator output signal begins to rise as capacitor C1 begins to charge under influence of $E_{in}$. As soon as $E_A$ is more than a few millivolts above ground, the output of comparator A2 goes HIGH, thereby turning on the counter.
3. The counter increments until it overflows (t1). The counter's overflow creates a *carry* pulse that tells the control section to switch S1 to connect the integrator input to the precise stable reference source.
4. At time t1 the counter is at zero, and the charge on C1 is proportional to the *average* value of $E_{in}$ during the $t_1$-$t_0$ interval.
5. Between $t_1$ and $t_2$ $E_{ref}$ causes C1 to *discharge* at a *constant* rate. During this same period the counter is incrementing once for each clock

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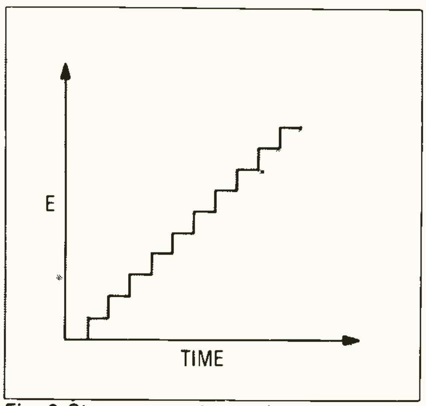



*Fig. 3-Step ramp output voltage*

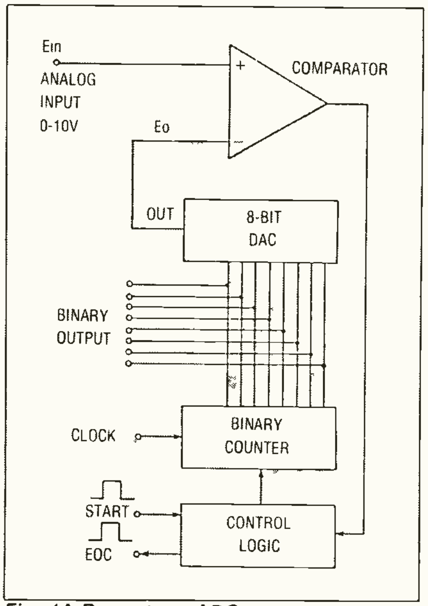



*Fig. 4A-Ramp type ADC*

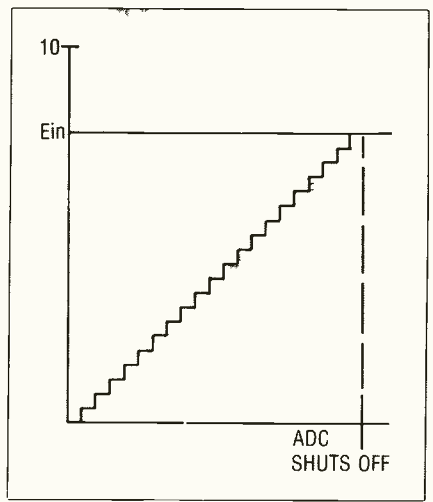



*Fig. 4B-Output function*

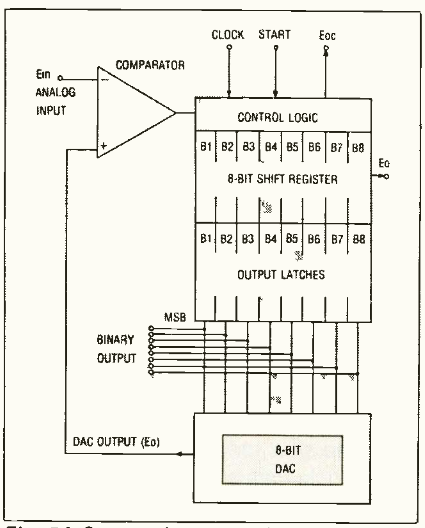



*Fig. 5A-Successive approximation ADC*

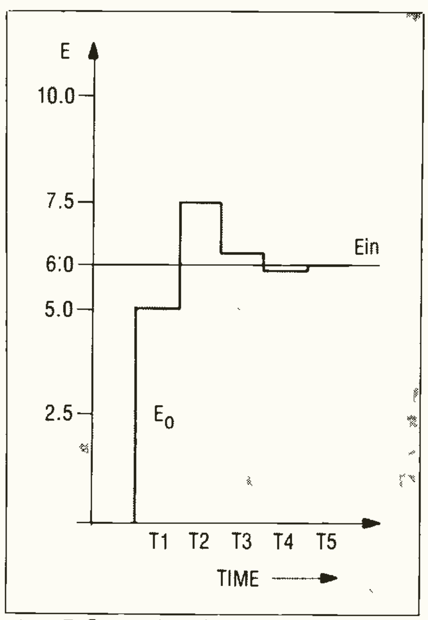



*Fig. 5B-Output function*

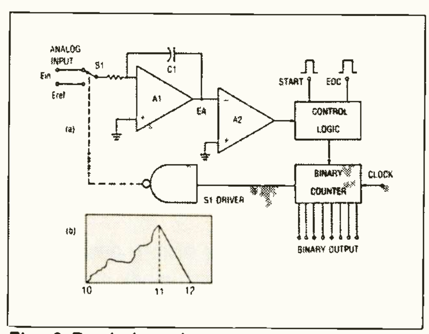
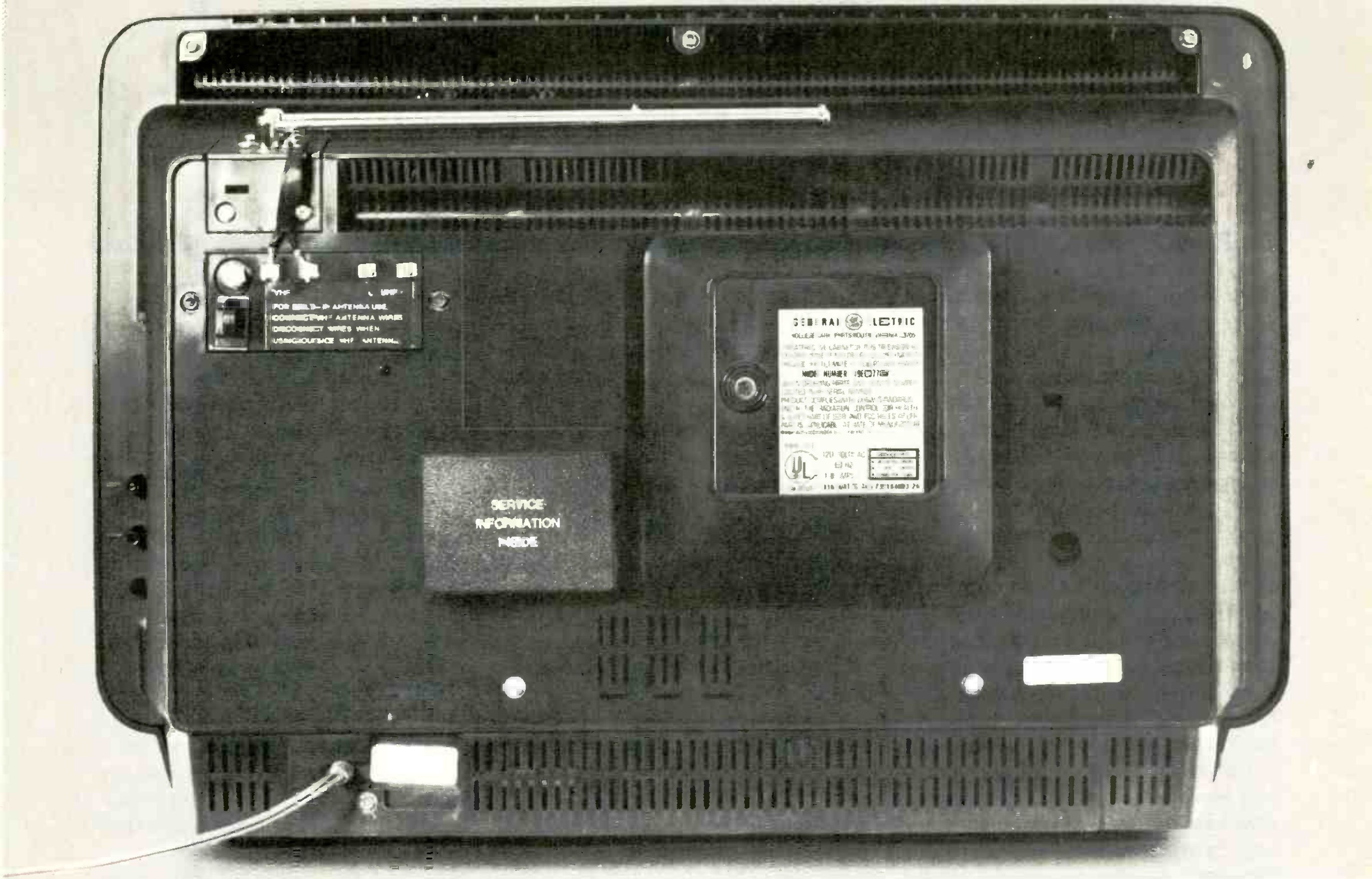



*Fig. 6-Dual slope integrator ADC*

# CAN YOU FIND THE SERVICE MANUAL IN THIS PICTURE?

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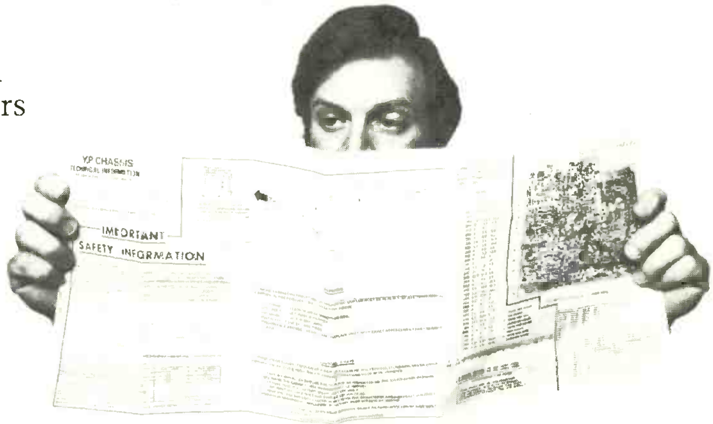


**GENERAL ELECTRIC**

# Pulses

## Vs sine waves

You cannot simply depend upon the apparent frequency of a waveform to predict circuit behavior. Here's an explanation why.

**By Bernard Daien**

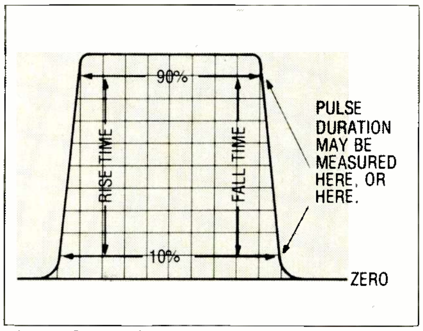


*Fig. 1–Pulse rise and fall times.*

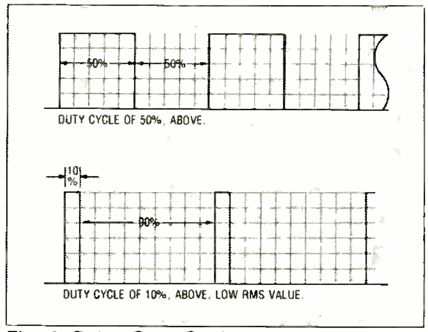


*Fig. 2–Pulse Duty Cycle.*

It may come as a shock to experienced technicians to learn that inductive reactance is not 2 pi f L, and capacitive reactance is not $\frac{1}{2 \text{ pi f C}}$ for most of the waveforms encountered in electronic equipment! Similarly, peak voltage is not 1.4 times rms for such waveforms.

The classic formulae apply only to a sine wave, which is a most unusual waveform because it is the only waveform that consists of a single frequency. All other waveforms consist of a fundamental and one or more harmonics. The formulae used for sine waves cannot be applied to non-sine waves, and other means must be used to deal with them.

Common examples of non-sine waveforms are the vertical and horizontal sync pulses, vertical and horizontal sweeps, video wave forms, audio waveforms, and practially all digital waveforms. Thus, it is essential that the modern technician understand non-sine waves. This article discusses, in easy style, some concepts of non-sine waves, how to deal with them, and how to use them.

### Terminology

The sine wave is the only waveform which cannot be considered to be a "pulse." All other waveforms consist of more than one frequency, all harmonically related. The output of a half wave rectifier is a series of pulses, even though it is half a sine wave. When we speak of pulses, the term "repetition rate" is used, not "frequency," since the pulse consists of many frequencies.

Other terms used with pulses can be defined with the aid of Fig. 1. . . "rise time" is the time required for the voltage or current to rise from the 10% level to the 90% level. "Fall time" is the time to fall from 90% to 10%. "Pulse duration" may be measured in any of several ways—so be careful. It can be measured at the 10% point, the 90% point, or in terms of a square wave, which contains the same amount of energy as the pulse being examined.

Each pulse shape has its own relationship between peak, average and rms. The common square wave pulse has a ratio of 1 to 1 to 1, i.e., peak, average, and rms are the same. A term commonly used is "crest factor," which is the ratio of peak to rms. As you know, a sine wave has a ratio of 1.4 between rms and peak; thus, it has a crest factor of 1.4. Some other wave forms frequently seen are the triangular wave with a crest factor of 1.73, and the previously mentioned square wave with a crest factor of 1.0.

Another variable we must deal with is "duty cycle." Fig. 2 illustrates pulses with 50% and 10% duty cycles. Pulses with a low percentage duty cycle have a small rms value. Viewed in a somewhat simplified way, duty cycle is the ratio of "on" to "off" time.

One way to determine the energy in a waveform is to reproduce it on graph paper, as shown in Fig. 3. Energy in the wave is proportional to the area under the curve. By counting the number of boxes, and the number of half boxes, etc., and adding them up, we can arive at the total number of boxes under the curve. We can then construct a square wave with the same *total number of boxes,* and the *same peak amplitude.* It then becomes a simple matter to determine any equivalent factor, since the rms, average, and peak of the reconstructed wave are equal.

### Pulse composition

A sine wave has a single frequency and, therefore, occupies a very small bandwidth. It passes through circuitry of any bandwidth, with no change in waveform, but it may be changed in amplitude. A pulse has changes in its waveform when passing through circuitry which is not capable of passing the entire bandwidth of the pulse. Since the pulse has harmonics, the bandwidth required is considerable. Fig. 4 illustrates some common waveforms and their harmonic content.

You already know that in a color TV set, horizontal sync pulses are formed into sharp spikes by the horizontal differentiator circuit. This is an example of how a pulse can be changed in shape by the bandwidth of the circuitry, since a differentiator is an RC high pass filter, which passes the high frequencies, but attenuates the low frequencies.

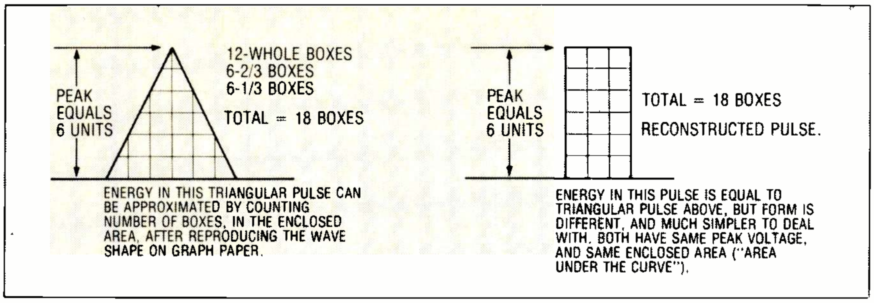

*Fig. 3–Pulse energy graphically determined.*

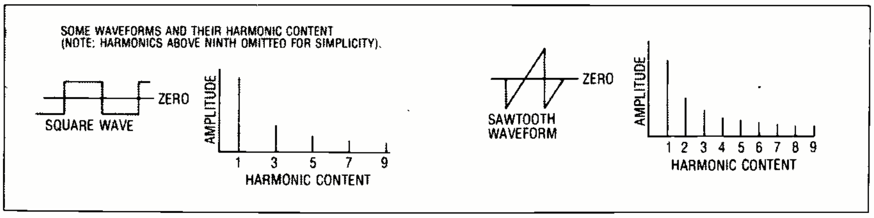

*Fig. 4–Harmonic content of waveform.*

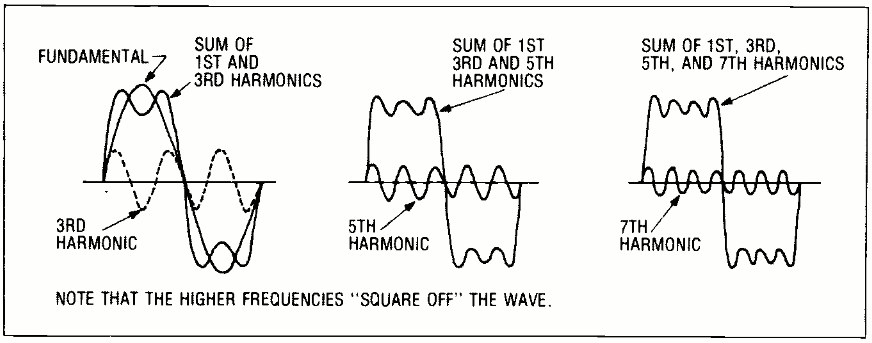

*Fig. 5–Harmonic series to approach a square wave.*

Look closely at Fig. 5. Notice that it is the higher frequencies which fill in the corners, and square off the sides of a square wave. If the high frequencies are suppressed, we get a sine wave (the fundamental only). If we suppress the low frequencies, we are left with only the steep sides of the wave or the spikes. . . which is the principle of differentiation.

A Frenchman, Jean Fourier (pronounced Foor-yay), first stated that pulses can be analyzed as a series of *harmonically related* sine waves. Fourier's Theorem resulted in some interesting revelations about pulses: 1. The fundamental frequency is the pulse repetition rate; 2. The waveshape depends upon which harmonics are present, their relative strengths, and phase relationships; 3. The series of pulses may contain a dc level.

Let's look at the last statement with the aid of Fig. 6, which is a series of identical square wave pulses with a 50% duty cycle. We rely upon this dc level when using "dc restoration" in a TV set.

We can sum up by stating that if the positive half of the wave is greater than the negative half, we have a net positive dc level. If the negative half is greater, we have a net negative dc level. The absolute value of the positive or negative dc level also depends upon the cycle, as discussed earlier.

## Square wave analysis

Square waves are easily generated by amplifying and clipping sine waves. The resulting square waveshape can be used to analyze the characteristics of bandpass amplifiers, such as audio amplifiers, video amplifiers, IF amplifiers, etc. By using the appropriate repetition rate, any circuitry can be quickly tested.

Fig. 7 shows some results commonly encountered in square wave testing, and the causes. Study of these waveforms reveals that tilting of the wave tops and bottoms indicates phase shift, with the direction of tilt revealing phase lead or lag. Rounding of the corners indicates loss of high frequencies. Dishing of the wave tops and bottoms indicates loss of lows. Overshooting on the square wave edges indicates excessive high frequency response. Ringing indicates poor transient response, instability, or the presence of a high Q tuned circuit which is shock excited by the fast rise and fall times of the pulse. It is quite common to have a combination of these defects, resulting, for example, in a wave which has both loss of lows and phase shift, as indicated by the presence of tilt and dishing.

When using an "X10" high impedance probe with an oscilloscope, you will notice an adjustable trimmer capacitor built into the probe. By viewing a good square wave, and adjusting the trimmer for the best waveform, you actually set the probe for "flat response, thus, passing the fundamental and all the harmonics of the wave. Without this adjustment, pulses would appear distorted on the scope screen.

## Reshaping a pulse

Since pulse shapes can be altered by passing the pulse through circuitry which does not have a flat bandpass, we can use this property to reshape a *square* wave by using a high pass *RC* filter or a low pass *RC* filter (RC filters don't "ring"). Look again at the waveforms shown in Fig. 7. Notice that the high pass RC filter yields a series of spikes, useful for sync purposes. This is the old familiar "differentiator" used in TV horizontal sync circuits. To achieve this, the RC time constant (R in ohms X C in farads) must be *short when compared to the period of the wave.* The low pass RC filter is, similarly, the "integrator" used in TV vertical sync circuits. To achieve this, the RC time constant must be *long when compared to the period of the wave.* For all practical purposes, we can substitute the words "duration of pulse" or "pulse width" for the term "period," in most cases.

It should be mentioned that pulses consisting of exponential curves, such as shown in Fig. 8, are not suitable for integration or differentiation. . . a not too well known fact, which has led to the frustration of many experimenters. You will recall that the waveshapes which are generated for sync and other purposes involving wave reshaping, are generally square, rectangular, triangular, sawtooth, or combinations thereof. All of these wave shapes have *straight sides.* Exponentially curved wave shapes are used very infrequently because of the above mentioned peculiarity. Remember, integration and differentiation is accomplished with RC filters. It is possible to change all wave forms, except sine waves with LC filters, such as narrow bandpass, band reject, etc., however. Or with other *sharply* tuned circuits.

Finally, it should be pointed out that since a pulse has harmonics of the repetition rate, these harmonics will be spaced throughout the frequency spectrum, often up into the UHF range.

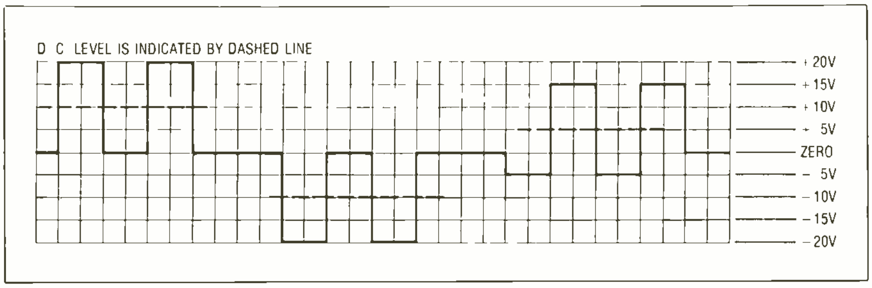


*Fig. 6–Pulse DC component.*

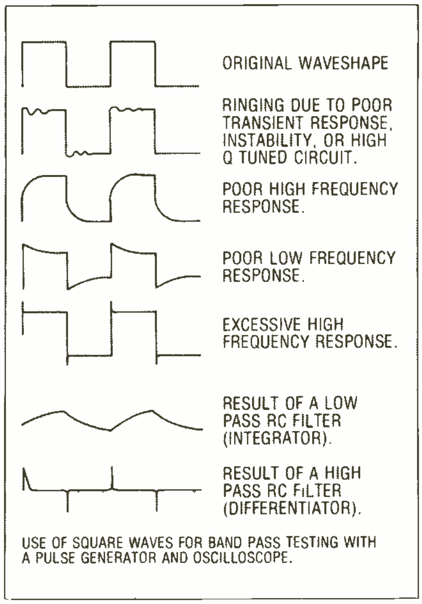


*Fig. 7–Use of square waves for bandpass testing with a pulse generator and oscilloscope.*

The spacing between harmonics is, of course, equal to the repetition rate. Thus, a 1kHz rep rate will have harmonics spaced every 1kHz through the audio spectrum. A 1MHz rep rate will yield harmonics every 1MHz all the way through the VHF range. This is why switching type power supplies put out so much hash over such a wide range of frequencies, since most of them run at 20kHz to 50kHz, with appreciable power levels. Anytime you are generating pulses, you must be careful about grounding, shielding, and filtering, or you will certainly have radiation problems.

## Summary

It was pointed out at the beginning of this article that the usual formulae are not suitable for use with non-sine waves (pulses). Now that you understand that a pulse consists of many different frequencies, in varying proportions, you can better understand why this is true.

Since most technicians have access to an oscilloscope, this article suggested the use of graphical methods of dealing with pulse analysis and pulse testing. There are mathematical methods of great precision, but all require extensive

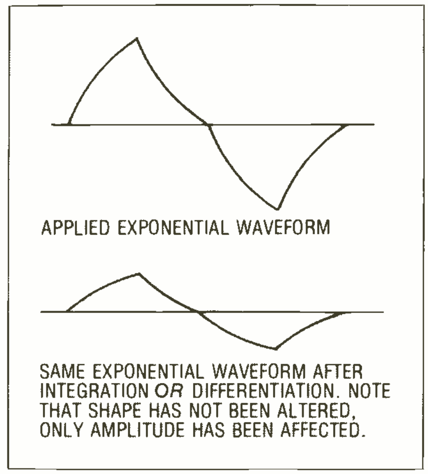


*Fig. 8–Exponential wave forms.*

use of higher mathematics, and precision measuring instruments, with the capability of handling waveforms with large crest factors. Unfortunately, most of the service shop type of digital voltmeters suffer from several faults which preclude their use for such measurements: A.) Frequency response is generally very limited. B.) They are only calibrated for either a sine wave, or for very low crest factors. C.) They are incapable of handling the very fast rise and fall times in pulses, even when the repetition rate is moderate.

Thus, the value of this article lies in giving the technician with service shop test equipment a practical entry into the world of pulses. Incidentally, since we are dealing with wide bandwidths, and high frequencies, don't forget to use your antenna transmission line theory. Impedances must be matched, and all interconnections become transmission lines. . . otherwise, you will start to see transmission line reflections, high frequency attenuation, and all the other problems usually associated with the transmission of high frequencies over wires! You cannot use high capacity audio shielded cable for your interconnects, unless they are kept *very* short. Remember the problems you had with wiring and grounding when you first tried to align a TV IF strip? Some modern computers are running at 100MHz and higher. That's twice the frequency of a

*continued on page 47*

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# Digital electronics–part IV

## More Flip-Flops

Flip-flops are available in several configurations. This month we examine three more types

**By Joseph J. Carr, CET**

In Part III of this series we introduced you to the concept of the "flip-flop," a digital circuit logic element somewhat more complex than a simple gate. The flip-flop functions as a one bit storage cell, or "memory." It was noted that there were a number of different types of flip-flop circuits, and they operated according to different sets of rules. But one common point among them all was the ability to store a single bit of information, i.e., a HIGH or a LOW condition ("1" or "0").

In Part III you were introduced to four types of flip-flop: NAND logic RS, NOR logic RS, clocked RS, and the master-slave flip-flop.

In this installment, we will discuss the type-T flip-flop, the J-K flip-flop, and the Type-D flip-flop. In considering the latter type, we will also consider a so-called latch circuit, which is a special case of the type-D flip-flop that has become a class of its own in IC families.

### Type-T flip flops

The Type-T flip-flop (also known as the toggle FF) is shown in Fig. 1A. This FF can be constructed by providing the feedback connections shown, around a master-slave FF. Recall that the M-S FF was constructed from a pair of RS FFs and an inverter. Note that the *Q* output is fed back to the reset input, and the *not-Q* output is fed back to the *set* input.

The type-T flip-flop functions as a binary divider, that is the output signal has a frequency that is one-half (i.e., divide by 2) of the input signal frequency (the clock frequency). The timing diagram for this circuit is shown in Fig. 1B. Note that the *Q* output changes state only on negative-going transitions (i.e., HIGH to LOW) of the clock pulse. At the first negative transition, the *Q* output will snap HIGH, and it will remain HIGH until the clock input sees another negative transition. This condition occurs at pulse No. 2, at which time the *Q* output goes LOW again. We, therefore, have binary division; one output pulse is produced for every two input pulses.

There are sometimes found differences in terminal designations from one text or spec sheet to another. In Fig. 1A, for example, we have called the clock input "MC for "main clock." But it is also very likely that you will see "T" for "toggle," or "$C_P$ for "clock."

### J-K flip-flops

One of the most useful, and perhaps most common, types of flip-flop is the J-K. There are several advantages to the typical J-K FF: a) there are no invalid or disallowed states in the clocked mode, b) it can cause the outputs to complement, and c) it can provide non-clocked operation (some IC versions).

Fig. 2A shows one of several popular ways to represent the J-K FF. In this case, we see that it is a type-T flip-flop with the feedback to the set and reset inputs controlled by a pair of two-input AND gates. One input from

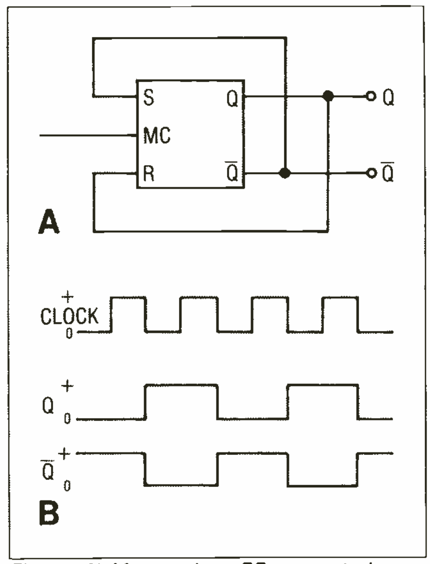


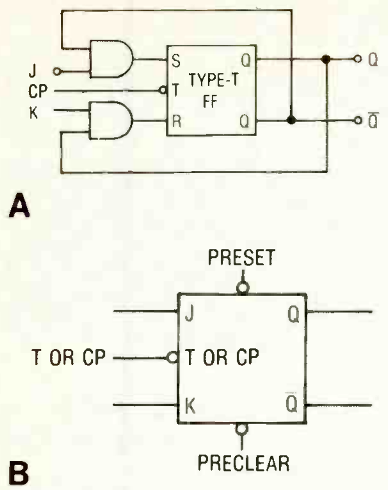

*Fig. 1 - A) Master-slave FF connected as a Type-T FF B) Timing diagram.*

each gate accepts the feedback lines, while the remaining inputs of the gates are used to form the "J" and "K" inputs, respectively.

Fig. 2B shows the circuit symbol for a J-K flip-flop. Not all versions of the J-K will have the direct mode (preset and preclear) inputs. These inputs do, however, make it a more useful device. The preset input may also be called a direct set, and the preclear input may be called either direct clear or direct reset.

Direct Mode Operation. The operation of the J-K FF in the direct mode is very simple. It is independent of conditions applied to the J and K inputs. The direct mode is controlled by conditions on the preset and preclear inputs, and the rules are summarized in Fig. 2C.

The direct mode inputs are active when LOW, so the only disallowed state occurs when both are LOW




| J | K | CLOCK | Q | Q̄ |
|---|---|---|---|---|
| 0 | 0 | | NO CHANGES | |
| 0 | 1 | | 0 | 1 |
| 1 | 0 | | 1 | 0 |
| 1 | 1 | | BINARY DIVISION | |

C

| PRESET | PRECLEAR | CLOCK | Q | Q |
|---|---|---|---|---|
| 0 | 0 | | DISALLOWED | |
| 0 | 1 | (DOESN'T CARE) | 1 | 0 |
| 1 | 0 | | 0 | 1 |
| 1 | 1 | | CLOCKED OPERATION | |

D

*Fig. 2 - A) J-K FF, B) Schematic symbol, C) Truth table for direct mode operation, D) Truth table for clocked mode operation.*

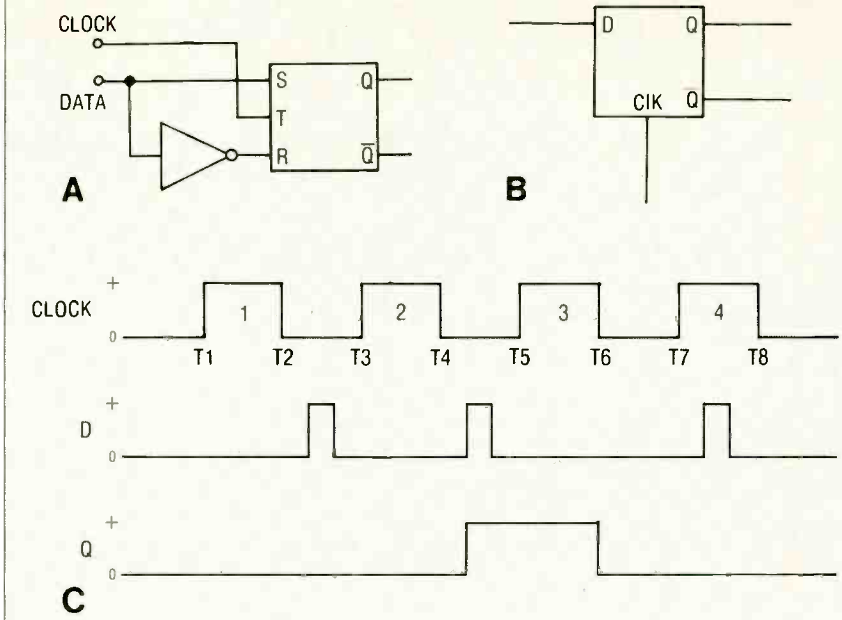



*Fig. 3 - A) Type-D FF circuit, B) schematic symbol, C) Timing diagram*

simultaneously.

If the preset input is LOW, and the preclear input is HIGH, then the outputs immediately go to a condition where *Q* is HIGH and not-*Q* is LOW.

If the preclear input is made LOW, and the preset input is made HIGH, then the outputs go directly to the state in which *Q* is LOW and not-Q is HIGH.

It is a general rule, when dealing with flip-flops of any type that set or preset operations make *Q* HIGH, and clear, preclear, or reset operations make *Q* LOW.)

If both preset and preclear inputs are made HIGH, then the flip-flop is ready for normal clocked operation.

Clocked Mode Operation. Whenever the preset and preclear inputs (where used) are simultaneously HIGH, the J-K FF will operate in the clocked mode. The rules for clocked operation are summarized in Fig. 2D.

Like the type-T FF, the J-K FF (in clocked mode) reponds on the negative-going transitions of the clock pulse. No output changes will occur, regardless of changes at the J and K inputs, until one of these negative-going clock pulse transitions is seen. The outputs will then respond according to the J-K input conditions. The rules for clocked operation of a J-K FF are as follows:

a) If both J and K are LOW, then the FF is inert and does nothing. No changes will occur at the outputs, even though the clock is pulsed.

b) If J is LOW and K is HIGH, then the clocking makes Q LOW and not-Q HIGH.

c) If J is HIGH and K is LOW, then clock pulse transitions make Q HIGH and not-Q LOW.

d) If both J and K are HIGH, then the J-K FF behaves very much like a type-T FF; clocking complements the outputs. This means that negative-going clock transitions force the outputs to go to the opposite state. The output waveform is identical to Fig. 1B.

The type-D flip-flop is shown in Fig. 3. The equivalent circuit is shown in Fig. 3A, while the usual schematic circuit symbol is shown in Fig. 3B.

The equivalent circuit is a clocked R S FF in which the set and reset inputs are fed by the same signal, but out of phase with each other. An inverter accomplishes this neat trick.

The common line to the set-reset-inverter is called the data or "D," input. This line is usually labeled "D" on most schematics and schematic symbols (i.e. Fig. 3B).

The rule for the operation of the type-D FF is very simple: data appearing on the D input will be transferred to the Q output only when the clock line is HIGH.

a) If the clock is HIGH, then the output follows changes in the D input (i.e., Q goes HIGH when D is HIGH and LOW when D is LOW).

b) If the clock is LOW, then the output retains the last data that existed on the D input at the instant the clock line dropped LOW.

These rules can be seen by the timing diagram in Fig. 3C. While reading the description below, keep in mind the rules of operation given above.

1. When the first clock pulse arrives (T1, T-2), the D input is LOW so the Q output will be LOW.

2. During the interval T2-T3, the D input goes HIGH, but since no clock pulse is present it cannot affect the outputs.

3. At the beginning of interval T3-T4, clock pulse No. 2 is HIGH, but the D input is LOW. The output, therefore, remains LOW.

4. About midway through clock pulse No. 2, however, the D input goes HIGH, forcing the Q output to also go HIGH.

5. The Q output stays HIGH even after clock pulse No. 2 goes LOW.

6. At the onset of clock pulse No. 3, the D input is LOW, so the Q output

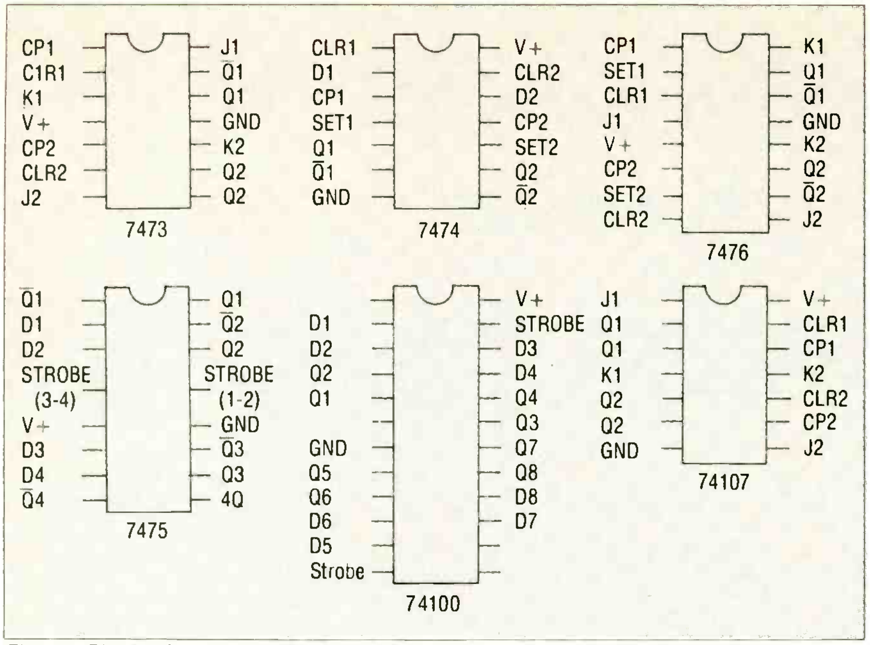



*Fig. 4 – Pinouts for popular FF ICs*

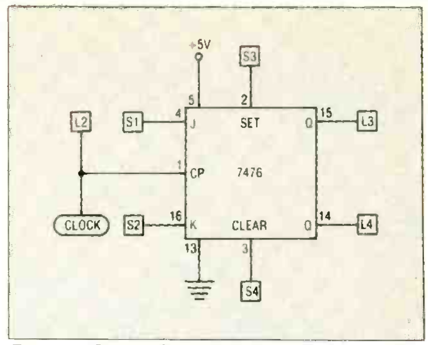



*Fig. 5 – Circuit for experiments.*

drops LOW also.

7. The pulse on the D-input during the interval T6-T7 cannot affect the Q output, because the clock input is LOW.

The so-called "data latch" is a special case of the type-D FF. This device is used in digital readout circuits, i.e., on a frequency counter or similar instrument, to hold current data until the new data has been updated and is ready for presentation. This gives the illusion that the data is updated instantaneously. In most cases, the clock input is called a strobe input. Data at the D input will be transferred to the outputs only when the strobe line is HIGH. The idea is to momentarily bring the strobe line HIGH when the data at the input is valid, and then let the strobe go LOW again until the new data is ready.

## IC flip-flop examples

Very few designers will use the gate circuits for flip-flops presented in this article. The reason is that IC manufacturers offer IC FFs that can be used as circuit building blocks, reducing the number of interconnections needed. Below are listed some of the more popular examples. (Fig. 4 shows the pinouts of the devices discussed in this section.)

7473 dual J-K level-triggered FF with preclear
Each section is a J-K FF, in which the clock input responds only when LOW (TTL).

7474 Dual Type-D, edge triggered FF. This is a type-D FF that allows output state changes only on positive-going transitions of the clock pulse. (TTL).

7475 Quad latch. This IC contains four type-D FFs, arranged so that the clock lines for two are tied to one strobe pin (No. 13), and the clock lines to the remaining two are connected to another pin (4). When the strobe lines are HIGH, the outputs will follow the data applied to the inputs, but when the strobe is LOW the outputs will retain the last valid data before the strobe pulse dropped LOW. (TTL).

7476 Dual level-triggered J-K FF with both preset and preclear inputs

74100 Dual quad latch circuit. Can be used as an 8-bit latch.

74107 Similar to 7473 but uses standard pinouts for +5 voltd and ground (TTL).

4013 Dual type-D FF (CMOS)

4027 Dual J-K FF (CMOS)

## Experiments

In the experiments to follow we will investigate the operation of the flip-flop. A type 7476 device is used because it has both preset and preclear inputs. The circuit of Fig. 5 is used. Only a Poweracc 102 is needed.

## Experiment No. 1

Direct mode J-K operation

1. Connect the circuit of Fig. 5
2. Set the following conditions
   a. J (S1) and K (S2); HIGH
   b. Set (S3) and clear (S4): LOW
   c. Clock: off
3. Observe Q (L3) and not-Q (L4). Q should be LOW (L3 off) and not-Q should be HIGH (L4 on).
4. Turn on the clock. Have any changes in L3/L4 taken place? (There should not be any change.)
5. Set J to HIGH. Any change? Set J to LOW, K to HIGH. Any change? Set J and K both HIGH. Any change?
6. Repeat steps 1- 5, but with set (S3) LOW and clear (S4) HIGH.

## Experiment No. 2.

Clocked J-K operation.

1. Connect the circuit of Fig. 5
2. Set up the following conditions
   a. Set (S3), clear (S4), J (S1) and K (S2): HIGH
   b. Clock: off
3. Turn the clock on, and observe L2 (clock signal) and L3 (Q output signal). Note the binary division action.
4. Make J LOW and K HIGH. Observe L3/L4.
5. Make J HIGH and K LOW. Observe L3/L4.

## Experiment No. 3.

Complementing the output on clock pulse. Connect the circuit of Fig. 5, except replace the clock with S6-Q. This will cause the clock input of the 7476 to go HIGH when S6 is pressed, and then drop back LOW when S6 is released. S6 is used to allow us to manually clock the FF, while observing the output.

1. Set S1 — S4 HIGH
2. Clear the FF by momentarily bring S4 LOW. Q is now LOW (L3 off) and not-Q is HIGH (L4 on).
3. Set J LOW

*continued on page 47*

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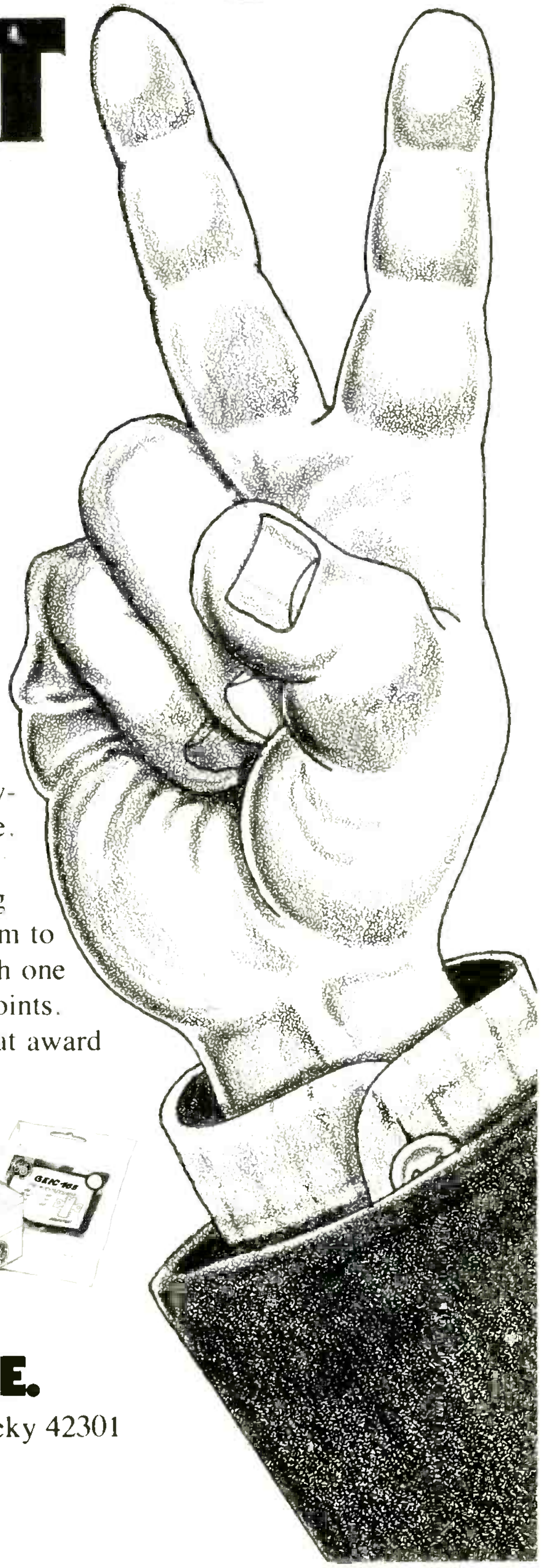

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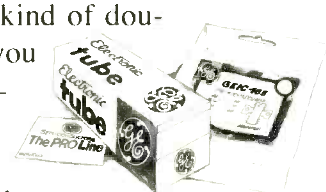


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**SK Solid State Replacement Guide,** 1979 edition, has recently been announced by RCA. The new edition reportedly lists 957 replacements for over 153,000 types of domestic and foreign semiconductor devices. A notable feature of the new guide is the dual stock number system referring where applicable to the ECG (GTE/Sylvania) numbering system. As an example, the SK 3444 is now listed as a SK 3444/123A since it is a direct replacement for the ECG-123A. The guide includes a comprehensive data section and an index. Available from your RCA SK distributor or for $1.50 from RCA Distributor and Special Products, PO Box 597, Woodbury, NJ 08096.

**A new 32-page catalog "1979 CSC" features signal generators, test instruments,** logic probes, frequency counters, solderless breadboards, digital troubleshooting instruments and IC test clips from *Continental Specialties Corporation*. New products in this catalog include four instrument cases and the experimentor system of complimentary breadboards, circuit boards and worksheet pads. The catalog is available from CSC distributors or Continental Specialties Corporation, 70 Fulton Terrace, New Haven, CT 06509.

**Walsco, Division of GC Electronics has recently published its 1979 catalog** featuring a number of new products. The catalog includes belts, idler and drive wheels and pressure rol-

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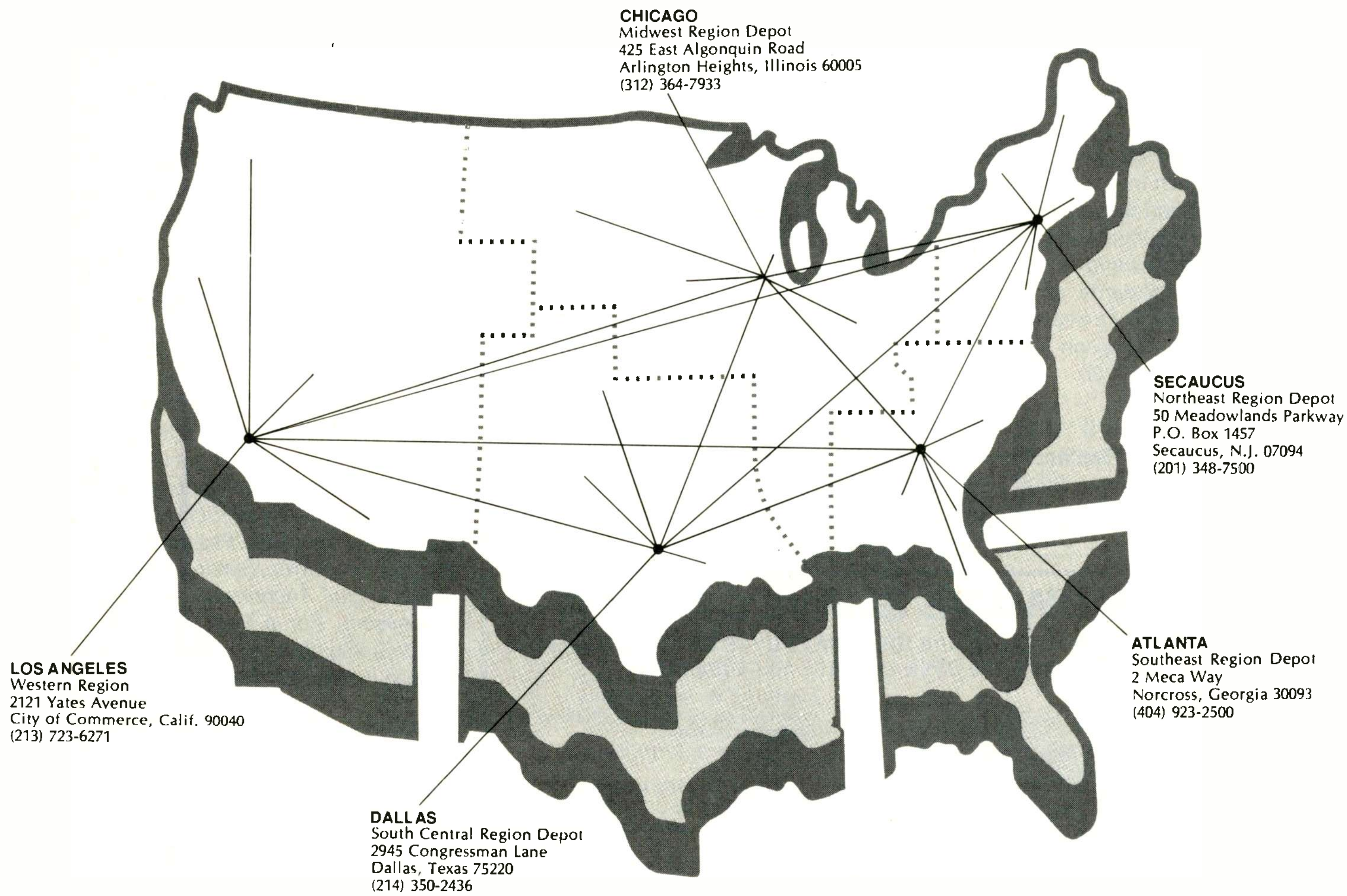


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**An expanded 1979 "ECG Semiconductor Master Replacement Guide and Catalog"** listing 2200 solid state replacement devices has been announced by *GTE Consumer Electronics*. The Sylvania ECG line presented in this 354 page book is stated to be the largest and most comprehensive selection of replacement semiconductors in the industry. The 1979 guide lists 596 additions to the ECG line. Copies are available from authorized Sylvania distributors or by mailing $2.95 to GTE Marketing Services Center, 70 Empire Drive, West Seneca, NY 14224.

**Tools and terminals** are the major subjects of two new catalogs issued by *Vaco Products Company*. Catalog SD-222 describes Vaco's "E" paks, featuring 41 bellmouthed insulated terminal styles, and 19 non-insulated styles, as well as Nylon ties, wire connectors and insulated Quick Connects. SD-222 also describes wire strippers and electrical tools. Catalog SD-233 features new product introductions including the TORX 5-in-1 magnetic screwdriver and a 5-in-1 magnetic screwdriver for mobile homes, RV's and campers.

Both catalogs are free by writing Vaco Products Co., 1510 Skokie Blvd., Northbrook, IL 60062 or call 312-564-3300.

**The "Radio Amateur's License Manual,"** 77th edition, has recently been published by the *American Radio Relay League*. The structure of amateur licensing, renewals, license modifications, upgrading, special licenses, and reciprocal and foreign operating are explained. The various configurations of call signs are covered. Then beginning with a novice checklist, (Novice license material is covered in "Tune in the World with Ham Radio,") it continues with a study guide for the Technician, General Class, Advanced Class and Amateur Extra Class Licenses. Study material, questions and answers are included. The "License Manual" also contains information on US and international amateur regulations and the FCC regulations, Part 97, covering amateur radio. The price is $4.00 and the "License Manual" is available at many distributors or American Radio Relay League, Newington, CT 06111.

*Heath/Schlumberger* has recently announced publication of its latest **Instruments Catalog.** This catalog features Heath/Schlumberger's line of assembled computers and electronic test equipment, chart recorders, oscilloscopes, power supplies, counters, multimeters, and signal and function generators. The catalog also lists Heath/Schlumberger's Continuing Education Programs on DC and AC Electronics, Semiconductor Devices, Digital Techniques, and Microprocessors. For a free catalog write Heath/Schlumberger, Dept. 570-200, Benton Harbor, MI 49022.

**A 24-page catalog of kits** of interest to the two-way radio shop or radio amateur has just been announced by *Hamtronics*. Products features include a new VHF FM receiver kit with four selectivity options, VHF transmitting and receiving converters, UHF receiving converters, FM transmitters and power amplifiers for VHF and UHF, preamps for VHF and UHF and RF probes for VTVM's. For a copy write Hamtronics, Inc., 65F Moul Rd., Hilton, NY 14468.

**A new 100 page professional antenna catalog** containing complete mechanical and electrical specifications for more than 250 land mobile antennas and accessories is now available from *The Antenna Specialists Company*. In addition to product data, the catalog contains information on system planning, special applications and performance standards. A copy is available to qualified two-way radio specialists from the Professional Products Div., The Antenna Specialists Co., 12453 Euclid Ave., Cleveland, OH 44106. ET/D



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# TEST INSTRUMENT REPORT

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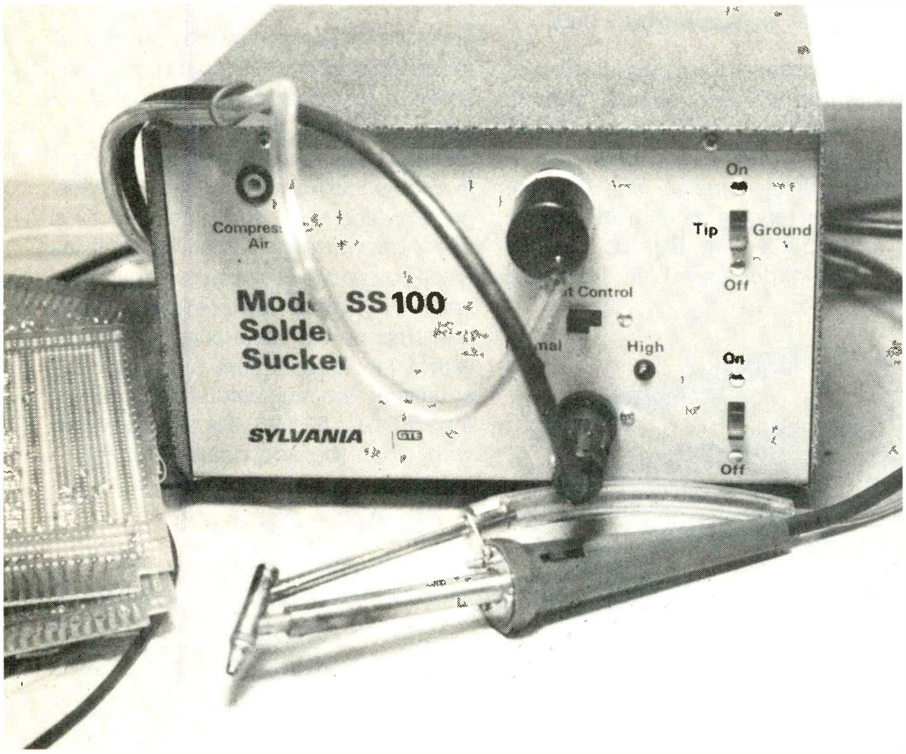



*For more information about this instrument, circle 150 on The Reader Service Card in this issue.*

# The Sylvania SS100 Solder Sucker

## Effective solder removal

**By Walter H. Schwartz**

tions require air pressure or a vacuum pump for operation. You look around for some other type of device and find that some of the spring operated solder suckers work pretty well, except like the bulbs, they require two hands to use—one for the soldering iron and one for the solder sucker. But then you find you must not use them in many of the new TV's, for they can generate as much as 20,000 volts of static charge when triggered, and you may have to replace every MOS device in the set if you do. So you, at least I usually do, clip the pins off the IC and pull each out separately. If the IC wasn't bad, it sure is now.

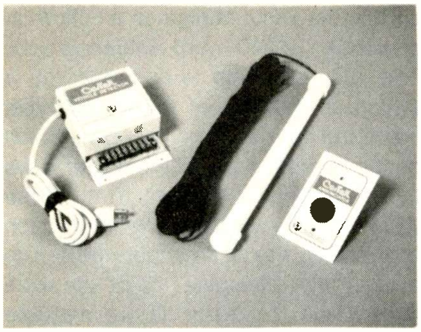
The Sylvania SS100 is not quite a test instrument, but its appearance and its price (about $200) make it more than a simple tool. It is the first and only, to my knowledge, complete and self-contained desoldering system available, not acknowledging the hand bulb types. It is a neat little package—9½ in. wide by 8½ in. high by 6 in. deep—which will fit nicely at the back of your bench, and which contains a small high capacity diaphragm type vacuum pump furnishing suction enough to clear most solder connections or circuit boards. Attached to the pump unit by means of a power cord and a vacuum hose is a hollow tip dual heat (20/40 watt) soldering iron. The vacuum pump is controlled by a switch on the side of the iron handle. Place the tip over the IC pin connection on the board, heat until the solder flows and suck it out of the joint. Turn off the vacuum pump when through with each connection. The air flow cools the iron tip excessively otherwise. Eight tip sizes from .031 in. to .090 in. I.D. are available for almost any size solder connection.

The unit ET/D used was very satisfactory. We were able to clean out plated-through holes in 1/16 in. board clearly enough so that TO-3 power transistors fell out of the board. I decided to try to salvage some prototype circuit cards that I had bought at a swapfest on the chance they could be salvaged. (New cost about $8, so for a dime each I thought I'd gamble.) The process was a bit time consuming, but I was able to push parts and leads free quite easily after going over the board with the SS100. (Now if I can just keep those kids interested long enough to salvage all of those cards.) The SS100 seems to have no trouble at all clearing solder from the single sided board, which is used in most consumer electronics, and it can be used satisfactorily to resolder most components. So instead of having that soldering iron ready to go all day on your bench, have the SS100 on 20 watt heat and use it as you would your regular iron. Which brings up the only complaint I have about it. The rack or cradle which is furnished with it does not hold the iron—unless the tip is carefully hooked in the hole. The vacuum hose and power cord are too heavy and pull it off the rack and it doesn't lie conveniently on the bench either. It needs a new holder.

Features include, in case I forgot any that are important, a compressed air outlet to help clear the tip of solder, silver-plated nickel tips, eight different sizes of tips (.031 in. and .063 in. are included), and an industrial service rating, which I assume allows continuous use.

Feedback from Sylvania: They don't recommend using the solder sucker as a soldering iron, though I experienced no difficulty with it. Their point is—if you feed excessive solder to the tip, it may fill up unless it is blown clean regularly. You won't really damage anything, just have to remove and clean the tip. ET/D

# NEW PRODUCTS

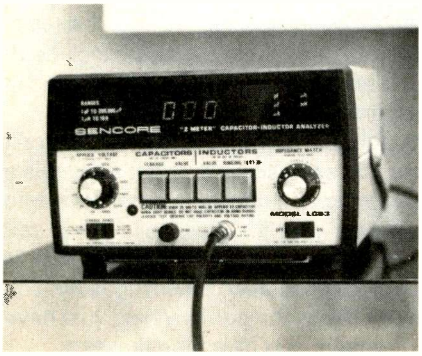


## Vehicle Detector
Circle No. 136 on Reader Inquiry Card

A new detecting system sets up an adjustable electro-magnetic field in a driveway, or any vehicle passage area, to detect vehicle entrance. Upon sensing, the system will activate outside lights and provide an audio alert signal. The system can be installed reportedly in less than four hours time. A low voltage probe is buried next to the driveway (pavement or roadway is not disturbed), and the electronics can be placed inside the premises, garage, house, office, or commercial area. The *Cartell* is suitable for residential applications, parking lots, drive-in windows, vehicle counting, traffic control, cemeteries, used car lots, service stations, etc. Vehicles and trucks leaving a protected premises will also activate it, thus increasing effectiveness for truck terminal applications. It is stated that a system can be purchased and installed for less than $350.

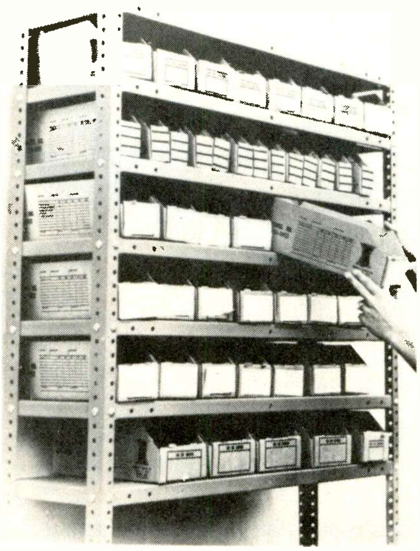
## "Z" Meter
Circle No. 137 on Reader Inquiry Card

*Sencore* has just introduced a unique digital, inductance/capacitance meter. The Model LC53 measures capacitor values from 1 pico farad to 200,000 microfarads and inductance values from 1 microHenry to 10 Henrys, checks capacitor leakage and dielectric absorption, and checks inductor "Q" by means of Sencore's ringing test. The LC53 is stated to be accurate to 1% on capacitance and 2% on inductance (plus a resolution error of plus or minus 2 counts on the third significant digit) and is auto ranging. Special provision is made for testing yokes and flybacks. The price is $695; a capacitor only checker, the CA55 is priced at $495.




## Shelf Boxes
Circle No. 138 on Reader Inquiry Card

A line of fiberboard shelf bins for low cost storage and inventory of small parts is now available from *Economy Carton Company*. Called Econo-Bins, the fiberboard units come in nine different size styles ranging from 2 in. wide x 12-in. deep x 4-½ in. high up to 12-in. wide x 12-in. deep x 4-½-in. high. The



Econo-Bins are designed to fit neatly and compactly into Econo-Bin steel storage racks. Up to 100 Econo-Bins can be stored in an Econo-Bin rack 36-in. wide x 12-in. deep x 75-in. high. Quantity lot prices range from 24 to 50 cents each depending on size. Prices of complete racks with 100 bins start at $90.00.

## Temperature Tester
Circle No. 139 on Reader Inquiry Card

*Universal Enterprises* MT012 is a general purpose indicating pyrometer for measuring temperatures from 0° F to 1200° F. Temperature is sensed by a probe with a fast response thermocouple sensor that has a welded, shielded hot junction and attachment clip. The MT012 is suitable for testing many items including baking ovens,

grills, fryers, process ovens, dryers and for measuring stack temperatures. Optional 4 foot disposable temperature probe, stock No. ATT7, is available for testing self cleaning ovens. It is housed in a compact (10 × 7½ × 3½ in.), hinged polyethylene case, and is covered by a one year warranty. Other features include color coded five way binding posts and a 4 inch meter with bold easy to read numerals on the scale plate. Complete with 4 foot temperature probe and instructions, the suggested trade price of the MT012 is $31.95. It is also available with a centrigrade scale, stock No. MT012C.

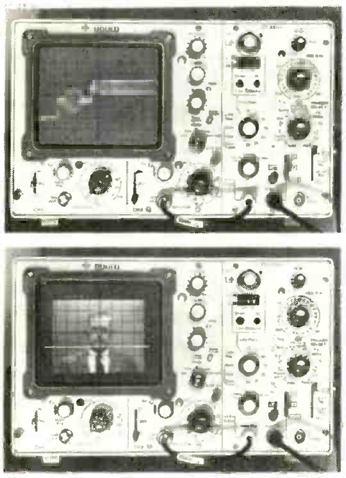
## Desoldering Tool
Circle No. 140 on Reader Inquiry Card


A desoldering tool that is refillable is now available from *Tech-Wick Tool*. The hand-held heat resistant plastic tool has a see-through plastic cap that snaps off for reloading. The stranded wick is available in three sizes: round .040, flat 5/64 width and flat 1/16 width. Each refill contains approximately 20 feet of pure copper stranded wick. The Tech-Wick Tool sells for $7.50, which includes a TWT Tool, plus one refill (approximately 20 feet of wick) in any of the three sizes. The refills are $4.50 each.

## Portable Video Monitoring Scope

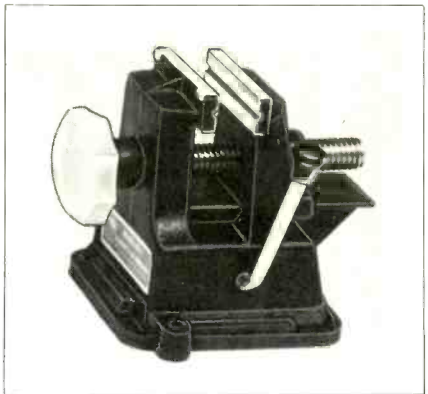
Circle No. 141 on Reader Inquiry Card

A new video monitoring oscilloscope, the *Gould* OS3350, combines the functions of a TV waveform monitor and a conventional 40MHz, dual trace oscilloscope in a single portable instrument. It has been developed for use in testing and servicing commercial TV, cable TV, closed circuit TV, Telefax and video recording/playback equipment including home systems. It is stated that a special timebase generator in the new scope provides comprehensive video triggering facilities which enable it to be used for both detailed line-by-line examination of 525-line TV waveforms and the viewing of complete pictures on its 8 x 10 cm CRT. (A 625-line version of the scope is also available.) The OS3350 accepts a standard 1-volt composite video input signal with or without "sound-in-sync" pulses and provides any of six triggering modes: vertical field 1; vertical field 2; vertical field 1 and 2 alternating; horizontal line repetitive; single horizontal line with line number indicated on a 3-digit LED display; and selection of individual line pairs specified for Telefax data. Triggering can be delayed continuously by up to 90 micro-seconds via a multiturn pot, which allows the signal to be examined in detail. When the instrument is used to display a TV picture, the line and field selected are displayed on the digital "up-down" counter. This corresponds with an electronic cursor on the picture, enabling waveforms to be closely related to their positions. In conventional operation the OS3350 functions as a general purpose 40MHz 5mV/cm dual-trace scope with single timebase control. The Gould OS3350 Video Monitoring Oscilloscope is priced at $3500.



## Light Duty Vise

Circle No. 142 on Reader Inquiry Card



The new Model VV-1 from *O.K. Machine and Tool Corporation* is a vacuum based light duty vise for holding small components and assemblies. Of ABS construction, it has 1½ in. wide jaws with 1¼ in. travel and an oversized knob for positioning. It also features screw lugs for permanent mounting. The price is $3.49.



Circle No. 107 on Reader Inquiry Card



Circle No. 115 on Reader Inquiry Card

## Low-Distortion Oscillator

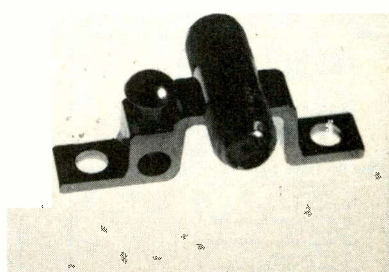
Circle No. 143 on Reader Inquiry Card

The new *Krohn-Hite* Model 4200A is a sine wave oscillator that can deliver a stated ½ watt of power output at less than 0.1% distortion over most of its 10Hz to 10 MHz operatig range. Its frequency response is reportedly flat within 0.025dB over most of this range. Maximum output voltage is 10V RMS open circuit, controllable in 10dB steps by a pushbutton attenuator and a separate vernier. Long term frequency stability is better than 0.02%. A fixed 1 volt output is available for synchronizing or as an auxiliary output. The price is $550.

## Grounding Block

Circle No. 144 on Reader Inquiry Card

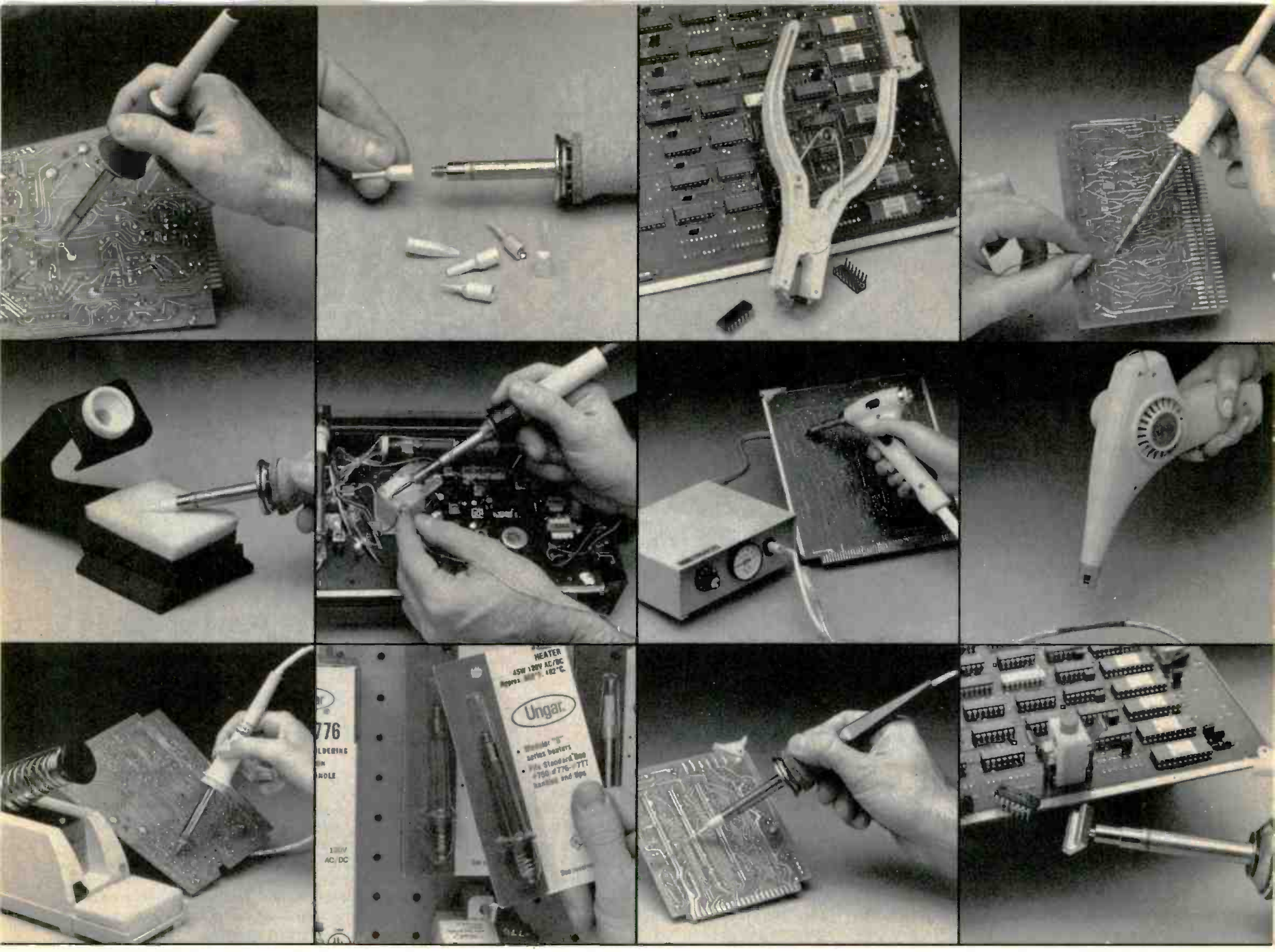
*AVA Electronics,* manufacturer of cable assemblies, RF coaxial adaptors and connectors for the CATV, MATV and CB markets, announces a new Grounding Block designated No. GB 570 A. The GB 570 A is said to be the most economical of static grounding blocks for CATV and MATV usage. It is simple to install and has female "F" connectors built in to each end of the barrel. The grounding block is die-cast zinc, nickel plated, for weather resistance.



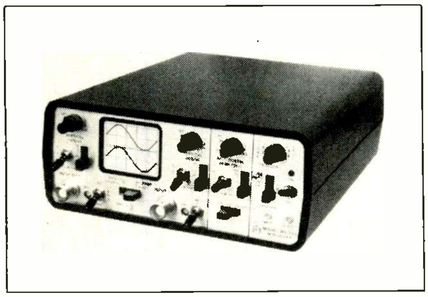
## Dual Trace Miniscope

Circle No. 145 on Reader Inquiry Card

*Non-Linear Systems* has recently introduced its Model MS-230 30MHz, battery operated, Dual Trace Miniscope. Package size is 2.9 inches high by 6.4


HEATER
Ungar

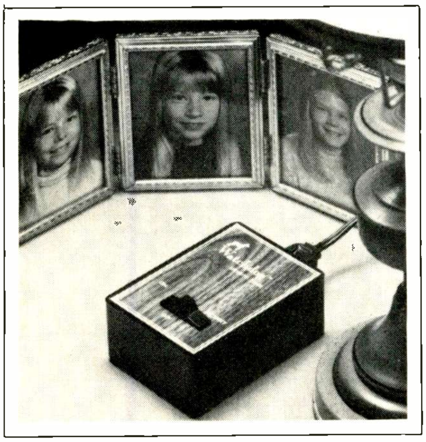
is stated to be 3.5 lb, including batteries. The MS-230 features alternate, chopped and separate sweep modes. Internal and external trigger modes are included. There are 12 vertical gain settings for each channel's range from 0.01 to 50 volts per division. Timebase settings number 21 from 0.05msec to 0.2 seconds per division. Verniers are provided for timebase and vertical amplifier adjustment. The MS-230 Miniscope includes a horizontal input channel and an internal calibrator. The graticule consists of .25 inch divisions arranged 5 across and 4 high. The MS-230 comes complete with input cables and a battery charger permitting battery or line operation. Accessories include a 10:1, 10 megohm probe and a leather carrying case with shoulder strap and belt loop. The price is $559.



### Security Timer

Circle No. 146 on Reader Inquiry Card

A new security timer from *A. M. Corporation* can turn lamps or radios on and off automatically at random intervals of 3 to 25 minutes, to give the impression of continuous activity inside a home or business. There is no predictable off/on pattern as with some security timers. The price is $19.95.



### Shutter Multi-Test

Circle No. 147 on Reader Inquiry Card

*National Camera, Inc.*, has recently introduced a shutter speed test instrument which simultaneously displays five digital readouts of information on focal-plane shutters. It shows leading and trailing contain times, and exposure at the lead edge, center and trail edge of the aperture. While it was designed for testing focal plane shutters, it also tests leaf-type shutters and flash synchronization. The Multi-Test includes a special light source and a 35mm format adapter containing three photo transistors which measure light at different points of the aperture.

## ACOUSTIC WAVES

*continued from page 25*

commercial communications and radar systems. The time has come for large-scale uses of the SAW filters in consumer electronics, particularly in television receivers.

Use of the SAW filter in a TV IF section can eliminate all or most of the conventional IF tuned circuits. The SAW filter has good transient response, good stability and high massreproducibility. The future will see a further refinement of the device and an extension of its uses in many different circuits found in television receivers and other consumer products. **ET/D**

## DATA CONVERTERS

*continued from page 28*

pulse received.

6. When $E_A$ is zero, the comparator output drops LOW, turning off the counter. The binary output of the counter at this instant represents the average value of $E_{in}$ during $t1 - t_0$.

The conversion time for fullscale signals is theoretically the same as for the ramp type ADC, namely $2^n$ clock pulses. But the typical dual slope circuit is limited to slower clock speeds by the time constant (R1C1) of the integrator.

None of the ADC circuits presented thus far is sensitive to errors in clock frequency. If the short term stability (i.e. over one conversion cycle) is good, then the count will accurately reflect the analog input value. **ET/D**

## SUMMER CES

*continued from page 20*

the future."

Highlights of this system are 2,048 upper and lower case characters, 16 colors, sound output and a digital to analog converter for voice and music generation, plus the software library of entertainment, education, and personal finance.

However, also included are two 8-inch floppy (storage) discs which allows the C8P to store pertinent information for use as a home controller "on-line." Through an AC interface the computer system can inject control signals on the AC power lines of a home which control remote switches for appliance and heat control. Also, when interfaced with a wireless home security system, such as smoke detectors, door contact switches, auto burglar alarms, etc., the computer can dial police or fire department numbers and *speak* to them to report an incident. **ET/D**

## PULSES

*continued from page 32*

TV IF strip. . . so you may as well get used to dealing with the interconnection problem. As a matter of fact, if you examine the wiring on some high frequency digital computer printed circuit boards, you will notice that the width of the signal path pattern is much wider than the signal current requires. If you look at the underside of the board, you will see a ground plane directly under the signal path pattern. This forms a sort of coaxial transmission line, with the PC board itself the insulation. . . and the signal paths are all terminated at *both* ends in their characteristic impedance in order to prevent reflections and consequent pulse distortions. **ET/D**

## DIGITAL IV

*continued from page 36*

4. Clock the FF by pressing S6 slowly several times.
5. Did anything change on L3/L4? It shouldn't.
6. Set J HIGH and K LOW
7. Clock the FF by pressing S6 slowly several times
8. Note that Q went HIGH on the first negative-going transition (releast of S6), but nothing else happened on subsequent clock pulses.
9. Set S1 — S4 HIGH
10. Set FF (S3 LOW momentarily). Q should be HIGH (L3 on) and not-Q LOW (L4 off).
11. Set K LOW
12. Clock the FF by pressing S6 slowly several times.
13. Set K HIGH and J LOW.
14. Clock the FF by pressing S6 slowly several times.
15. Note Q/not-Q (L3/L4) changes, and compare with step 8. Note the differences. **ET/D**

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**RATES:** 45 cents per word (minimum charge, $15). Bold face words or words in all capital letters charged at 60 cents per word. Boxed or display ads charged at $55 per column inch (one inch minimum). For ads using blind box number, add $5 to total cost of ad. Send ad copy with payment to Dawn Anderson, ELECTRONIC TECHNICIAN/DEALER, 1 East First Street, Duluth, MN 55802.

**BOX NUMBER REPLIES:** Mail box number replies to: ELECTRONIC TECHNICIAN/DEALER, Classified Ad Department, One East First Street, Duluth, MN 55802. Please include box number in address.

## FOR SALE

**REPLACEMENT COLOR YOKES-DEALERS ONLY.** Zenith 95-2501-2532-2638-2667-S89633 etc. $19.95. Magnavox 361380-1 $21.95 etc. Sylvania, G.E. etc. $17.95 to $22.95. Request for price list on your letterhead. David Sims Enterprises, Inc., 665 Jerricho Turnpike, Huntington Station, N.Y. 11746. 516-549-3925 TF

B & K 415 Sweep & Marker Generator, mint condition $395.00 or best offer. J & M TV, 8033 Norwalk Blvd. Whittier CA 90606. 213-695-4237.

Obsolete hard-to-get tubes and vibrators, reasonable. Send your needs—Morris Radio & Television, Danbury, CT 06810. TF

**TV TECHNICIAN AND DEALERS, "INCREASE YOUR INCOME THOUSANDS OF DOLLARS YEARLY,"** "Rent-Lease-Sell TV's with a guaranteed system," Send stamp or call (1-805) 937-4905 for free details, basic plan $15.00, deluxe version $25.00, master plan $40.00...Perry's Rental System, Box 1407, Santa Maria, CA 93456. TF

Picture Tube Rebuilding Equipment with or without TV Service Department. Produce 48 Quality Tubes per week. Sell to Distributors, TV Shops and Retail. Everything you need for a Profitable Business. Very Reasonable. Write R. Nass, 23 Terry Lane, Pomona, NJ 08240.

**TUBES**—Receiving, Industrial and Semiconductors, factory boxed. Free price list. Low, low prices. **TRANSLETERONIC INC.** 1365-39th Street, Brooklyn, N.Y. 11218E 800-221-5802, 212-633-2800. 4/79

**VIDEO MOVIES** G/PG/R/X: Beta or Vhs, bought, sold, rented. Blank tapes, Video recorders, supplies: Cat $1.00, refundable. Astro Electronics, 160 Woodbridge Ave., Highland Park, NJ 08904. 11/79

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We buy and sell NEW AND USED CRT rebuilding machinery. COMPLETE TRAINING. Buy with CONFIDENCE from the ORIGINAL MFGR. For complete details, send name, address and zip code to:

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EG. 1-9/ 10-24—SG613-8.50/7.30-SID 30-15 2.60/2.30, -2SC867A 5.10/4.90-2SC1114 5.50/4.80-2SC1358 6.50/5.70, -2SC1124 1.50/1.30-2SC634A 0.45/0.41. Contact us for complete list of Japanese semiconductors and pricing information. Bescor, 547 S. Broadway, Hickville, NY 11801 (516) 822-3988

**TECH BENCH** kit or plans. Designed for the TV/Radio Tech. Test instrument shelf on two power columns with 10 fused outlets. Bench has four fused outlets with C-MOS grounding, four large tool drawers and neon bench lighting. E-Z build construction. Plans and kit information $1.98 plus 50¢ handling. Technical Workshop, Box 368, Placentia, CA 92670. 8/79

LINEAR AMPLIFIER, 2-30 MHz, 100 or 200 watt solid state. 300 MHz COUNTER. Modulation BOOSTER. Omnidirectional BASE ANTENNA. Plans $3.00 each. $10.00/all. Catalog of others. **Panaxis** Box 130-ET8 Paradise, CA 95969

Save Hundreds; American Made (AGC Optional) quality Head-Ends, V/V, U/V Converters, Camera Modulators. Factory prices. Send $5.00 (or letterhead). Box 809, Boynton Beach, Fla. 33435.

**BUILD FLYBACK AND TRANSFORMER TESTER FOR UNDER $5.00. SEND TWO DOLLARS FOR PLANS TO: ROSS ELECTRONICS, 6206 N. FRANCISCO, CHICAGO, IL 60659.**

# send a message...
# ...write here.

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1. Number of insertions: (circle) 1 2 3 6 12
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ELECTRONIC BARGAINS, CLOSEOUTS, SURPLUS! Parts, equipment, stereo, industrial, educational. Amazing values! Fascinating items unavailable in stores or catalogs anywhere. Unusual FREE catalog. ETCO-013, box 762, Plattsburgh, NY 12901. TF

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Full line GTE Sylvania receiving tubes at 70% discount full warranty replacement. Electrolytics axial type 100mfd-450v 99¢, 80-450v 88¢, 200mfd-200v 88¢, 40-450v 69¢, 2200mfd-50v 99¢, 47-150v 35¢, 470mfd-75v RCA #134179, 59¢. Redcoat Electronics 66-15 Thornton Pl., Forest Hills, NY 11374.

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SONY-PANASONIC-RCA-ZENITH-EXACT REPLACEMENT PARTS-LARGE INVENTORIES-SEND PART OR MODEL NUMBERS-WILL UPS OR COD-GREEN TELE RADIO DISTRIBUTORS, 172 SUNRISE HIGHWAY, ROCKVILLE CENTRE, N.Y. 11570. TF

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**Automobile radio and tape replacement parts:** Delco, Chrysler, Philco-Ford, Motorola, Panasonic and many others. Large inventory. **Laran Electronics Inc.** 3768 Boston Road, Bronx, NY 10469 (212) 881-9600 out of New York state (800) 223-8314. TF

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**COLOR PICTURE TUBE REBUILDING EQUIPMENT. SEMIAUTOMATIC ELECTRONICALLY CONTROLLED PROCESS. COMPLETE TRAINING.** Call or write Atoll Television, 6425 W. Irving Park, Chicago, IL 60634. Phone 312-545-6667. 8/79

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**For Sale:** All new picture tube Rebuilding Equipment. First class professional Grade. 2 ovens, Litton sealing machine, etc. $5800 or offer. Call or write: T&C Services, Inc., 37 W. Quincy, Westmont, IL. 60559. 312-963-4020. 12/79

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**MATV-CATV INSTALLERS** Get lowest prices on antenna accessories, fastest service from **ANTSCO CORPORATION.** Call collect, ask for catalog & prices. All orders shipped same day. Sierra Madre, CA. 91024. 213-355-2510. 1/80

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TV AND RADIO TUBES 36¢ EA!! Send for free color parts catalog. Your order free if not shipped in 24 hours. Cornell Electronics 4215-17 University San Diego California 92105 TF

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For Sale: Heath Schlumberger SG57A TV Post Marker/Sweep Generator, like new $150.00, Also approx. 300 vintage Sams Photo Fact folders $50.00. J. Criley, 633 Herman Rd. Butler, PA 16001.

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Sams' Photofact's some early, some late. Over 200 in all. Send for list of folder numbers. Will sell all for $200.00 plus freight or $2.00 each. Ray's TV, 4841 East View Drive, New Orleans, LA 70126.

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SATELLITE TELEVISION-MOVIES, SPORTS, ETC. BUILD OR BUY YOUR OWN EARTH STATION. Send $3.00 for information Satellite Television, Box 140, Oxford, NY 13830.

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**Video Tape**—4 hr. VHS $15.99, 2 hr. Sony $12.25, 3 hr. Sony $16.95, Video Recorders, cameras. Entertainment Electronics, 8-B Centre Ave., East Rockaway, NY 11518. 516-887-2550. 9/79

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AM RADIO reception systems for interiors of buildings, ships, tunnels, etc. Receiver connection not required. Catalog A, Extronix, Inc. 64 Gough Ave., Ivyland, PA. 18974. 12/79

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One used Lakeside picture tube rebuilding machine, complete. Good condition. Many extra supplies. Send for list and details. Phillips, Box 652, Whitmore Lake, Michigan 48189.

## HELP WANTED

TUNER TECH NEEDED. MUST BE TOP NOTCH AND CAPABLE OF MANAGEMENT. Call TOLL FREE 1-800-433-7124 (In Texas call 1-800-772-7411) BETWEEN 5 and 6 PM Central Time. 8/79

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ELECTRONICS/AVIONICS EMPLOYMENT OPPORTUNITIES. Report on jobs now open. Details FREE. Aviation Employment Information Service, Box 240Y, Northport, New York 11768. 8/79

## WANTED

**MANUFACTURERS:** New Electronic distributor needs tube transistor, antenna and other lines. ELECTRONIC MERCHANDISE WANTED. Elect. Dept. P. O. Box 4013, Delaware City, DE 19706.

---

**TUNER SERVICE** serving over 300 dealers in the Chicago area wants additional lines. Write or call: Economy Tuner Service. 4901 N. Elston, Chicago, IL 60630. Phone 312-282-3939.

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**WANTED:** Vertical rotary burner type necking and sealing machine for picture tubes. R.E.W. Electronics, Rt. 2 Barrington, N.H. 03825. 603-742-0717. 10/79

---

**WANTED** 18VDBP22 picture tubes 1 to 1000. New/Reblt. Advance Schools, Inc., 5900 Northwest Hwy., Chicago IL 60631.

## BUSINESS OPPORTUNITIES

T.V. Sales service 28 years in same location. Carry in service Zenith-Sale service dealer. Choice location on US #1 South Broward-North Dade County Line. $12,500.00.All fixture parts ect. equipment. Paul's TV Sales Service, 222 N. Federal Hwy, Hallandale, FL 33009. 8/79

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**MECHANICALLY INCLINED INDIVIDUALS:** Assemble electronic devices in your home. Investment, knowledge, or experience not necessary. Get started in spare time. Above average profits. $300-$600/wk. possible. Sales handled by others. Write for free details. Electronic Development Lab, Drawer 1560B, Pinellas Park, FL 33656.

---

TV Sales and service. Oldest established TV business in town. Authorized Zenith and RCA dealer. 40 Miles west of Chicago. Grossed $131,000 last year. Asking $20,000. Write 710 South Northwest Highway, Barrington, Illinois, 60010. 312-381-7444.

---

TV sales and services. Must sell. Well equipped and stocked, reasonable rent. Est. over 15 years. $15,000.00. Walk out. 212-768-0767. Brooklyn NY.

---

Business Opportunity. TV sales and service business doing $50,000/yr, Zenith and RCA sales and warranty. Everything goes, owner retiring from 15 years service. No. California Mountain community of 5000 at 2400 ft. elevation. Only shop within 35 miles. Write to "Dick"; P. O. Box 816; Hayfork, CA 96041. 9/79

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BROADCAST STATION. Start your own, any type! Unique Cable FM station operation-investments/experience unnecessary! Receive free tapes, records. Get your FCC license! Much more. Free details. "Broadcasting:", Box 130 ET8, Paradise, CA 95969

# AD INDEX



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# ET/D TEKFAX

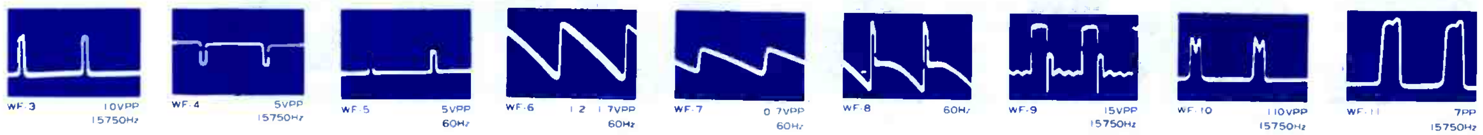
COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS



# 1802

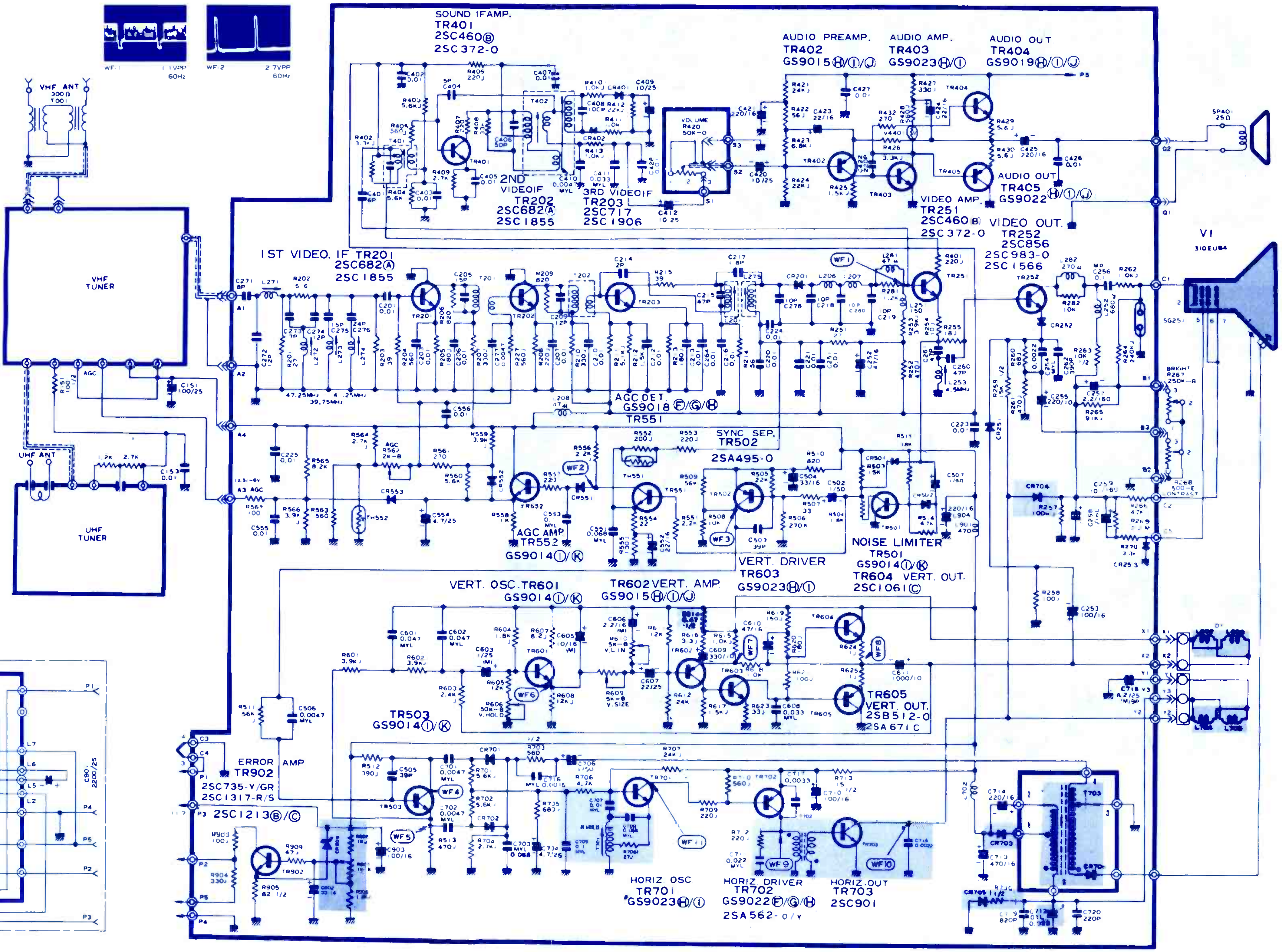
**WARDS**
B&W Model GEN
11208A

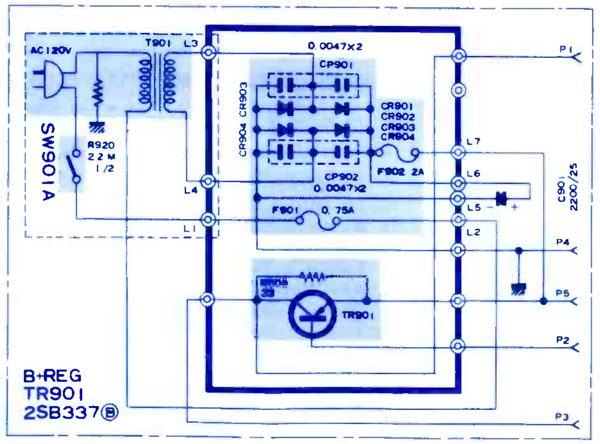
**AUGUST • 1979**




NOTES:

1. Resistors are shown in ohms. K = 1,000, M = 1,000,000
2. Capacitors are shown in $\mu F$ otherwise noted: P = $\mu\mu$
3. All resistors are ± 5 % tolerance Unless Otherwise Indicated.
4. All waveforms measured with strong signal Input. Contrast set to give normal picture.
5. Voltage reading taken with "VTVM" from point indicated to chassis ground. line voltage 120V
6. Voltage reading may vary ± 20 %




PRODUCT SAFETY COMPONENTS

THE DESIGN OF THIS RECEIVER CONTAINS MANY CIRCUITS AND COMPONENTS INCLUDED SPECIFICALLY FOR SAFETY PURPOSES. FOR CONTINUED PROTECTION NO CHANGES SHOULD BE MADE TO THE ORIGINAL DESIGN AND COMPONENTS SHOWN IN SHADED AREAS ON THE SCHEMATIC SHOULD BE REPLACED WITH EXACT FACTORY REPLACEMENT PARTS. THE USE OF UNAUTHORIZED SUBSTITUTE PARTS MAY CREATE A SHOCK, FIRE, X-RADIATION OR OTHER HAZARD. SERVICE SHOULD BE PERFORMED BY QUALIFIED PERSONNEL ONLY.

RELIABILITY AND PERFORMANCE

FOR CONTINUED RELIABILITY AND PERFORMANCE, EXACT FACTORY

FOR CONTINUED RELIABILITY AND PERFORMANCE,EXACT FACTORY REPLACEMENTS ARE RECOMMENDED FOR ALL OTHER PARTS REPLACED. IF A SUBSTITUTE MUST BE USED, BE SURE ITS QUALITY AND SPECIFICATIONS ARE IDENTICAL TO THE ORIGINAL PART.

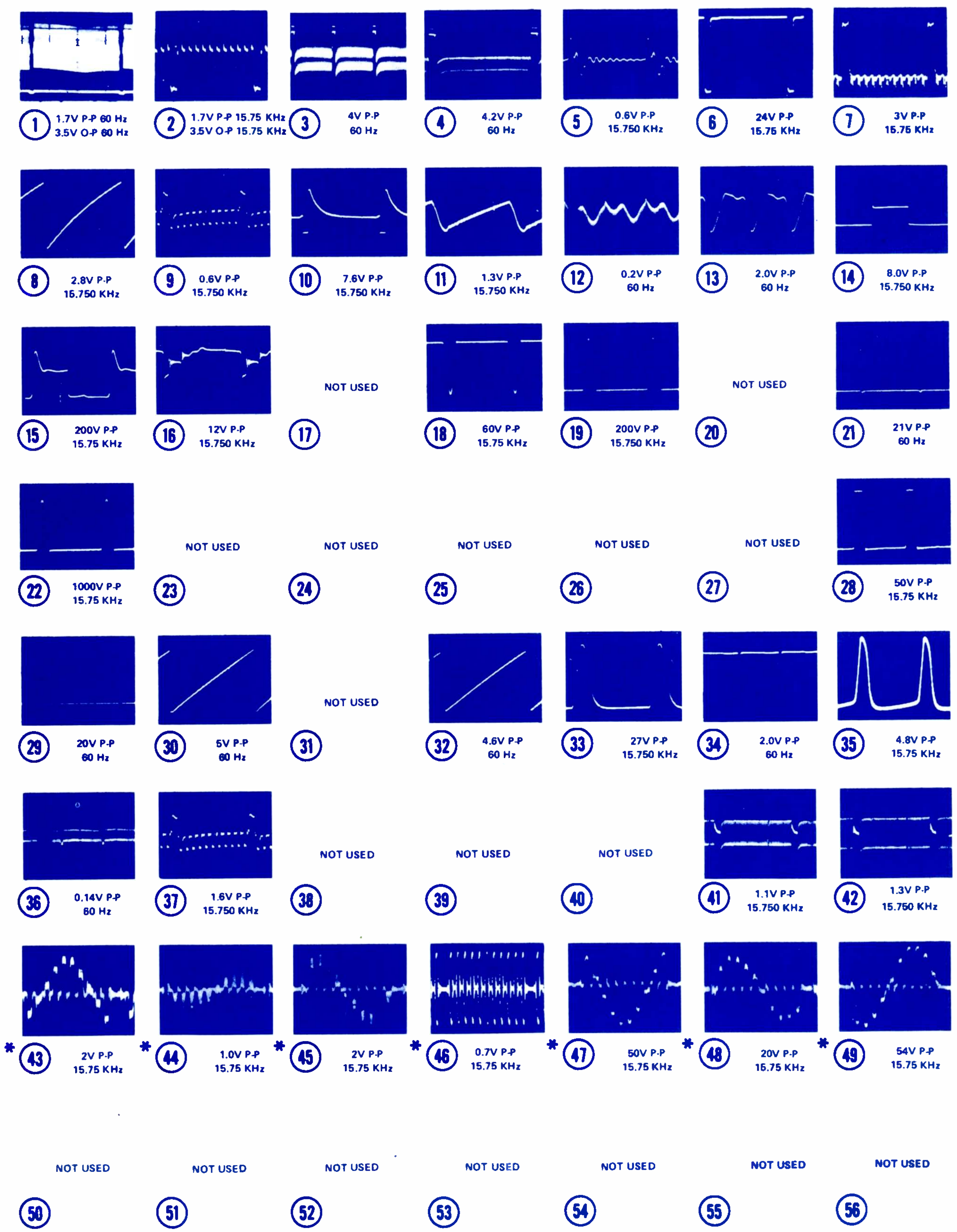
# 1803

## ZENITH Color TV Chassis 19KC52

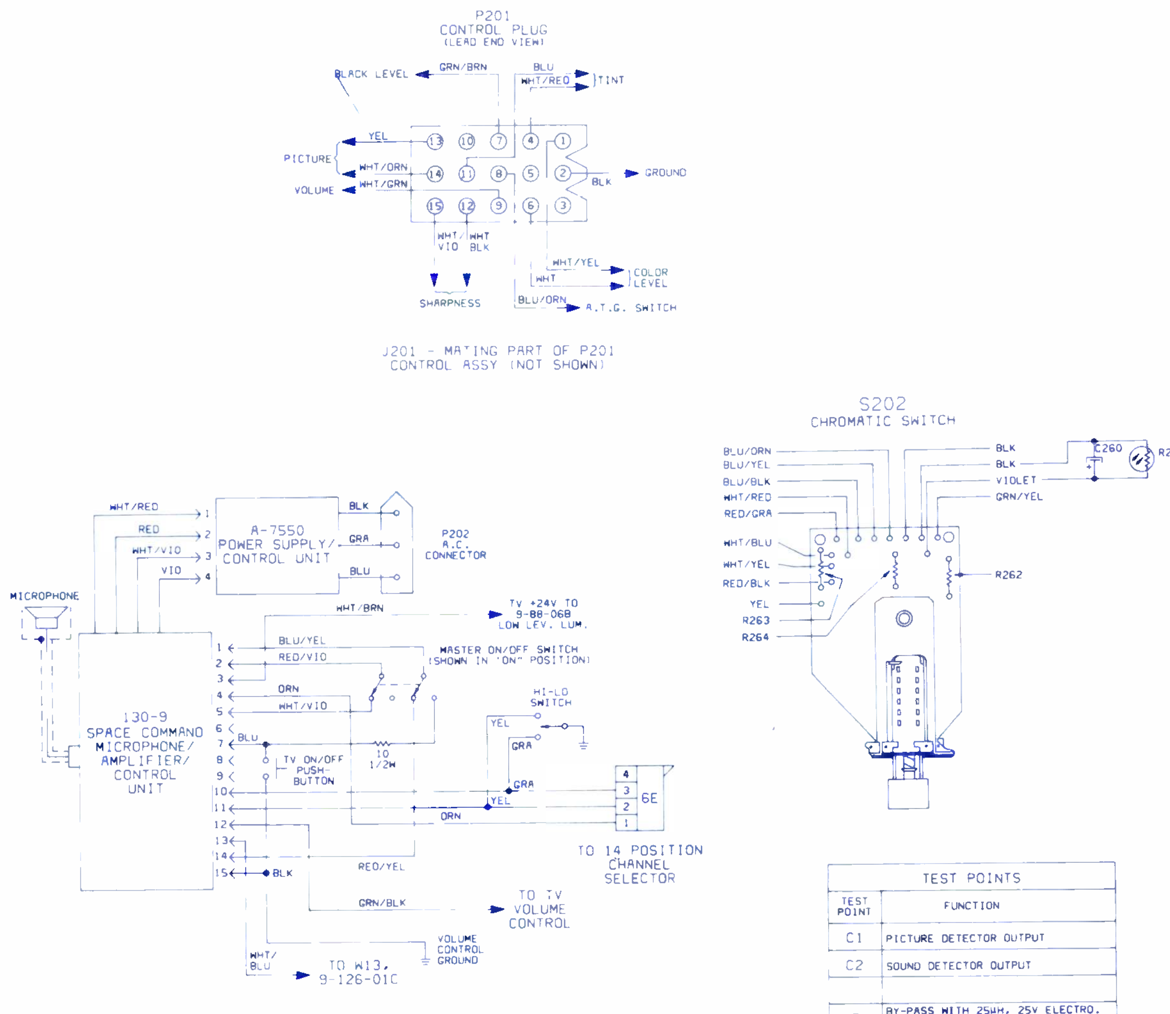
**AUGUST • 1979**

ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS

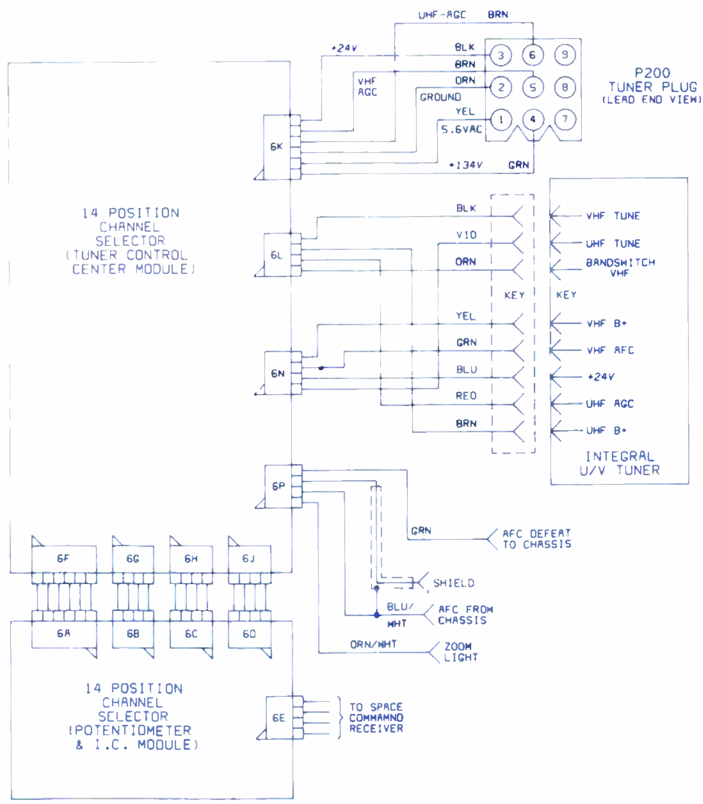



*** FOR WAVEFORMS 43 THROUGH 49, BYPASS TEST POINT "D" WITH 1.0 MF CAPACITOR.**




## TEST POINTS

| TEST POINT | FUNCTION |
|---|---|
| C1 | PICTURE DETECTOR OUTPUT |
| C2 | SOUND DETECTOR OUTPUT |
| D | BY-PASS WITH 25UH, 25V ELECTRO. DURING COLOR ALIGNMENT. |
| E | I.F. A.G.C. |
| H | ZERO BEAT OF HORIZONTAL HOLD |
| J | FOR COLOR ALIGNMENT |
| JJ | FOR COLOR ALIGNMENT |
| N | AUDIO OUTPUT TO SPEAKER |
| Q | A.C.C. VOLTAGE |
| R | RED COLOR AMP. COLLECTOR |
| G | GREEN COLOR AMP. COLLECTOR |
| B | BLUE COLOR AMP. COLLECTOR |
| S | BEAM CURRENT ADJUSTMENT |

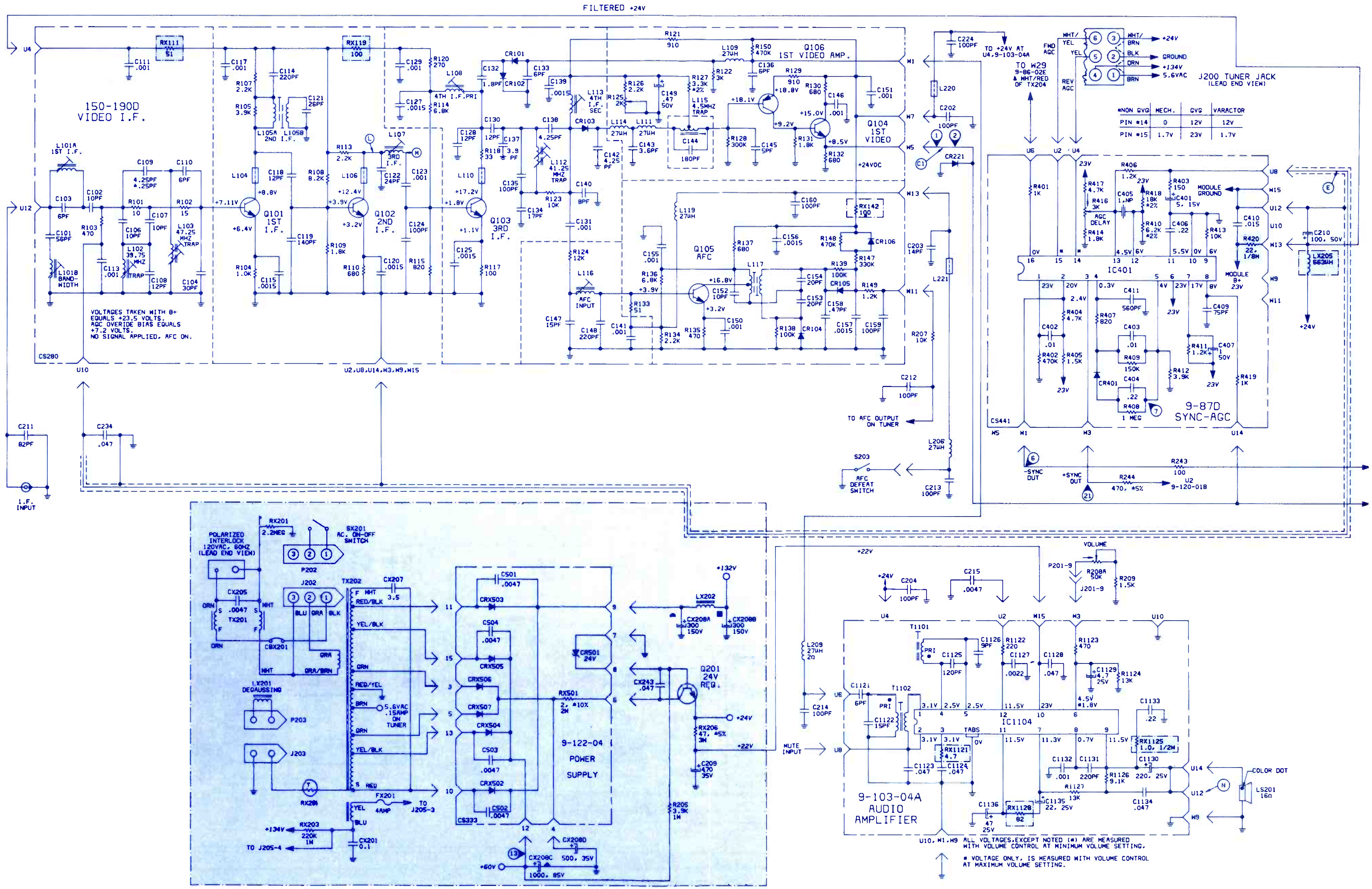



APPLICABLE NOTES: CHASSIS ONLY-

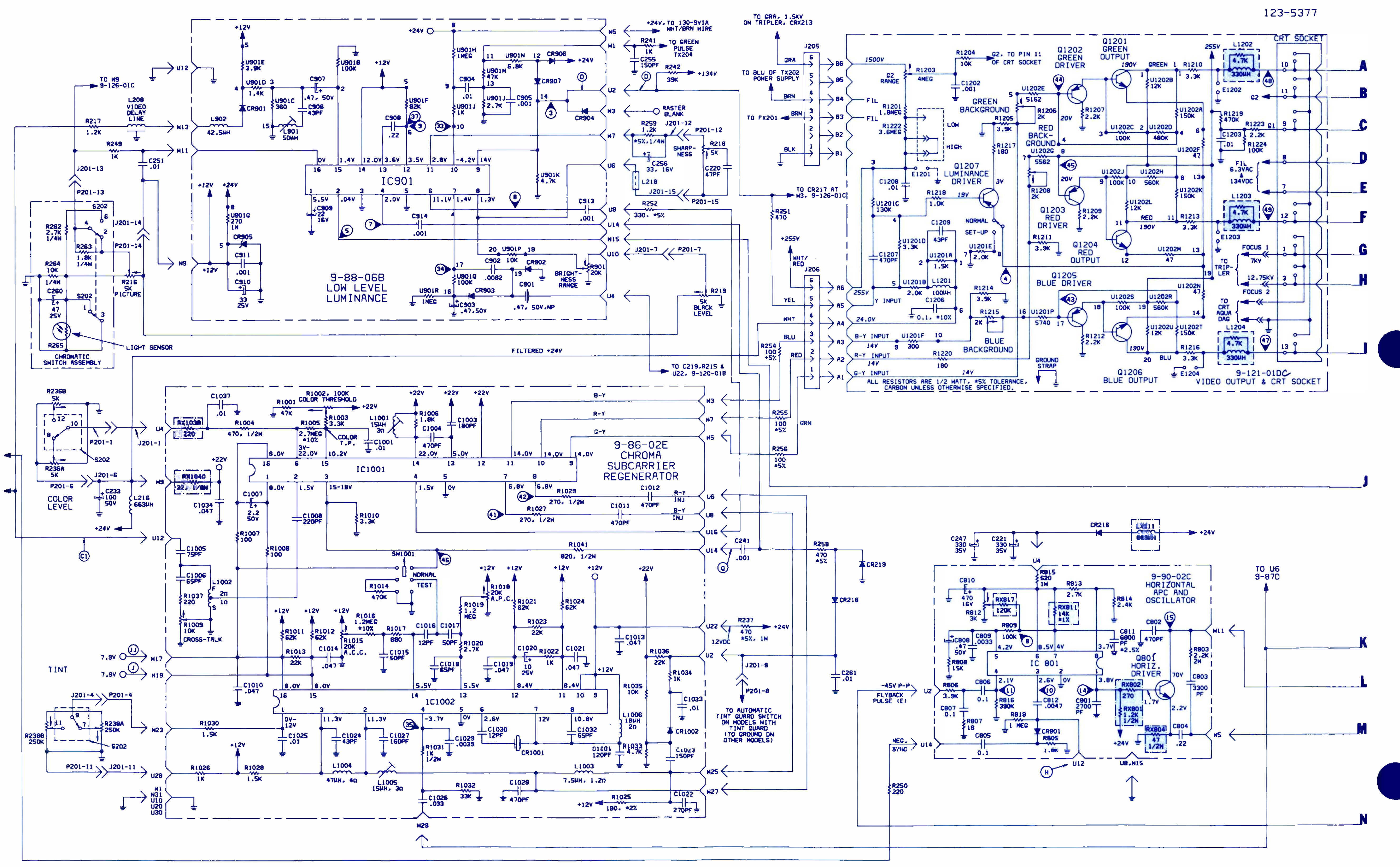
1. TURN POWER OFF BEFORE REPLACING SEMICONDUCTORS.
2. PHOTOGRAPHS TAKEN ON A STANDARD GATED RAINBOW COLOR BAR SIGNAL, THE TINT SETTING ADJUSTED FOR PROPER COLOR. THE WAVE SHAPES AT THE RED, GREEN AND BLUE CATHODES OF THE PICTURE TUBE DEPEND ON THE TINT, COLOR LEVEL, CONTRAST AND PICTURE PEAKING CONTROLS.
3. FOR WAVE FORMS 43 THRU 49, TEST POINT "D" MUST BE BY-PASSED WITH A 0.1 UF CAPACITOR TO GROUND.
4. ALL VOLTAGES MEASURED FROM CHASSIS TO POINTS INDICATED.
5. ALL VOLTAGES ARE DIRECT CURRENT (DC) UNLESS OTHERWISE SPECIFIED.
6. ALL DC VOLTAGES TO BE MEASURED WITH A VACUUM TUBE VOLTMETER HAVING ELEVEN MEGOHM INPUT RESISTANCE.
7. ALL VOLTAGE MEASUREMENTS TO BE MADE WITH NO SIGNAL PRESENT AND NORMAL SETTING OF CONTROLS. CHANNEL SELECTOR SET TO CHANNEL 2 UNLESS OTHERWISE SPECIFIED.
8. RESISTANCE MEASUREMENTS SHOWN WITH COILS DISCONNECTED FROM CIRCUIT.
9. ALL RESISTORS ARE ±10% TOLERANCE, 1/2 WATT, CARBON UNLESS OTHERWISE SPECIFIED.
10. COIL RESISTANCE NOT GIVEN ARE UNDER ONE OHM.
11. ALL CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED. FOR CAPACITOR TOLERANCE, SEE PARTS LIST.
12. CATHODE RAY TUBE 2ND ANODE VOLTAGE TO BE MEASURED WITH ELECTROSTATIC OR 20K OHMS PER VOLT MINIMUM HIGH VOLTAGE METER.
13. ARROWS ON POTENTIOMETER INDICATE CLOCKWISE ROTATION.
14. (A)→ INDICATES ALIGNMENT AND TEST POINT
15. o— INDICATES VOLTAGE SOURCE
16. INDICATES ±20% TOLERANCE MAY BE USED
17. INDICATES WAVE FORM CHECK POINTS (SEE CHART, WAVE FORM MEASURED FROM POINT INDICATED TO CHASSIS GROUND)
18. INDICATES WAVE FORM (SEE CHART), WAVE FORM MEASURED ACROSS POINTS INDICATED (NOT TO CHASSIS GROUND). OSCILLOSCOPE SHOULD NOT BE GROUNDED TO CHASSIS. REVERSING LEADS REVERSES WAVE FORM.

ADDITIONAL INFORMATION NEXT PAGE

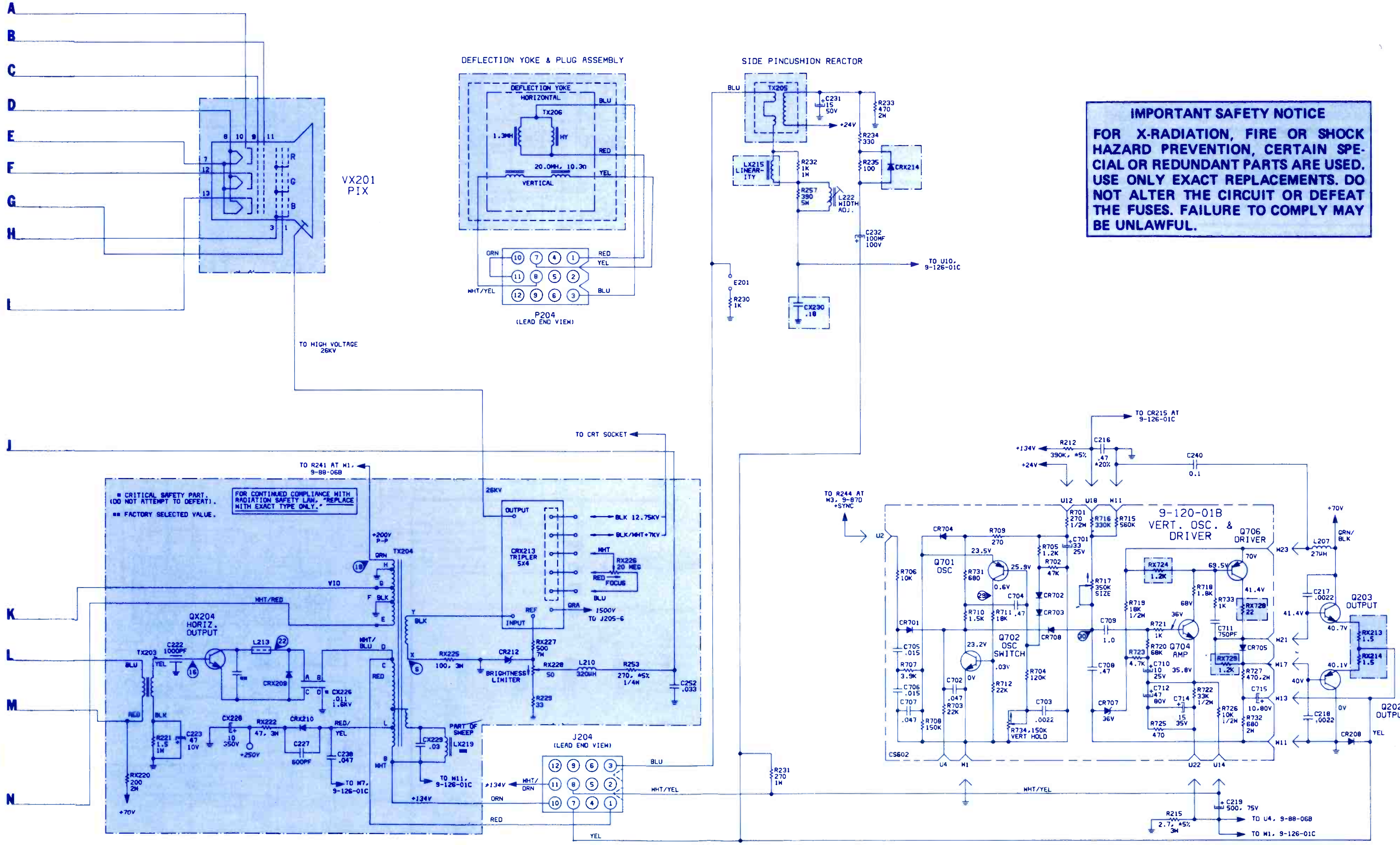
**ZENITH**
Color TV Chassis
19KC52



**ZENITH**
Color TV Chassis
19KC52



**ZENITH**
Color TV Chassis
19KC52




IMPORTANT SAFETY NOTICE

FOR X-RADIATION, FIRE OR SHOCK HAZARD PREVENTION, CERTAIN SPECIAL OR REDUNDANT PARTS ARE USED. USE ONLY EXACT REPLACEMENTS. DO NOT ALTER THE CIRCUIT OR DEFEAT THE FUSES. FAILURE TO COMPLY MAY BE UNLAWFUL.

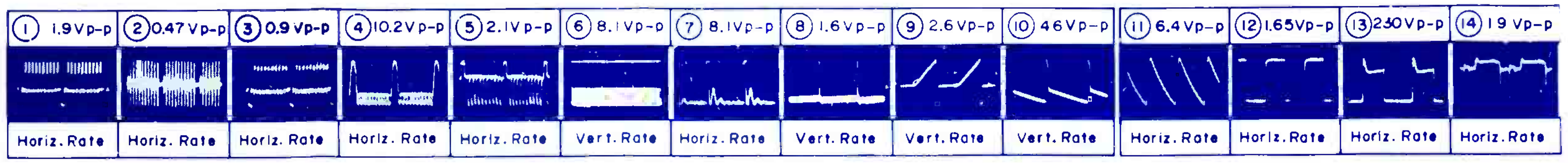
**1804**

**SHARP**
Color TV Model
19C79A

**AUGUST • 1979**

ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS




## SAFETY PRECAUTION:

A. Service personnel should be thoroughly familiar with safety procedures before attempting repairs.

B. ⚠ and shaded components have special characteristics important to safety. For continued protection, replacement parts must be idential to those used in the original circuit.

C. The use of a substitute replacement part which does not have the same safety characteristics as the factory recommended replacement parts shown in this service manual may create shock, fire, x-radiation or other hazards.

D. Before returning the receiver to the customer, to make leakage current measurements:

1. Between all exposed metal parts and any exposed metal parts having a return to chassis, and
2. Between exposed metal parts and earth ground.

(Refer to the IMPORTANT SERVICE NOTES appearing on page 2.)

## SAFETY NOTE:

1. DISCONNECT THE AC PLUG FROM THE AC OUTLET BEFORE REPLACING PARTS.
2. SEMICONDUCTOR HEAT SINKS SHOULD BE REGARDED AS POTENTIAL SHOCK HAZARDS WHEN THE CHASSIS IS OPERATING.
3. THE CHASSIS IN THIS RECEIVER IS HOT. (CONNECTED TO ONE SIDE OF THE AC LINE) USE AN ISOLATION TRANSFORMER BETWEEN THE LINE CORD AND POWER RECEPTACLE, WHEN SERVICING THIS CHASSIS.

**NOTE:**

1. The unit of resistance "ohm" is omitted (K-1000 ohms M-1 Meg ohm).
2. All resistors are 1/4 watt, unless otherwise noted.
3. All capacitors µF, unless otherwise noted P-µµF.

**VOLTAGE MEASUREMENT CONDITIONS:**

1. DC voltages are measured with VTVM placed between points indicated and chassis ground, line voltage set at 120V AC and all controls set for normal picture unless otherwise indicated.
2. Voltage in parenthesis measured with no signal.
3. Voltages without parenthsis measured with 1000µV B & W or Color signal.

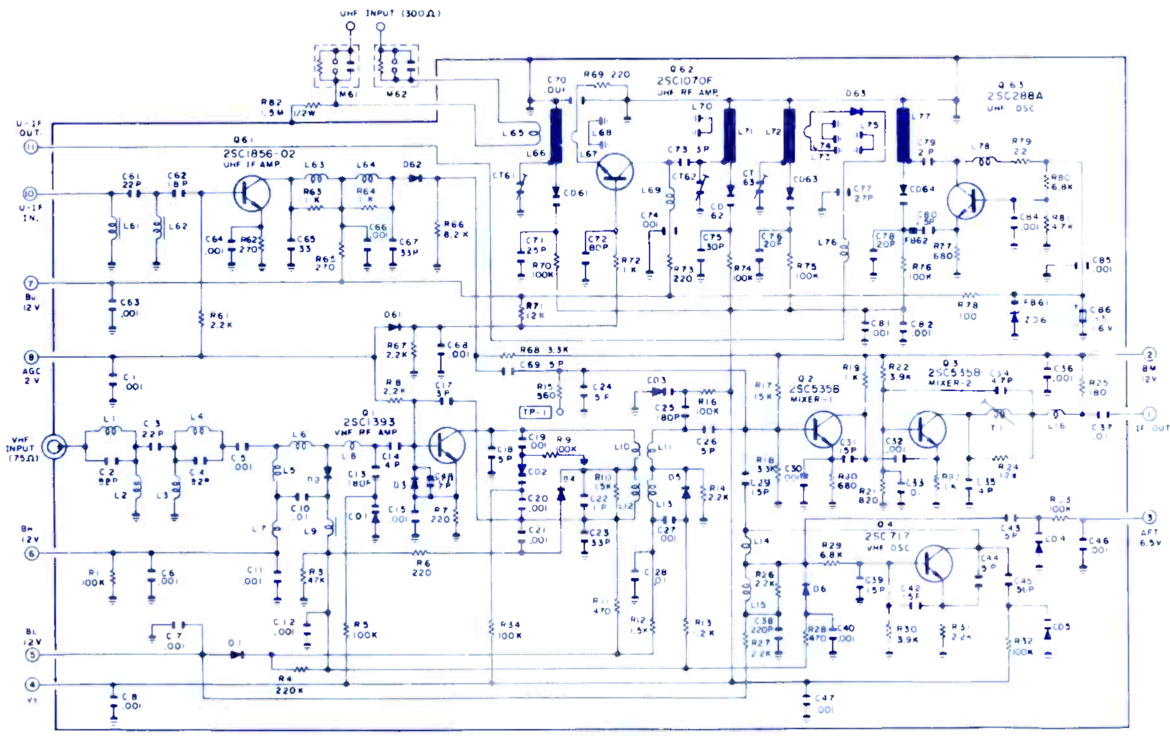
**WAVEFORM MEASUREMENT CONDITIONS:**

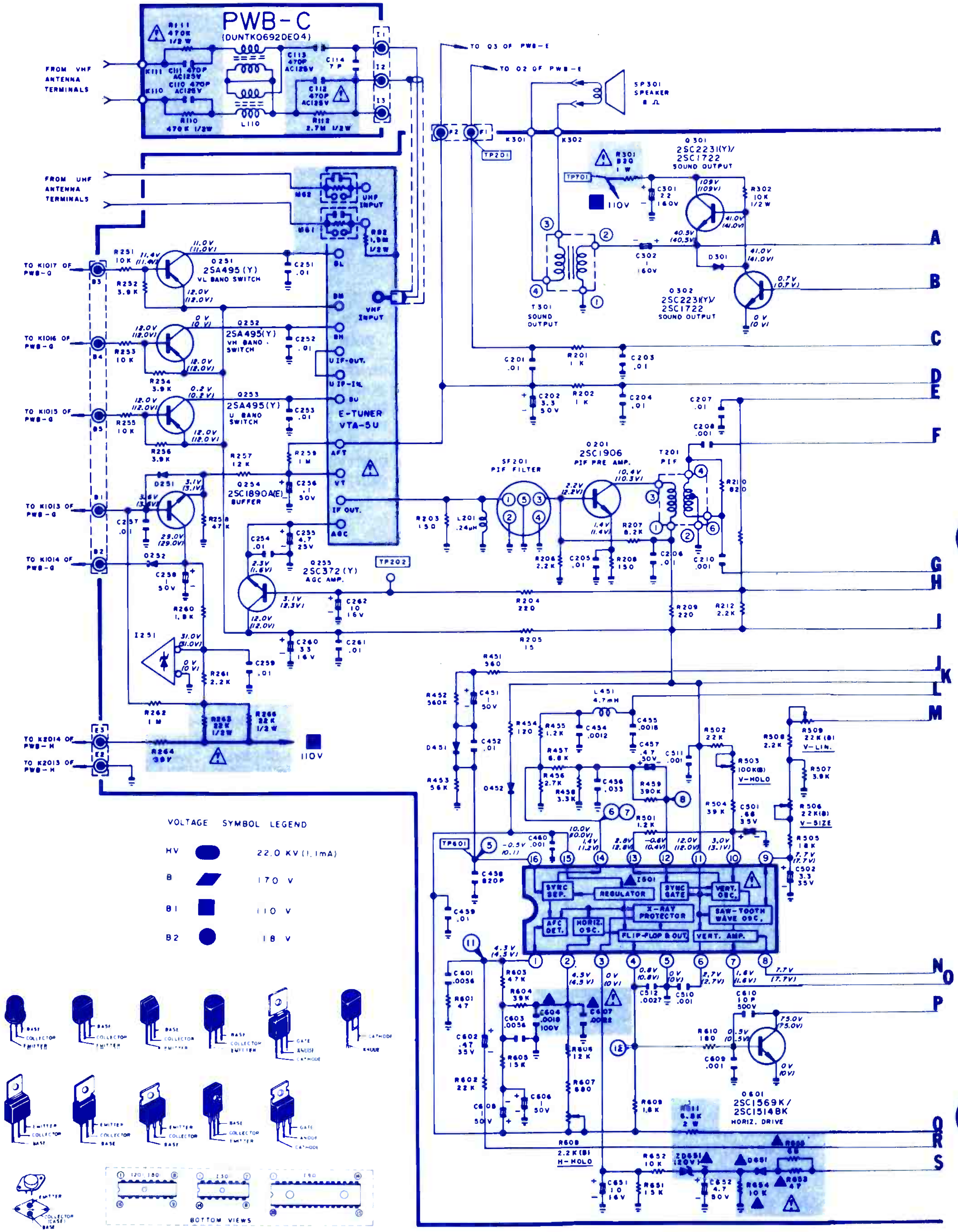
Color bar generator signal of 1.9V peak to peak applied at pin 26 of 1801.

**CIRCUIT PROTECTION**

The entire receiver is protected by a 4.0A (F701) fuse, mounted on PWB-A, that is wired into one side of the AC line input.

TUNER





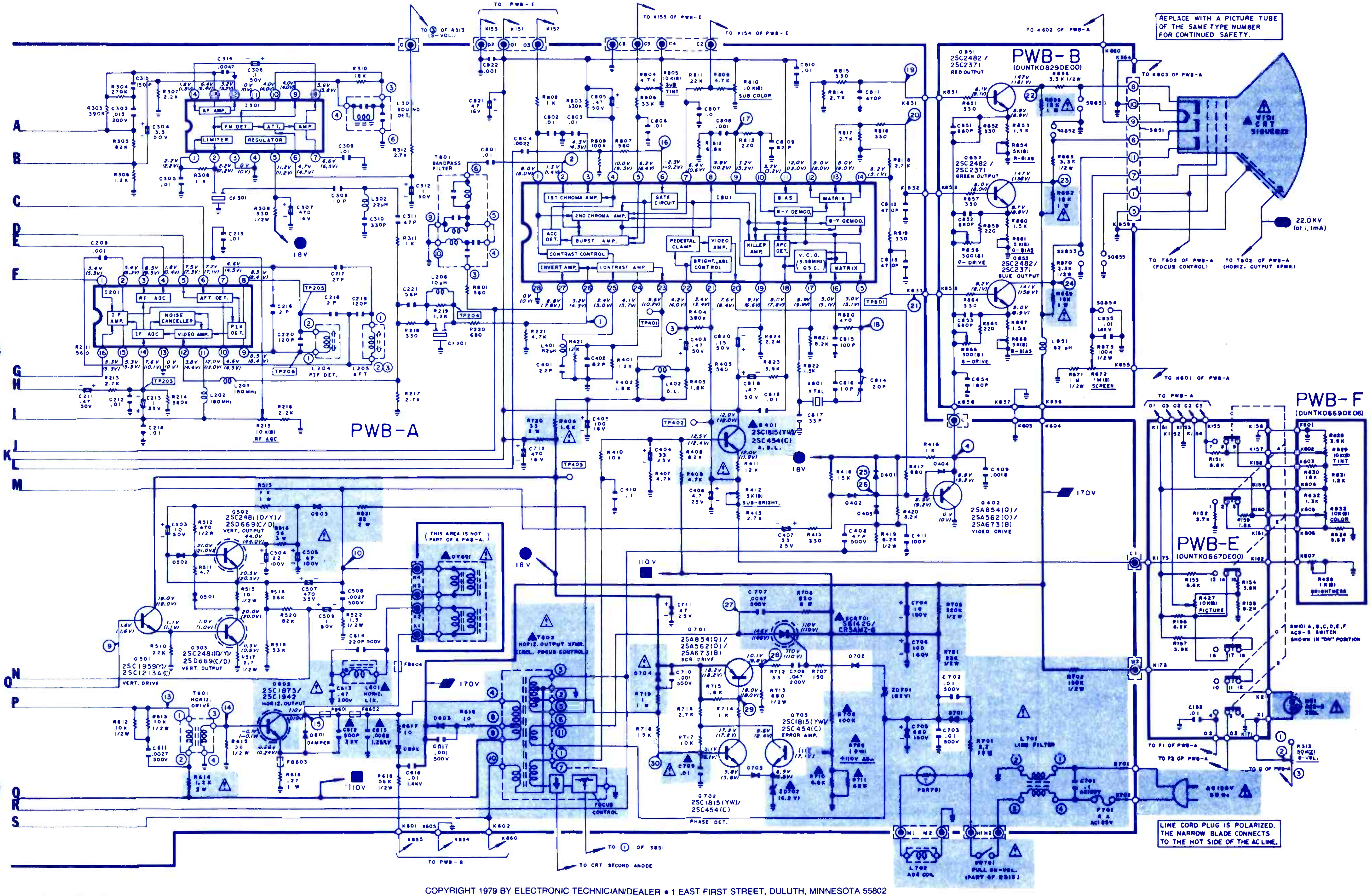

VOLTAGE SYMBOL LEGEND

| | | |
|---|---|---|
| HV | ⬬ | 22.0 KV (1.1mA) |
| B | ▰ | 170 V |
| B1 | ■ | 110 V |
| B2 | ● | 18 V |

BOTTOM VIEWS

**SHARP**
Color TV Model
19C79A


⚠ AND SHADED COMPONENTS: SAFETY RELATED PARTS, ▲MARK: X-RAY RELATED PARTS.



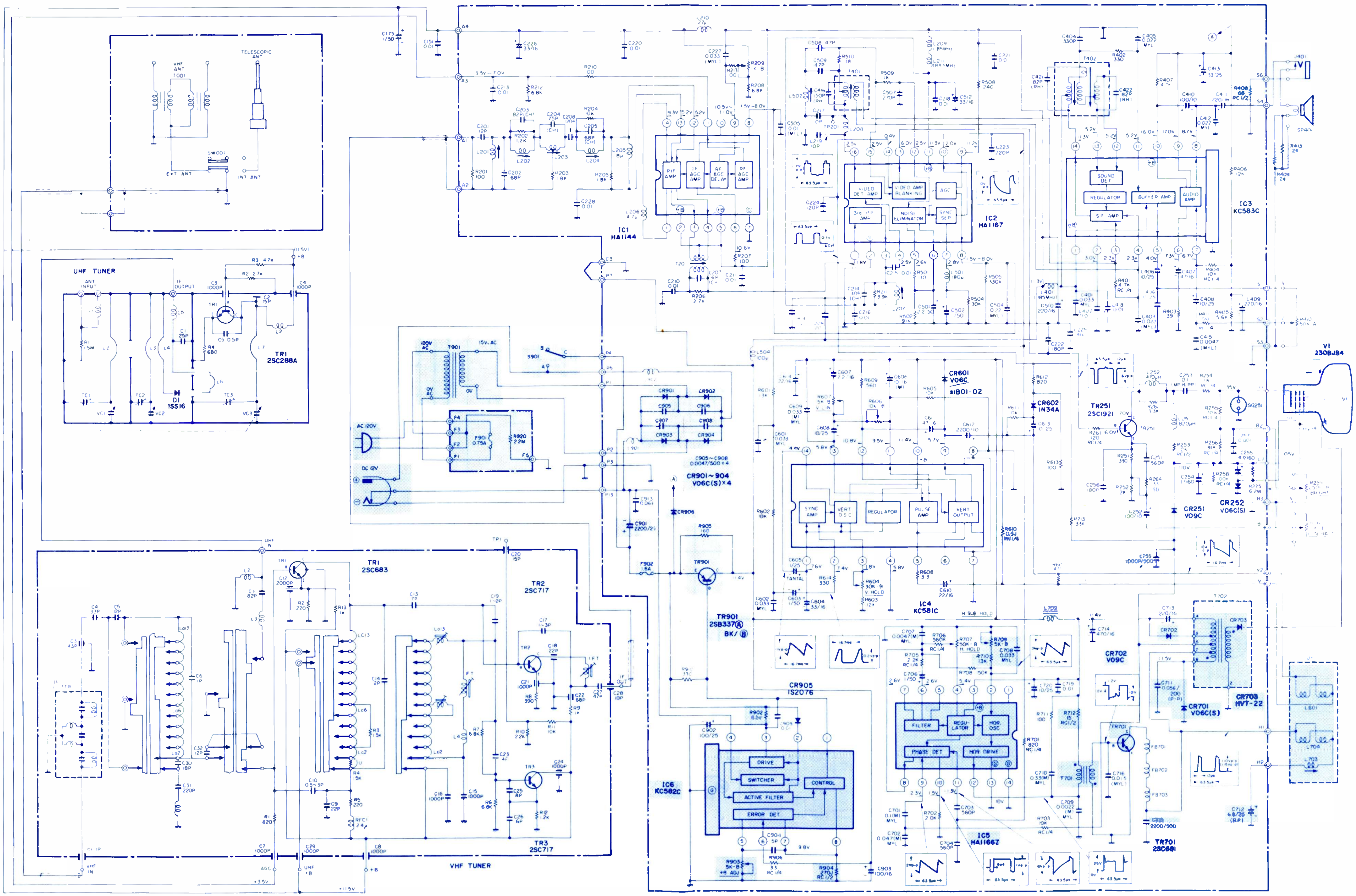
# 1805

**HITACHI**
B&W Chassis SXSL

**AUGUST • 1979**

ET/D TEKFAX
COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS

PRODUCT SAFETY NOTE: Shaded components have special characteristics important to safety. Before replacing any of these components, read carefully, the PRODUCT SAFETY NOTICE of this Service Manual. Don't degrade the safety of the receiver through improper servicing.



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An invaluable Japanese to Japanese substitution guide for approximately 3000 transistors

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- Introduction includes a guide to understanding Japanese transistors
- A 90 page, 8½" by 11" soft cover book

# PARTS PROCUREMENT PROBLEMS

## FUJI-SVEA Has the Largest Inventory of Original Japanese Parts Anywhere

## Seeking Original Japanese Replacement Parts for CB, TV and Stereo Repair Use?

| TYPE | 25-UP | 10-24 | 1-9 |
|---|---|---|---|
| 2SA 473 | .45 | .55 | .60 |
| 2SA 483 | 2.00 | 2.20 | 2.50 |
| 2SA 484 | 1.50 | 1.75 | 1.95 |
| 2SA 485 | 1.40 | 1.60 | 1.80 |
| 2SA 489 | 1.10 | 1.25 | 1.40 |
| 2SA 490 | .70 | .80 | .90 |
| 2SA 493 | .45 | .53 | .59 |
| 2SA 495 | .30 | .35 | .40 |
| 2SA 496 | .50 | .64 | .70 |
| 2SA 497 | 1.00 | 1.20 | 1.30 |
| 2SA 505 | .50 | .64 | .70 |
| 2SA 509 | .30 | .35 | .40 |
| 2SA 525 | .50 | .64 | .70 |
| 2SA 530 | 1.50 | 1.70 | 1.90 |
| 2SA 537A | 1.50 | 1.70 | 1.90 |
| 2SA 539 | .40 | .45 | .50 |
| 2SA 545 | .45 | .53 | .59 |
| 2SA 561 | .30 | .35 | .40 |
| 2SA 562 | .30 | .35 | .40 |
| 2SA 564A | .20 | .27 | .30 |
| 2SA 565 | .70 | .80 | .90 |
| 2SA 566 | 2.50 | 2.70 | 3.00 |
| 2SA 606 | 1.00 | 1.20 | 1.30 |
| 2SA 607 | 1.10 | 1.25 | 1.40 |
| 2SA 624 | .70 | .80 | .90 |
| 2SA 627 | 3.10 | 3.30 | 3.60 |
| 2SA 628 | .30 | .35 | .40 |
| 2SA 634 | .40 | .45 | .50 |
| 2SA 640 | .30 | .35 | .40 |
| 2SA 642 | .30 | .35 | .40 |
| 2SA 643 | .30 | .40 | .45 |
| 2SA 653 | 1.90 | 2.10 | 2.40 |
| 2SA 659 | .35 | .40 | .45 |
| 2SA 661 | .50 | .64 | .70 |
| 2SA 663 | 3.65 | 3.80 | 4.20 |
| 2SA 666 | .35 | .40 | .45 |
| 2SA 671 | .80 | .90 | 1.00 |
| 2SA 672 | .30 | .35 | .40 |
| 2SA 673 | .35 | .40 | .45 |
| 2SA 678 | .35 | .40 | .45 |
| 2SA 679 | 4.20 | 4.40 | 4.90 |
| 2SA 680 | 4.20 | 4.40 | 4.90 |
| 2SA 682 | .80 | .90 | 1.00 |
| 2SA 683 | .30 | .35 | .40 |
| 2SA 684 | .35 | .40 | .45 |
| 2SA 695 | .40 | .53 | .59 |
| 2SA 697 | .40 | .53 | .59 |
| 2SA 699A | .50 | .64 | .70 |
| 2SA 705 | .40 | .53 | .59 |
| 2SA 706 | .85 | 1.00 | 1.10 |
| 2SA 715 | .60 | .70 | .80 |
| 2SA 719 | .30 | .35 | .40 |
| 2SA 720 | .30 | .35 | .40 |
| 2SA 721 | .30 | .35 | .40 |
| 2SA 725 | .30 | .35 | .40 |
| 2SA 726 | .30 | .35 | .40 |
| 2SA 733 | .20 | .27 | .30 |
| 2SA 738 | .40 | .53 | .59 |
| 2SA 740 | 1.50 | 1.70 | 1.90 |
| 2SA 743A | .85 | 1.00 | 1.10 |
| 2SA 744 | 4.20 | 4.40 | 4.90 |
| 2SA 745R | 3.80 | 4.00 | 4.40 |
| 2SA 747 | 4.20 | 4.40 | 4.90 |
| 2SA 748 | .70 | .80 | .90 |
| 2SA 750 | .35 | .40 | .45 |
| 2SA 755 | .80 | .90 | 1.00 |
| 2SA 756 | 2.30 | 2.40 | 2.65 |
| 2SA 758 | 3.40 | 3.55 | 3.90 |
| 2SA 764 | 3.80 | 4.00 | 4.40 |
| 2SA 765 | 3.10 | 3.30 | 3.60 |
| 2SA 774 | .40 | .45 | .50 |
| 2SA 777 | .50 | .64 | .70 |
| 2SA 794A | .60 | .70 | .80 |
| 2SA 798 | .50 | .55 | .60 |
| 2SA 814 | .70 | .80 | .90 |
| 2SA 815 | .60 | .70 | .80 |
| 2SA 816 | .50 | .64 | .70 |
| 2SA 818 | .70 | .80 | .90 |
| 2SA 837R | 2.50 | 2.70 | 2.90 |
| 2SA 839T | 1.30 | 1.45 | 1.60 |
| 2SA 908 | 8.60 | 8.80 | 9.80 |
| 2SA 913 | .70 | .80 | .90 |
| 2SB 22 | .30 | .35 | .40 |
| 2SB 54 | .20 | .27 | .30 |
| 2SB 55 | .40 | .53 | .59 |
| 2SB 75 | .35 | .40 | .45 |
| 2SB 77 | .35 | .40 | .45 |
| 2SB 173 | .30 | .35 | .40 |
| 2SB 175 | .20 | .27 | .30 |
| 2SB 176 | .30 | .35 | .40 |
| 2SB 178 | .35 | .40 | .45 |
| 2SB 186 | .20 | .27 | .30 |
| 2SB 187 | .20 | .27 | .30 |
| 2SB 202 | 1.10 | 1.20 | 1.30 |
| 2SB 220 | .90 | 1.10 | 1.20 |
| 2SB 303 | .30 | .35 | .40 |
| 2SB 324 | .30 | .35 | .40 |
| 2SB 337 | .70 | .80 | .90 |

| TYPE | 25-UP | 10-24 | 1-9 |
|---|---|---|---|
| 2SB 346 | .30 | .35 | .40 |
| 2SB 367 | 1.10 | 1.25 | 1.40 |
| 2SB 368B | 1.80 | 2.00 | 2.25 |
| 2SB 379 | .70 | .80 | .90 |
| 2SB 381 | .30 | .35 | .40 |
| 2SB 400 | .30 | .35 | .40 |
| 2SB 405 | .30 | .35 | .40 |
| 2SB 407 | .80 | .90 | 1.00 |
| 2SB 415 | .30 | .35 | .40 |
| 2SB 434 | .80 | .90 | 1.00 |
| 2SB 435 | .90 | 1.10 | 1.20 |
| 2SB 440 | .40 | .53 | .59 |
| 2SB 449 | 1.30 | 1.45 | 1.60 |
| 2SB 461 | .90 | 1.10 | 1.20 |
| 2SB 463 | .90 | 1.10 | 1.20 |
| 2SB 471 | 1.10 | 1.25 | 1.40 |
| 2SB 472 | 2.10 | 2.50 | 2.80 |
| 2SB 473 | .80 | .90 | 1.00 |
| 2SB 474 | .70 | .80 | .90 |
| 2SB 481 | .90 | 1.10 | 1.20 |
| 2SB 492 | .60 | .70 | .80 |
| 2SB 507 | .80 | .90 | 1.00 |
| 2SB 509 | 1.10 | 1.20 | 1.30 |
| 2SB 511 | .70 | .80 | .90 |
| 2SB 514 | .70 | .80 | .90 |
| 2SB 523 | .70 | .80 | .90 |
| 2SB 526C | .70 | .80 | .90 |
| 2SB 527 | .90 | 1.10 | 1.20 |
| 2SB 528D | .70 | .80 | .90 |
| 2SB 529 | .70 | .80 | .90 |
| 2SB 530 | 3.20 | 3.40 | 3.70 |
| 2SB 531 | 1.80 | 2.00 | 2.25 |
| 2SB 536 | 1.00 | 1.20 | 1.30 |
| 2SB 537 | 1.00 | 1.20 | 1.30 |
| 2SB 539 | 3.20 | 3.40 | 3.70 |
| 2SB 541 | 3.20 | 3.40 | 3.70 |
| 2SB 554 | 5.00 | 6.00 | 6.60 |
| 2SB 556 | 3.20 | 3.40 | 3.70 |
| 2SB 557 | 2.10 | 2.50 | 2.80 |
| 2SB 561B | .35 | .40 | .45 |
| 2SB 564 | .40 | .53 | .59 |
| 2SB 595 | 1.10 | 1.40 | 1.50 |
| 2SB 596 | 1.10 | 1.40 | 1.50 |
| 2SB 600 | 5.00 | 6.00 | 6.60 |
| 2SC 183 | .40 | .53 | .59 |
| 2SC 184 | .40 | .53 | .59 |
| 2SC 281 | .30 | .35 | .40 |
| 2SC 283 | .40 | .53 | .59 |
| 2SC 284 | .80 | .90 | 1.00 |
| 2SC 317 | .40 | .53 | .59 |
| 2SC 352A | 2.00 | 2.20 | 2.50 |
| 2SC 353A | 1.40 | 1.60 | 1.80 |
| 2SC 367 | .60 | .70 | .80 |
| 2SC 369 | .30 | .35 | .40 |
| 2SC 370 | .20 | .27 | .30 |
| 2SC 371 | .30 | .35 | .40 |
| 2SC 372 | .20 | .27 | .30 |
| 2SC 373 | .20 | .27 | .30 |
| 2SC 374 | .30 | .35 | .40 |
| 2SC 375 | .30 | .35 | .40 |
| 2SC 377 | .30 | .35 | .40 |
| 2SC 380 | .20 | .27 | .30 |
| 2SC 381 | .35 | .40 | .45 |
| 2SC 382 | .35 | .40 | .45 |
| 2SC 383 | .35 | .40 | .45 |
| 2SC 387A | .35 | .40 | .45 |
| 2SC 388A | .40 | .53 | .59 |
| 2SC 394 | .20 | .27 | .30 |
| 2SC 403 | .30 | .35 | .40 |
| 2SC 430 | .50 | .64 | .70 |
| 2SC 454 | .30 | .35 | .40 |
| 2SC 458 | .20 | .27 | .30 |
| 2SC 460 | .35 | .40 | .45 |
| 2SC 461 | .35 | .40 | .45 |
| 2SC 478 | .60 | .70 | .80 |
| 2SC 481 | 1.30 | 1.40 | 1.50 |
| 2SC 482 | 1.10 | 1.25 | 1.40 |
| 2SC 484 | 1.30 | 1.40 | 1.50 |
| 2SC 485 | 1.30 | 1.40 | 1.50 |
| 2SC 486 | 1.30 | 1.40 | 1.50 |
| 2SC 493 | 3.00 | 3.20 | 3.40 |
| 2SC 495 | .45 | .55 | .60 |
| 2SC 496 | .45 | .55 | .60 |
| 2SC 497 | 1.10 | 1.25 | 1.40 |
| 2SC 509 | .35 | .40 | .45 |
| 2SC 510 | 1.30 | 1.40 | 1.50 |
| 2SC 515A | .80 | .90 | 1.00 |
| 2SC 517 | 2.50 | 2.70 | 3.00 |
| 2SC 535 | .30 | .35 | .40 |
| 2SC 536 | .30 | .35 | .40 |
| 2SC 537 | .30 | .35 | .40 |
| 2SC 627 | 1.30 | 1.45 | 1.60 |
| 2SC 631 | .35 | .40 | .45 |
| 2SC 632A | .35 | .40 | .45 |
| 2SC 634A | .35 | .40 | .45 |
| 2SC 680 | 1.90 | 2.10 | 2.40 |
| 2SC 681A | 3.00 | 3.25 | 3.50 |
| 2SC 684 | .80 | .90 | 1.00 |

| TYPE | 25-UP | 10-24 | 1-9 |
|---|---|---|---|
| 2SC 693F | .20 | .27 | .30 |
| 2SC 696 | 1.00 | 1.20 | 1.30 |
| 2SC 708 | 1.30 | 1.45 | 1.60 |
| 2SC 710 | .20 | .27 | .30 |
| 2SC 711 | .20 | .27 | .30 |
| 2SC 712 | .20 | .27 | .30 |
| 2SC 715 | .30 | .35 | .40 |
| 2SC 717 | .35 | .40 | .45 |
| 2SC 727 | 1.00 | 1.20 | 1.30 |
| 2SC 730 | 3.00 | 3.20 | 3.40 |
| 2SC 731 | 2.50 | 2.70 | 2.90 |
| 2SC 732 | .20 | .27 | .30 |
| 2SC 733 | .20 | .27 | .30 |
| 2SC 734 | .20 | .27 | .30 |
| 2SC 735 | .20 | .27 | .30 |
| 2SC 738 | .20 | .27 | .30 |
| 2SC 756 | 1.50 | 1.80 | 2.00 |
| 2SC 756A | 1.50 | 1.80 | 2.00 |
| 2SC 763 | .35 | .40 | .45 |
| 2SC 772 | .30 | .35 | .40 |
| 2SC 773 | .35 | .40 | .45 |
| 2SC 774 | 1.00 | 1.20 | 1.30 |
| 2SC 775 | 1.40 | 1.60 | 1.80 |
| 2SC 776 | 2.00 | 2.20 | 2.50 |
| 2SC 777 | 3.00 | 3.25 | 3.50 |
| 2SC 778 | 2.90 | 3.20 | 3.40 |
| 2SC 781 | 1.90 | 2.10 | 2.40 |
| 2SC 783 | 2.10 | 2.50 | 2.80 |
| 2SC 784 | .30 | .35 | .40 |
| 2SC 785 | .35 | .40 | .45 |
| 2SC 789 | .80 | .90 | 1.00 |
| 2SC 790 | .80 | .90 | 1.00 |
| 2SC 793 | 2.00 | 2.20 | 2.50 |
| 2SC 799 | 2.00 | 2.20 | 2.50 |
| 2SC 828 | .20 | .27 | .30 |
| 2SC 829 | .20 | .27 | .30 |
| 2SC 830H | 2.50 | 2.70 | 3.00 |
| 2SC 838 | .35 | .40 | .45 |
| 2SC 839 | .30 | .35 | .40 |
| 2SC 853 | .70 | .80 | .90 |
| 2SC 867 | 3.20 | 3.40 | 3.70 |
| 2SC 867A | 3.20 | 3.40 | 3.70 |
| 2SC 870 | .35 | .40 | .45 |
| 2SC 871 | .35 | .40 | .45 |
| 2SC 895 | 4.20 | 4.40 | 4.90 |
| 2SC 897 | 2.00 | 2.20 | 2.50 |
| 2SC 898 | 2.50 | 2.70 | 3.00 |
| 2SC 900 | .20 | .27 | .30 |
| 2SC 923 | .20 | .27 | .30 |
| 2SC 929 | .20 | .27 | .30 |
| 2SC 930 | .20 | .27 | .30 |
| 2SC 941 | .20 | .27 | .30 |
| 2SC 943 | .35 | .40 | .45 |
| 2SC 945 | .20 | .27 | .30 |
| 2SC 959 | 1.00 | 1.20 | 1.30 |
| 2SC 971 | .70 | .80 | .90 |
| 2SC 982 | .70 | .80 | .90 |
| 2SC 983 | .50 | .64 | .70 |
| 2SC 1000 | .35 | .40 | .45 |
| 2SC 1012 | 1.20 | 1.40 | 1.50 |
| 2SC 1013 | .50 | .64 | .70 |
| 2SC 1014 | .50 | .64 | .70 |
| 2SC 1017 | .80 | .90 | 1.00 |
| 2SC 1018 | .60 | .70 | .80 |
| 2SC 1030 | 1.80 | 2.10 | 2.40 |
| 2SC 1047 | .35 | .40 | .45 |
| 2SC 1051 | 3.40 | 3.55 | 3.90 |
| 2SC 1060 | .70 | .80 | .90 |
| 2SC 1061 | .70 | .80 | .90 |
| 2SC 1076 | 30.00 | 35.00 | 39.00 |
| 2SC 1079 | 3.40 | 3.55 | 3.90 |
| 2SC 1080 | 3.40 | 3.55 | 3.90 |
| 2SC 1096 | .45 | .55 | .60 |
| 2SC 1098 | .50 | .64 | .70 |
| 2SC 1111 | 2.10 | 2.50 | 2.80 |
| 2SC 1114 | 4.20 | 4.40 | 4.90 |
| 2SC 1115 | 2.50 | 2.70 | 3.00 |
| 2SC 1116 | 3.20 | 3.40 | 3.70 |
| 2SC 1116A | 3.40 | 3.55 | 3.90 |
| 2SC 1124 | .80 | .90 | 1.00 |
| 2SC 1127 | .80 | .90 | 1.00 |
| 2SC 1161 | 1.30 | 1.45 | 1.60 |
| 2SC 1162 | .70 | .80 | .90 |
| 2SC 1166 | .20 | .27 | .30 |
| 2SC 1167 | 3.80 | 4.00 | 4.40 |
| 2SC 1170B | 3.80 | 4.00 | 4.40 |
| 2SC 1172B | 3.20 | 3.60 | 3.95 |
| 2SC 1173 | .50 | .55 | .60 |
| 2SC 1175 | .35 | .40 | .45 |
| 2SC 1177 | 11.00 | 12.60 | 14.00 |
| 2SC 1189 | 1.00 | 1.10 | 1.20 |
| 2SC 1209 | .30 | .35 | .40 |
| 2SC 1211D | .30 | .35 | .40 |
| 2SC 1212A | .80 | .90 | 1.00 |
| 2SC 1213 | .30 | .35 | .40 |
| 2SC 1215 | .35 | .40 | .45 |
| 2SC 1222 | .20 | .27 | .30 |
| 2SC 1226 | .50 | .55 | .60 |

| TYPE | 25-UP | 10-24 | 1-9 |
|---|---|---|---|
| 2SC 1226A | .50 | .55 | .60 |
| 2SC 1237 | 1.80 | 2.00 | 2.25 |
| 2SC 1239 | 2.20 | 2.70 | 2.90 |
| 2SC 1279 | .50 | .55 | .60 |
| 2SC 1306 | 1.30 | 1.45 | 1.60 |
| 2SC 1307 | 1.90 | 2.10 | 2.40 |
| 2SC 1310 | .20 | .27 | .30 |
| 2SC 1312 | .20 | .27 | .30 |
| 2SC 1313G | .20 | .27 | .30 |
| 2SC 1316 | 4.20 | 4.40 | 4.90 |
| 2SC 1317 | .20 | .27 | .30 |
| 2SC 1318 | .35 | .40 | .45 |
| 2SC 1325A | 6.50 | 6.90 | 7.60 |
| 2SC 1327 | .20 | .27 | .30 |
| 2SC 1330 | .50 | .55 | .60 |
| 2SC 1335 | .50 | .55 | .60 |
| 2SC 1342 | .45 | .53 | .59 |
| 2SC 1344 | .45 | .53 | .59 |
| 2SC 1358 | 4.20 | 4.40 | 4.90 |
| 2SC 1359 | .30 | .35 | .40 |
| 2SC 1360 | .50 | .55 | .60 |
| 2SC 1362 | .35 | .40 | .45 |
| 2SC 1364 | .35 | .40 | .45 |
| 2SC 1377 | 3.20 | 3.40 | 3.70 |
| 2SC 1383 | .30 | .35 | .40 |
| 2SC 1384 | .35 | .40 | .45 |
| 2SC 1396 | .45 | .53 | .59 |
| 2SC 1398 | .70 | .80 | .90 |
| 2SC 1400 | .35 | .40 | .45 |
| 2SC 1402 | 3.00 | 3.20 | 3.40 |
| 2SC 1403 | 3.20 | 3.40 | 3.70 |
| 2SC 1407 | .50 | .55 | .60 |
| 2SC 1419 | .60 | .70 | .80 |
| 2SC 1444 | 1.60 | 1.80 | 2.00 |
| 2SC 1445 | 2.50 | 2.70 | 2.90 |
| 2SC 1447 | .60 | .70 | .80 |
| 2SC 1448 | .70 | .80 | .90 |
| 2SC 1449 | .60 | .70 | .80 |
| 2SC 1451 | 1.00 | 1.10 | 1.20 |
| 2SC 1454 | 3.20 | 3.40 | 3.70 |
| 2SC 1475 | .80 | .90 | 1.00 |
| 2SC 1478 | .50 | .55 | .60 |
| 2SC 1509 | .50 | .55 | .60 |
| 2SC 1567 | .60 | .70 | .80 |
| 2SC 1567A | .60 | .70 | .80 |
| 2SC 1584 | 6.00 | 6.30 | 7.00 |
| 2SC 1586 | 6.50 | 6.90 | 7.60 |
| 2SC 1624 | .60 | .70 | .80 |
| 2SC 1626 | .60 | .70 | .80 |
| 2SC 1628 | .60 | .70 | .80 |
| 2SC 1647 | .70 | .80 | .90 |
| 2SC 1667 | 3.00 | 3.20 | 3.40 |
| 2SC 1669 | .90 | 1.00 | 1.10 |
| 2SC 1674 | .30 | .35 | .40 |
| 2SC 1675 | .20 | .27 | .30 |
| 2SC 1678 | 1.10 | 1.25 | 1.40 |
| 2SC 1679 | 3.00 | 3.20 | 3.40 |
| 2SC 1681 | .30 | .35 | .40 |
| 2SC 1682 | .30 | .35 | .40 |
| 2SC 1684 | .30 | .35 | .40 |
| 2SC 1687 | .40 | .45 | .50 |
| 2SC 1688 | .35 | .40 | .45 |
| 2SC 1708 | .30 | .35 | .40 |
| 2SC 1728 | .70 | .80 | .90 |
| 2SC 1730 | .45 | .53 | .59 |
| 2SC 1756 | .50 | .55 | .60 |
| 2SC 1760 | .70 | .80 | .90 |
| 2SC 1816 | 1.50 | 1.75 | 1.95 |
| 2SC 1856 | .45 | .53 | .59 |
| 2SC 1885 | .45 | .53 | .59 |
| 2SC 1908 | .30 | .35 | .40 |
| 2SC 1909 | 1.80 | 2.00 | 2.25 |
| 2SC 1945 | 4.50 | 5.00 | 5.60 |
| 2SC 1957 | .60 | .70 | .80 |
| 2SC 1969 | 3.60 | 4.00 | 4.40 |
| 2SC 1973 | .70 | .80 | .90 |
| 2SC 1975 | 1.30 | 1.70 | 1.90 |
| 2SC 1978 | 5.40 | 6.00 | 6.60 |
| 2SC 2028 | .50 | .64 | .70 |
| 2SC 2029 | 1.50 | 1.80 | 2.00 |
| 2SC 2074 | .80 | .90 | 1.00 |
| 2SC 2076 | .50 | .64 | .70 |
| 2SC 2091 | .90 | 1.10 | 1.20 |
| 2SC 2092 | 1.80 | 2.00 | 2.25 |
| 2SC 2098 | 3.20 | 3.40 | 3.70 |
| 2SC 2166 | 1.40 | 1.60 | 1.80 |
| 2SD 72 | .50 | .64 | .70 |
| 2SD 77 | .35 | .40 | .45 |
| 2SD 90 | 1.30 | 1.45 | 1.60 |
| 2SD 91 | 1.30 | 1.45 | 1.60 |
| 2SD 92 | 1.30 | 1.45 | 1.60 |
| 2SD 93 | 1.60 | 1.80 | 2.00 |
| 2SD 118 | 2.90 | 3.20 | 3.40 |
| 2SD 130 | 1.10 | 1.25 | 1.40 |
| 2SD 187 | .35 | .40 | .45 |
| 2SD 201 | 2.30 | 2.40 | 2.65 |
| 2SD 202 | 3.40 | 3.55 | 3.90 |
| 2SD 218 | 2.50 | 2.70 | 3.00 |

| TYPE | 25-UP | 10-24 | 1-9 |
|---|---|---|---|
| 2SD 234 | .60 | .70 | .80 |
| 2SD 235 | .60 | .70 | .80 |
| 2SD 261 | .35 | .40 | .45 |
| 2SD 287 | 2.50 | 2.70 | 2.90 |
| 2SD 300 | 4.50 | 5.00 | 5.60 |
| 2SD 313 | .60 | .70 | .80 |
| 2SD 315 | .60 | .70 | .80 |
| 2SD 325 | .60 | .70 | .80 |
| 2SD 330 | .60 | .70 | .80 |
| 2SD 350 | 3.80 | 4.00 | 4.40 |
| 2SD 380 | 5.20 | 5.40 | 5.95 |
| 2SD 381 | .85 | 1.00 | 1.10 |
| 2SD 424 | 3.80 | 4.00 | 4.40 |
| 2SD 425 | 2.90 | 3.20 | 3.40 |
| 2SD 426 | 3.10 | 3.30 | 3.60 |
| 2SD 427 | 1.80 | 2.00 | 2.25 |
| 2SD 525 | .90 | 1.10 | 1.20 |
| 2SD 526 | .60 | .70 | .80 |
| 2SK 19BL | .50 | .55 | .60 |
| 3SK 22Y | 1.40 | 1.60 | 1.80 |
| 3SK 39 | .90 | 1.10 | 1.20 |
| 3SK 40 | .90 | 1.10 | 1.20 |
| 3SK 41 | 1.30 | 1.45 | 1.60 |
| 3SK 45 | 1.30 | 1.45 | 1.60 |
| AN 203 | 1.40 | 1.60 | 1.80 |
| AN 214Q | 1.50 | 1.70 | 1.90 |
| AN 239 | 4.20 | 4.40 | 4.90 |
| AN 247 | 2.50 | 2.70 | 3.00 |
| AN 274 | 1.50 | 1.75 | 1.95 |
| AN 313 | 3.00 | 3.20 | 3.40 |
| AN 315 | 1.80 | 2.00 | 2.25 |
| BA 511A | 1.80 | 2.00 | 2.25 |
| BA 521 | 1.90 | 2.10 | 2.40 |
| HA 1151 | 1.50 | 1.75 | 1.95 |
| HA 1156W | 1.60 | 1.80 | 2.00 |
| HA 1306W | 2.00 | 2.20 | 2.50 |
| HA 1339 | 2.50 | 2.70 | 3.00 |
| HA 1339A | 2.50 | 2.70 | 3.00 |
| HA 1342A | 2.50 | 2.70 | 3.00 |
| HA 1366W | 2.50 | 2.70 | 3.00 |
| HA 1366WR | 2.50 | 2.70 | 3.00 |
| LA 4031P | 1.80 | 2.00 | 2.25 |
| LA 4032P | 1.80 | 2.00 | 2.25 |
| LA 4051P | 1.80 | 2.00 | 2.25 |
| LA 4400 | 1.90 | 2.10 | 2.40 |
| LA 4400Y | 2.00 | 2.20 | 2.50 |
| LA 4420 | 2.00 | 2.20 | 2.50 |
| LD 3001 | 2.00 | 2.20 | 2.50 |
| M5 1513L | 2.00 | 2.20 | 2.50 |
| STK 011 | 3.80 | 4.00 | 4.40 |
| STK 013 | 7.60 | 8.00 | 8.80 |
| STK 015 | 4.20 | 4.40 | 4.90 |
| STK 435 | 4.50 | 5.00 | 5.60 |
| STK 439 | 7.90 | 8.00 | 8.80 |
| TA 7045M | 2.00 | 2.20 | 2.50 |
| TA 7055P | 2.00 | 2.20 | 2.50 |
| TA 7061AP | .90 | 1.10 | 1.20 |
| TA 7062P | 1.10 | 1.25 | 1.40 |
| TA 7203P | 2.50 | 2.70 | 2.90 |
| TA 7204P | 2.00 | 2.20 | 2.50 |
| TA 7205P | 1.60 | 1.80 | 2.00 |
| TA 7222P | 3.40 | 3.55 | 3.90 |
| TA 7310P | 1.30 | 1.45 | 1.60 |
| TBA 810SH | 1.90 | 2.10 | 2.40 |
| TC 5080P | 5.00 | 5.20 | 5.80 |
| TC 5081P | 3.00 | 3.20 | 3.40 |
| TC 5082P | 3.40 | 3.55 | 3.90 |
| UHIC 001 | 4.20 | 4.40 | 4.90 |
| UHIC 002 | 4.20 | 4.40 | 4.90 |
| UHIC 003 | 4.20 | 4.40 | 4.90 |
| UHIC 004 | 4.20 | 4.40 | 4.90 |
| UHIC 005 | 4.20 | 4.40 | 4.90 |
| uPC 20C | 2.10 | 2.50 | 2.80 |
| uPC 563 | 1.90 | 2.10 | 2.40 |
| uPC 575C2 | 1.30 | 1.45 | 1.60 |
| uPC 576 | 1.90 | 2.10 | 2.40 |
| uPC 592H | .70 | .80 | .90 |
| uPC 1001H | 1.90 | 2.10 | 2.40 |
| uPC 1008C | 4.20 | 4.40 | 4.90 |
| uPC 1020H | 1.90 | 2.10 | 2.40 |
| uPC 1025 | 1.90 | 2.10 | 2.40 |
| uPC 1154 | 2.00 | 2.20 | 2.50 |
| uPC 1155 | 2.00 | 2.20 | 2.50 |
| uPC 1156 | 1.90 | 2.10 | 2.40 |
| uPD 861 | 8.00 | 8.40 | 9.50 |
| uPD 857 | 8.00 | 8.40 | 9.50 |
| uPD 858 | 6.00 | 6.30 | 7.00 |
| PLL 01A | 3.00 | 4.20 | 4.60 |
| PLL 02A | 5.00 | 5.20 | 5.90 |
| PLL 03A | 7.60 | 8.00 | 8.80 |
| C-3001 | 1.30 | 1.45 | 1.60 |
| 2SC F8 | 2.20 | 2.70 | 2.90 |
| 4004 | 1.90 | 2.10 | 2.40 |
| 4005 | 2.00 | 2.20 | 2.50 |
| SG 613 | 5.20 | 5.40 | 5.95 |
| 78L05 | .90 | 1.00 | 1.10 |
| MPS U31 | 1.50 | 1.70 | 1.90 |
| SN 7400 | .15 | .17 | .19 |

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