ET/D

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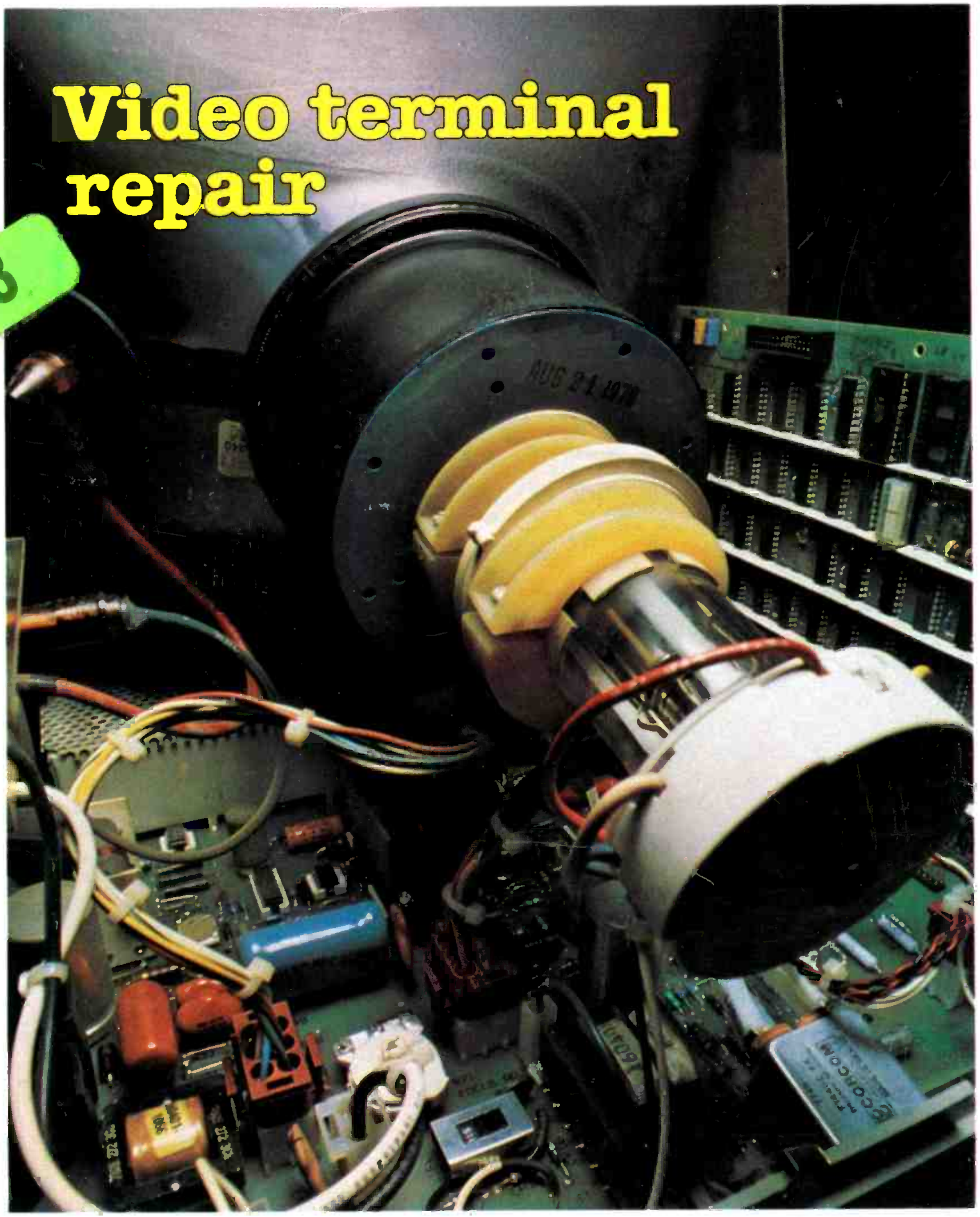
ELECTRONIC TECHNICIAN/DEALER

LEADING THE CONSUMER AND INDUSTRIAL SERVICE MARKETS

Video terminal repair



HBJ A HARCOURT BRACE JOVANOVICH PUBLICATION

INDUSTRY REPORT

Franchise Organization Planned for Service Industry

A franchise organization—known as Tronics 2000—will soon be offered to consumer electronics serviceshops across the nation.

David J. Hagelin, former publisher of ET/D who has been in the electronics industry for over six years, is president of the organization. Hagelin, who is based in Bloomington, Ind., resigned his post with ET/D Dec. 1 to start up his organization.

During an interview with ET/D, Hagelin said the idea for Tronics 2000 was born when it was recognized that it would fill an important gap in the industry. "It has long lacked a unified identity in the minds of the American consumer. Consequently it has suffered because of it. Tronics 2000," he said, "will be a service organization bringing together all of the essential qualities of a nationwide organization for the individual franchisee while preserving the essential independence and pride in individual ownership well known in the consumer electronics service industry.

"In effect, we hope to offer our affailiates substantial profit opportunities through the services and programs which we plan to offer, not the least of which will be the 'big company' prestige a franchisee will enjoy while remaining an independent businessman with a standing in his local community.

"Right or wrong, in the eyes of the consumer, bigness, high quality and value, often go hand-in-hand," Hagelin said.

Hagelin said the Tronics 2000 concept is new to the consumer electronics industry and the closest thing he could think of insofar as comparison with another industry would be the relationship and effect the Century 21 franchise organization has had on the independent real estate industry.

"Consumer electronics is expanding at a tremendous rate," Hagelin said. "Just look around you. Some 17 million television sets are sold each year. The audio components market is a $2 billion a year business and growing at 20 per cent. It is conservatively estimated that video disc players and video cassette players will comprise a $4.2 billion a year market by 1985.

"Yet in the face of these glowing and optimistic forecasts, the number of consumer electronics serviceshops is dwindling steadily," he said. "There is only one reason, the lack of a universal identity backed by sound business management practices. This is where Tronics 2000 will fill an essential role in our industry.

Hagelin said it is the intention of Tronics 2000 to spawn in the minds of the American consumer the concept of an integrated, complete one-stop home electronics repair center. A network of centers where the consuming public can bring his valued and generally expensive electronics components—be it television, stereo, video equipment—for repair and be assured of professional, quality and dependable service at an equitable price for all.

"Such an image has been lacking and Tronics 2000, through its nationwide appeal, will fill this long standing void," Hagelin said.

Heath Forms Educational Division

Heath Company, for years the leading force in electronic kits, has announced formation of a new continuing education division aimed at the electronic technician/engineer finding himself in need of educational upgrading in today's rapidly evolving technological environment.

The new division, called Heath/Zenith Educational Systems, initially will offer over 30 self-instructional educational programs—all priced under $100—in eight basic electronics oriented environments. These are automotive, microcomputer, mathematics, test instrumentation, microprocessors, advanced digital techniques, advanced electronic design, and basic electronics. According to Heath/Zenith, each course is complete with instructional tools such as cassettes, flip-charts, programmed learning coursebooks, plus all actual components needed to conduct experiments.

An example of the course material in advanced electronic design are four courses: operational amplifiers, active filters, IC timers, and phase locked loops.

A company spokesman reports that "all early kit oriented learning programs designed for hobbyists and beginners have been phased out and replaced with innovative, college level, topical self-paced learning programs for adult continuing education."

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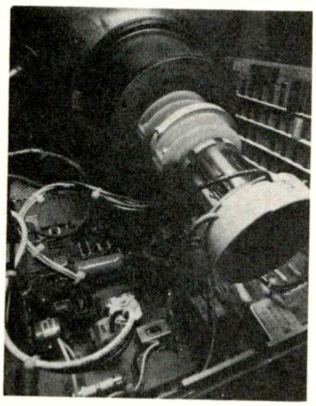

On the cover: The video terminal—symbol of our electronically oriented society. Our lead feature this month deals with the basic circuitry inside of them and what it means to you.

FEATURES

DEPARTMENTS

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Additionally, the spokesman said, training equipment for use by individuals or classroom teaching is being offered. This would include lab trainers, tabletop test and experimentation stations equipped with power switching, socketing, and peripheral electronic functions needed for breadboard design and course experiments. These trainers are available for basic electronics, digital and microprocessor courses and are priced between $150 and $250. However, they are also available in kit form at 50 to 60 per cent savings, according to Heath/Zenith.

The new division, headed by Louis Frenzel, Jr., is licensed in Michigan as a school. In 1979 Heath educational sales totaled $11 million.

Sharp Says Video Rental is Key

Video equipment rental, including programming rentals, are the real key to growth in the home video market, according to Sharp TV General Manager, Robert Whitehouse.

"Marketing the products of the 80s with the techniques of the 50s will not work," he said.

In promoting the rental concept, Whitehouse said that this concept overcomes the three major problems facing the expansion of the video industry at the present time: lack of standardization, availability of software, and pricing.

"Standardization," he said, "becomes a non-question when somebody is renting. He is looking at a very short term situation and has no concern whether his program is on Beta, VHS or disc...Similarly, software availability is completely eliminated when you have a rental situation because the consumer makes the decision immediately as to whether the software for his short interval of leasing or renting is adequate. for his needs.

"Finally, leasing and rental overcome the aspect of price because if the consumer can rent a video disc and player for $10 a night, he can see 50 movies before the purchaser of a $500 machine can even see his first."

Audio Service Business — "Optimistic"

The outlook for the high end audio service business is generally optimistic according to the general concensus of a panel comprised of ten service technician/managers.

The panel, members of Yamaha's National Service Advisory Council, was questioned over a wide range of topics ranging from future service growth, salaries, manufacturer relationships, warranty policies and other areas during a recent meeting held in Buena Park, Calif., Yamaha's national headquarters in the United States.

When asked what they felt was the general outlook for service opportunities in high end audio, eight of the 10 members responded with answers in the good to excellent category. Most reported that they felt increased product sophistication and greater demands on technician skills are among the problems that will have to be faced for anyone in audio service.

Across the board the panel reported a technician "shortage" but most said sensible service rates coupled with salaries ranging up to $25,000 per year for competent technicians would tend to help the audio service industry meet this challenge.

The panel members, representing geographic areas from across the United States, said that generally the level of competition for audio service in their service areas was no major problem due to the large number of "small" service shops without the manpower to handle any sufficient number of hi end audio manufacturer's lines. Also, the large number of audio discounters without service capability made the outlook for service growth and expansion appear good.

A major criticism of the panel members was that very few audio component manufacturers offer any kind of viable service training. Of the 20 manufacturers of high end audio equipment listed, the council members said 14 had no factory training available on their products and 16 of them conducted no infield training programs.

Zenith Announces First Quarter Results

Zenith Radio Corporation reports earnings for the first quarter of 1980 were $6.6 million, 35 cents per share, compared with $3.7 million, 20 cents per share, for the first quarter of 1979.

Sales totaled $271 million during the first three months of 1980, an improvement over the $237 recorded during the comparable period a year earlier. Zenith's board also declared a quarterly dividend of 15 cents, payable June 30.

Mallory & Co. becomes Duracell International

The corporate name of P.R. Mallory & Co. has been changed to Duracell International Inc., according to a statement from the firm's headquarters at Bethel, CT.

Duracell International Inc., is a wholly owned subsidiary of Dart Industries, Inc., which acquired P.R. Mallory in late 1978. The company manufactures a variety of high performance batteries sold under the DURACELL trademark. ET/D

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LETTERS

HELP NEEDED:

I had such a good response to a letter published by you before, when in need of a meter movement for a KNIGHT KG625 that I am again asking for you to help me.

I have, in my shop, for service, an old radio that the owner wants fixed, if possible. It is a "STROMBERG-CARLSON" NUMBER 400-H. If anyone out there has any literature on it, if they will provide me with it I would greatly appreciate it.

I will be willing to pay any reasonable price for schematic or other "dope" on this receiver.

Thank you.
James S. McIntyre, Owner
Macs Radio & TV Repairs
Star Route, Box 607
Pettus, WV 25153

A schematic for an old Sears Silvertone radio, Model #6424.
David A. Weaver
Weaver's TV and Electronics
Mt. Zion, WV 26151

I need a diagram of Hammarlund HC-10 converter.
E.J. Mich
4609 Blakiston St.
Philadelphia, PA 19136

I need balast tube 50A7 for an old radio and will be glad to pay if anyone can supply me with one.
Ralph Kinirral
Kinirral Electronics, Inc.
68-26 64th Place
Glendale, NY 11227

I enjoy your magazine very much. The Service Seminar and TEXKFAX pays for the cost in time saved in my shop.

A friend of mine was given an organ for their church and it needed some work done on it.

It is a Minshall made by Minshall-Estey Organ Inc., which I understand has gone out of business.

I need a schematic for it and any other information I can get. Can you help me?

Minstall-Estey Organ Inc., Brattleboro, VT, Pat. No. 1956350-RE2083, Model 3, Serial 62.
Francis W. Romer
Romer's TV
Rt. 1 Box 421A
Catlettsburg, KY 41129

BOUQUETS—AND REQUESTS

To let you know that I have retired in Electronics, 1976. So, now I am retiring ET/D. It has been very rewarding for me to be in electronics, also ET/D, where I found many interesting articles in new technology in electronics, and helpful aids. I am now taking it easy and do a lot of traveling in the summer, where I had neglected the years I have been in business, 36 years. I sold my TV shop in April 1977, also stock and equipment.

In closing, I thank you for such a fine magazine, for our service technicians in our great country, the U.S.A.
Chris Reinisch
247 S.E. 2nd St.
Garrison, N.D. 58540

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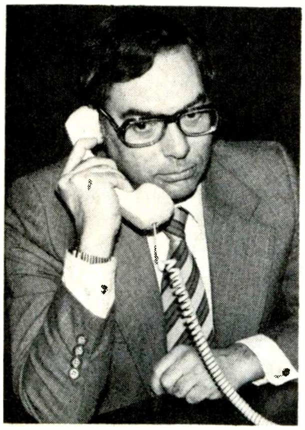
FROM THE EDITOR'S DESK



There are some momentous events taking place right now in the consumer electronics service industry—events that could materially effect the professional lives of each and every one of you on a day-to-day basis.

Two of them occurred at the recently completed Electronic Distribution Show (EDS) in Las Vegas. The first is the continually evolving types of test equipment with which technicians must contend as we move into an electronics world that is ever more oriented toward digital technology and the microprocessor. I'l have more to say on this and a complete show wrapup next month in the July issu of ET/D.

I have also returned from the 1980 Sylvania National Convention at t e latter's new training center in Batavia, N.Y., where Sylvania introduced its new product lines for 1981, including the new E50 chassis with lower power, synthesized tuning, and infra red remote.

But more than that I learned while there of that manufacturer's on-going committment to the service industry—and ultimately the technician in the field—in the number of high technology educational programs now under development there for the training benefit of technicians as they move further into the world of digital electronics.

This manufacturer is going into the 1980s with its eyes wide open. Not only is Sylvania offering special educational packages on digital, but there is also under development a unique computerized service aid called Computer Fix-it. Why this hasn't happened before now I'll never know, but the essence of the Sylvania program—and they are capable of putting this program on-line right now—is a computer based diagnostic routine. A service technician can actually dial into the memory bank at Batavia which is programmed with fault symptons and diagnostic repair routines.

Not only does this sympton/repair routine tell you likely causes of failure on a chassis by chassis basis, but it also lists the specific repair parts that have been needed to make those repairs in the past. Think of the impact this program could have just in the reduction of "callbacks" for lack of the right part.

This program can be implemented in one of two ways, either via direct telephone link to Sylvania, or via keyboard access to the main memory bank which will display a list of proper repair parts needed. The beauty of this program is that if the latter method is used a technician will be able to access the main computer using Sylvania's InteliVision keyboard system which will be readily available at the distributor headquarters—or even in the customer's home. This is a very exicting development.

The third event of which I spoke is out of the EDS show and of truly "shocking" proportions for the entire service industry.

The announcement concerned itself with the news that a franchise organization—Tronics 2000—is being developed for application to the consumer electronics service industry.

This event potentially holds more ramifications from the standpoint of individual technicians, individual serviceshops and even from the manufacturers point of view, than any announcement of which I am aware, that has eminated from our industry for years.

At a time when we see some manufacturers going the "factory service" route, at a time when we see some independents waxing stronger while others fall by the wayside, at a time when we see record numbers of consumer productry being poured into the American home—we can indeed look about us and see an industry in traumatic change.

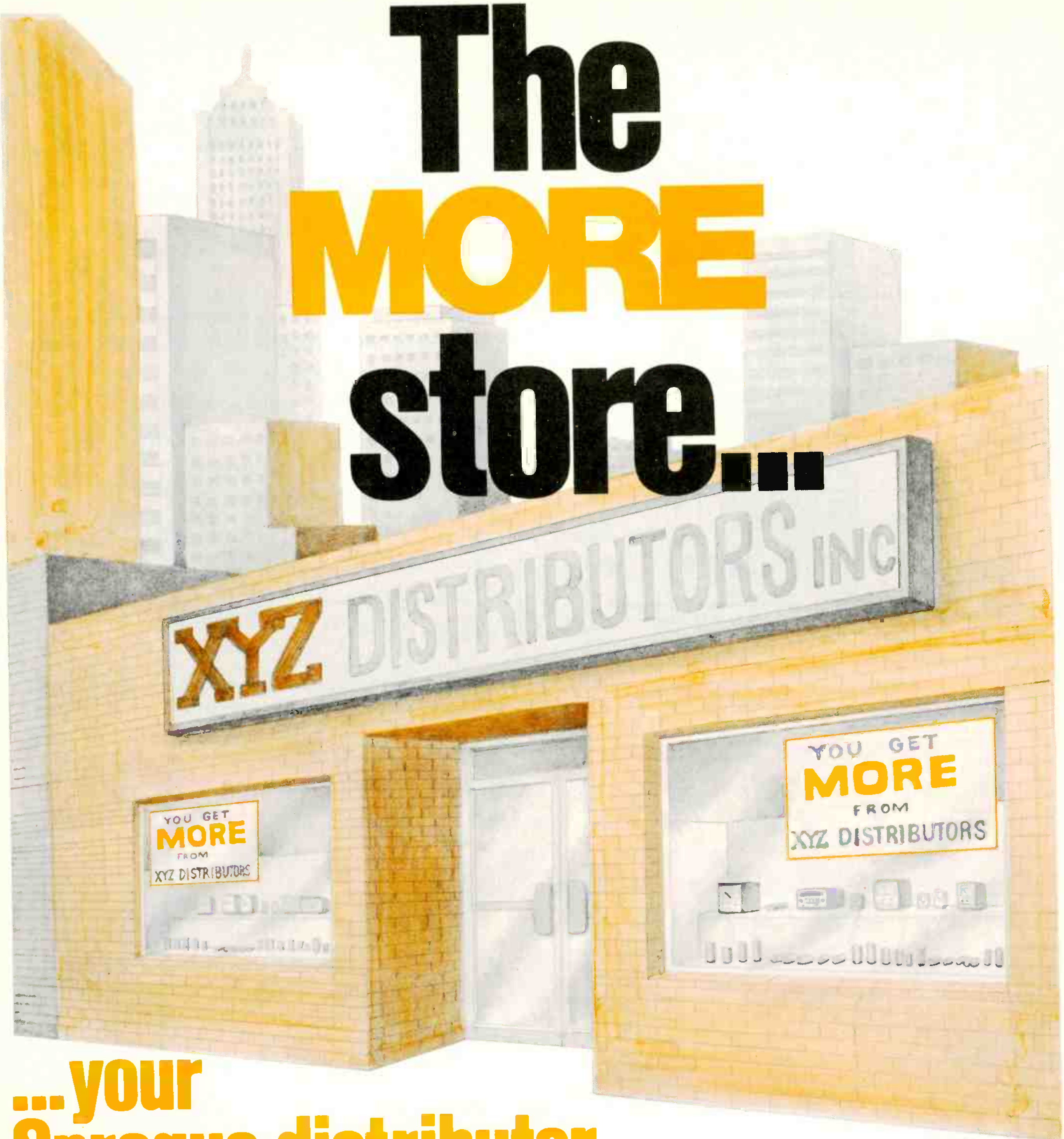
Remember this: There will always be consumer electronics service. The forces shaping the industry are out there now forging their own destinies.

Are you going to be part of it?—if so, welcome to the 1980s.

Sincerely

Richard W. Lay

The MORE store...



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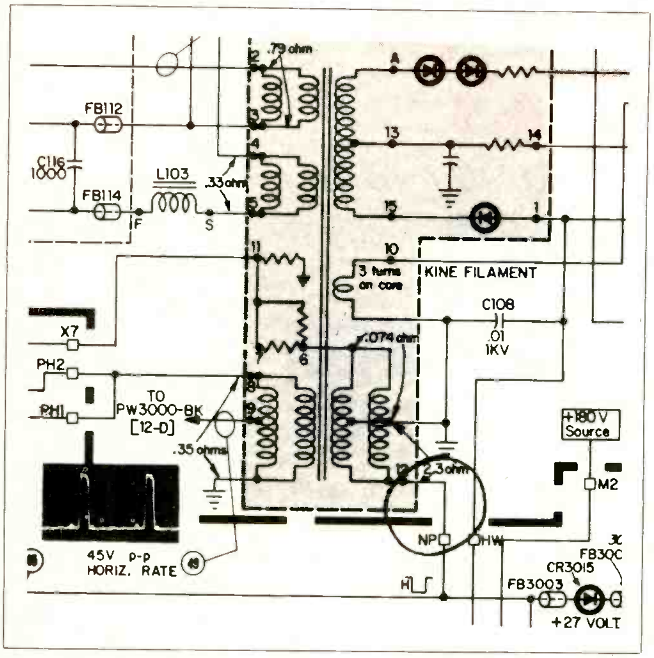
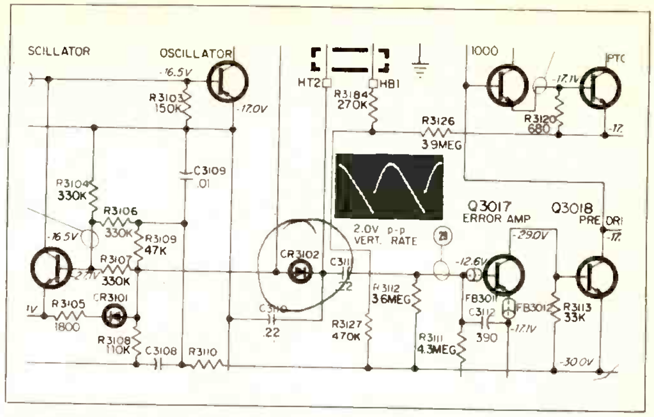
SERVICE SEMINAR

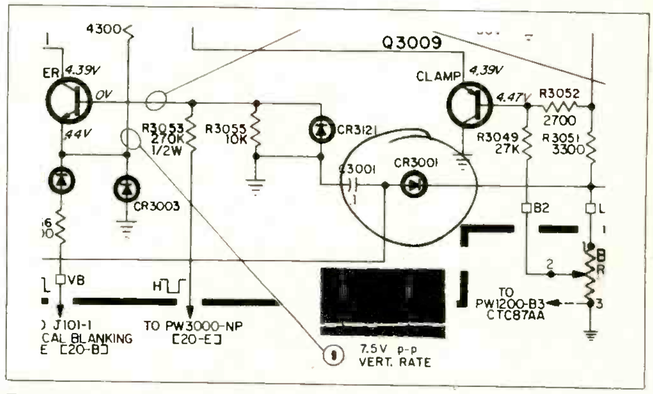
RCA

CTC 87, Set shuts down. Possible cause: short, between lead that connects terminal 12 of IHVT to terminal PW 3000-NP, and chassis.



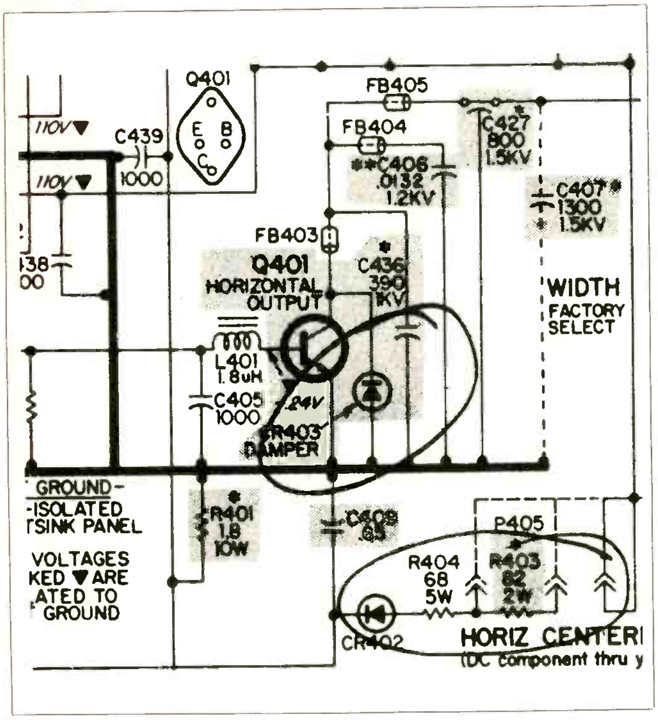


Vertical overscan and retrace lines in top half of picture. Possible cause: leaky CR 3102 in vertical oscillator circuit.

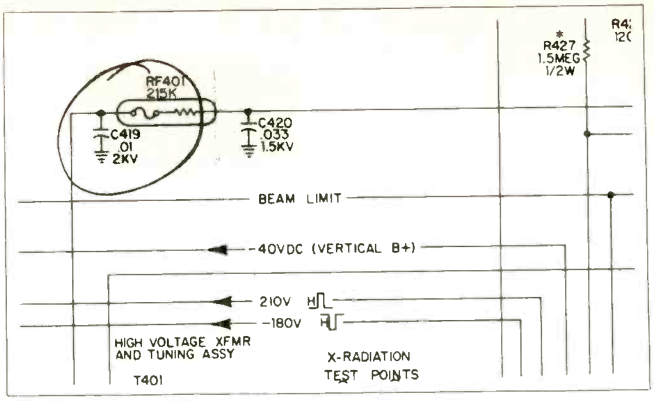


Brightness increases until shutdown occurs. Possible cause: leaky CR 3001 in brightness limiter circuit.

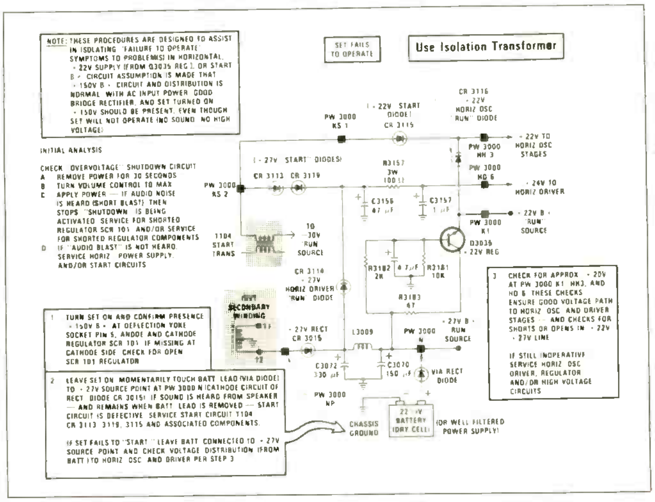
CTC 92, Shut down at normal line voltage, black vertical line at reduced line voltage. R403 and R404 overheat. Possible cause: Shorted damper (CR403).



No raster, HV and sound normal. Replaced defective C434, CR407, R440, R435 then overheats—terminal dc or triple, measures -1000 units. Possible cause: leaky C419 (.01 mfd, 2KV). Check by substitution.



Start up circuit check out procedures. ET/D



NEWSLINE

NEW PRODUCT INTRODUCTIONS FLOOD MARKET. It's that time of year again and consumer electronics manufacturers are flooding the market with their 1981 product lines. Among those already having announced are Sylvania, Sony and RCA. As we go to press with this issue General Electric and Zenith were also announcing their new entries to distributors. We'll have a complete rundown on all the new circuits in our annual television issue in September.

SYLVANIA INTRODUCES NEW E50 SERIES CHASSIS. Sylvania is out this year with significant changes in television, even though physically the E50 is in many ways similar to the E48. Sylvania has switched from a ferro-resonant self regulating transformer to a lower power high frequency switching type power system. Additionally, the E51 (25-inch) and the E53 (19-inch) carry frequency synthesized digital tuning with infra-red remote control as well as 100 degree in-line picture tubes.

NEW VCRs. Also announced were three new VHS format video recorders, two table models and a portable unit. The high end models carry 14 day programmability and screen monitored fast forward and reverse. The portable unit is notable for its whopping 36 per cent reduction in weight.

RCA SHOWS ITS NEW CTC108. RCA's new CTC108 (19-inch) chassis carries significant new circuitry in its IF strip and tuning system. RCA has gone to a SAW filter approach which replaces three or four interstage tuned circuits and this model uses synchronous video detection. Added to its frequency synthesized tuning system, introduced last year, is a capability which allows the user to receive cable mid band channels A-2 through I simply with the flip of a switch.

SONY SHOWS NEW BETAMAX. Sony is out with its new 14-day programmable SL-5800 Betamax with all of the features of earlier models plus faster (up to 20 times normal) forward and reverse--and, freeze frame. In television the line includes the largest and smallest screen sizes on the market, the 26-inch and the new 3.7-inch AC-DC portable unit. Sony now features electronic tuning in all of its color models.

U.S. ENDS TV DUMPING CASE. The United States apparently has decided to settle its long running television dumping case with the manufacturers of imported TVs. According to statements from the Carter administration, the U.S. will wind down the controversy for about $77 million--or about 50 cents on the dollar. The case arose primarily from the fact that Japanese manufacturers were allegedly selling their sets in the United States cheaper than in Japan because of subsidies offered by the Japanese government.

How video terminals work

The computer's TV

Like the home TV receiver, the proliferation of video terminals throughout the land in homes, small business and industry, represent a huge service potential for the independent electronics service shop. In this article the author presents a preliminary rundown on the simple operating principles and describes the various types.

By Joseph J. Carr, CET

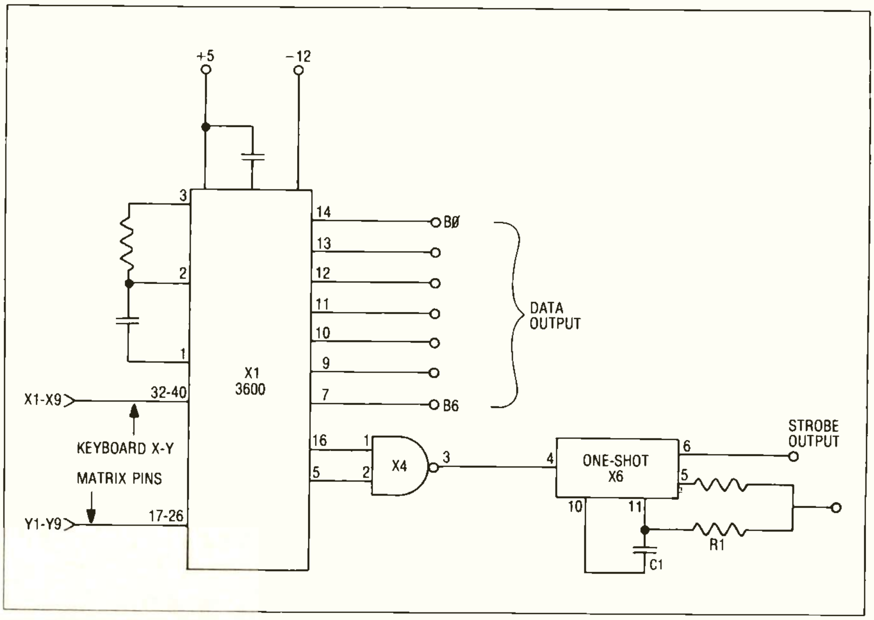


Fig. 1 One of the most popular, and simplest, of all the circuits found in the keyboard section is displayed above.

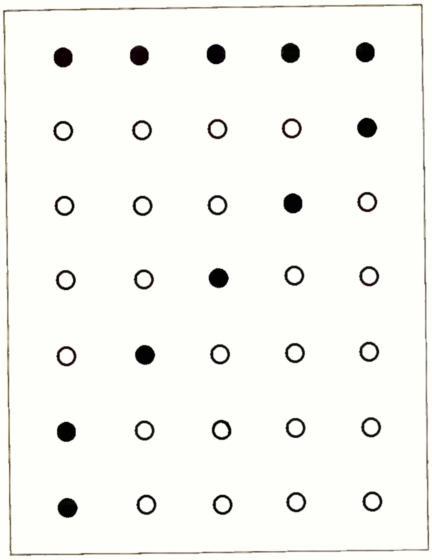
The cathode ray tube video readout terminal is one of the most popular computer peripherals. It is generally lower in cost, and easier to use, than printer devices. Unless a "hard copy" (i.e. paper) printout is needed, therefore, it is often the case that users will opt for the video terminal.

These terminals come in various styles. Some are nothing more than closed circuit television sets, or modified broadcast receivers as used by many hobbyists, with the computer doing the job of creating the video signal. Still others are designed as stand-alone peripherals that will take a serial or parallel stream of data bits and convert them into characters on the screen. The terminal might have an internal memory of its own, or might use an area of the computer's memory in order to store the characters being displayed.

Some video terminals are display only, which means the computer can output data to the terminal but will not receive anything back. Still other terminals are outfitted with a keyboard, and will allow communication with the computer through one of the input ports.

A few models are actually oscilloscopes with some extra electronics that will permit character display. Both of the major oscilloscope manufacturers offer models for use as computer displays. Most, however, are a lot like ordinary broadcast and closed circuit television receivers! The computer, or an external video display electronics package, will create the data and synchronization pulses necessary to display the characters on the screen. Even many of the models that are self-contained, complete with keyboard, actually contain an ordinary TV chassis!

Video terminals represent a large service market, especially for independents. These machines are found every place, often many miles from the site of the actual computer! A MODEM and telephone landlines will carry the data back to some central



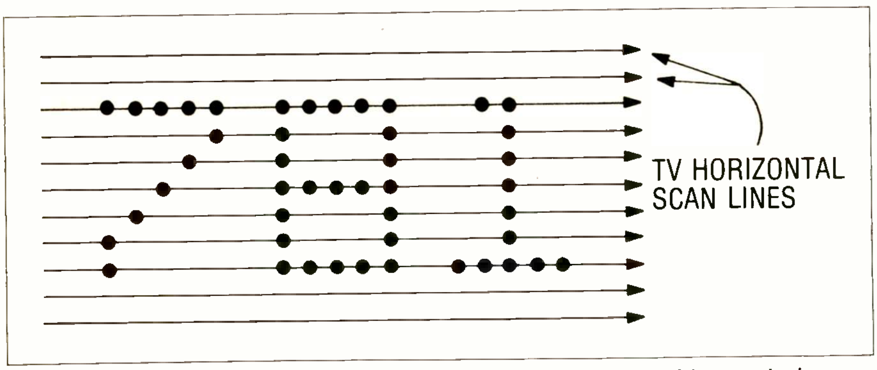


Fig. 2A & 2B Shown above are graphic representations of how the video terminal display creates the characters. At points where dots occur the terminal's electronics issues an unblanking signal that turns on the CRT to produce the spot of light.

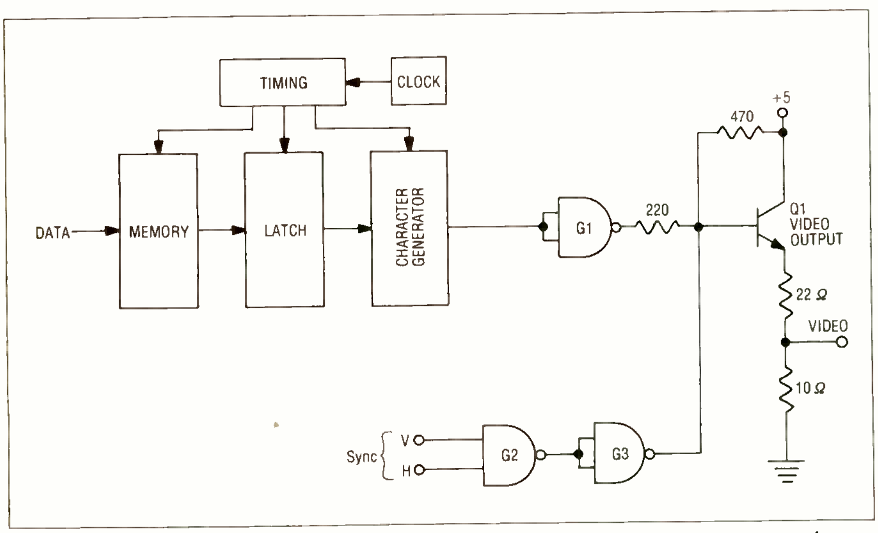


Fig. 3 The principal components of the character generator and video system are the memory, a buffer latch, the generator circuit and composite video.

computer. Timesharing of the computer permits many users at the same time. This means that there may well be a lot more video terminals on a system than computers. Even when the computing power is decentralized from the mainframe type of machine, ala microcomputers, there will still be at least one video terminal for each user! Clearly, these machines represent a service market for many independents, and the technology is not terribly high in most of them.

The problems seen will be varied, and will include a healthy mix of ordinary TV problems and digital problems. You will also see some "transmission line problems" that one normally associates with TV and two-way radio antennas (how does SWR grab you?)

Keyboards

The keyboard is a typewriter like assembly that will create encoded data representing the letters of the alphabet, numerics, punctuation and certain control signals. In most computer systems the keyboards will use the ASCII code. This code is a 7 bit code, and requires an 8th bit as the strobe. This strobe is almost always the most significant bit in the code, and will go active only when the data on the other bits of the data word is valid (some keyboards output trash ...random pulses ... between keypress operations).

There are several different ways to generate the codes, but one of the most popular, and certainly the simplest, is the circuit of Fig. 1. This keyboard is based on a specialized I.C. that is called a *keyboard encoder*. The I.C. will contain a clock (frequency set by R1/C1), and a read only memory (ROM) that is programmed with the codes for the system being used (i.e. ASCII, BAUDOT, etc.).

When a key is pressed on the keyboard, a pair of contacts are closed that will short together two of the matrix pins on the encoder I.C. This action will cause the I.C. to address the correct location in memory, and output the code for the key pressed. At the same time, both inputs of NAND gate X4 go HIGH, causing its output to drop LOW, triggering the one-shot multi-vibrator (X6) that generates the strobe pulse. In some models, the strobe pulse will go high for only a few milliseconds, and then returns LOW. In still others, the strobe line goes HIGH as long as the key is pressed. Most of the problems associated with keyboards seem to be wear of the contacts, with a few electronics problems. Both the ordinary logic and the encoder are readily available, so the electronic problems are usually repairable. Some manufacturers also make individual keys available, but the usual solution for worn out buttons is a new keyboard. In low quantities, these cost from $40 to $250, depending upon complexity and the number of characters or other features.

Character display

The video terminal forms the characters in a *dot matrix*, which is either a 5X7 or 7X9 pattern of dots (Fig. 2A). The video circuitry will turn on the correct set of dots for that particular character; in the case of a TV readout, the dots are unblanked spots on an otherwise turned-off CRT screen. In Fig. 2A, the figure "7" is shown. Note that a 5X7 dot matrix will display only upper case letters. If we want all 128 possible characters in the 7-bit ASCII scheme, we will require a 7X9 dot matrix. The idea is similar, but the timing is different.

How does the TV screen create the dots? See Fig. 2B. The CRT is normally blanked off, so will appear black. At the points where the dots are to occur, the video terminal electronics will issue an unblanking pulse that briefly turns on the CRT to produce the spot of light.

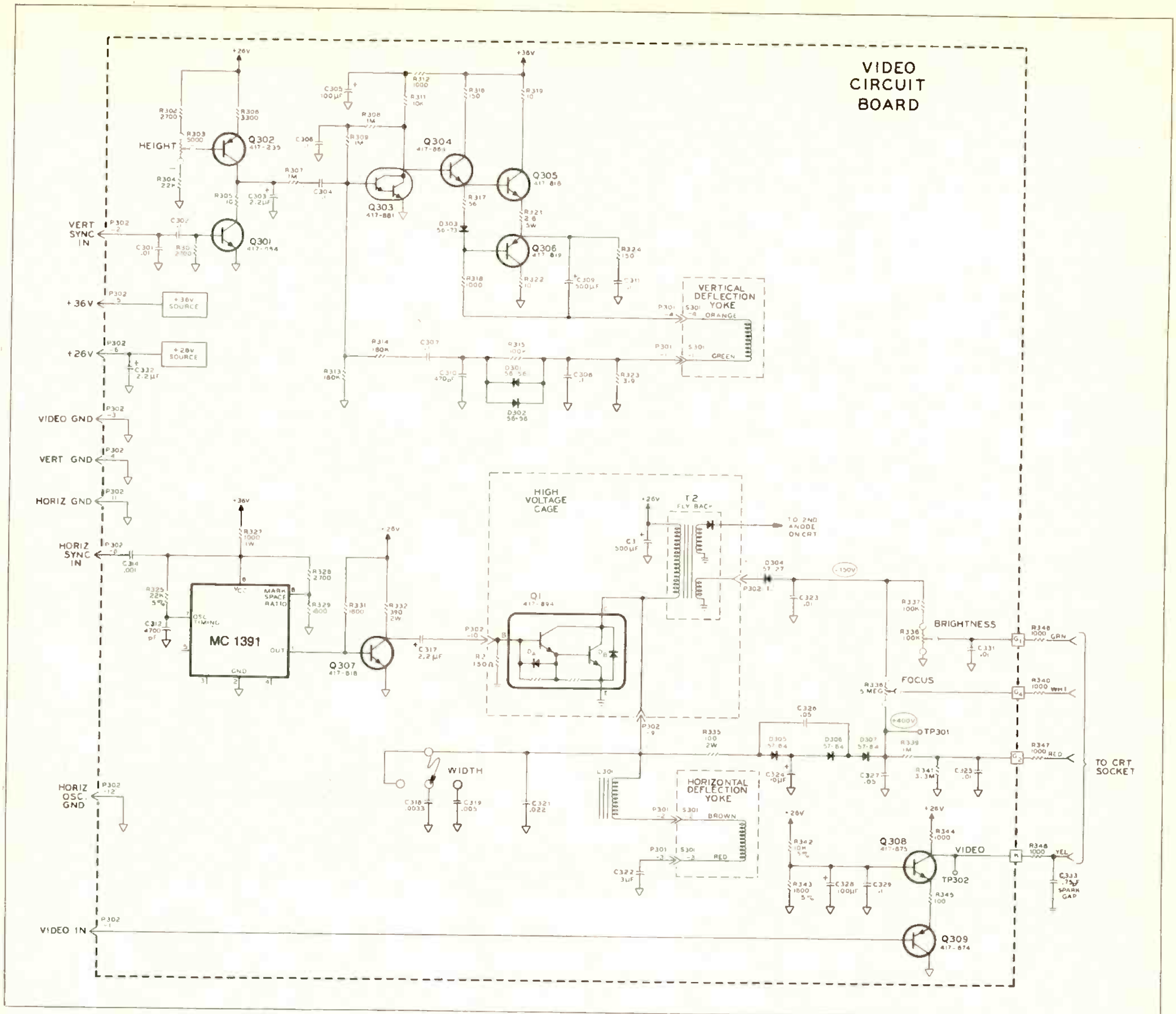


Fig. 4 Schematic drawing of the video board from a Heath model H9 video terminal.


Fig. 5 In many cases the video display unit for a typical small hobbyist computer system is nothing more than an ordinary broadcast TV receiver.

Under normal circumstances, we will keep the raster scanning, but turned off. In most video terminals, the scan is adjusted to sweep 2/3 to 3/4 of the total CRT (TV techs would call it underscanned). This is done for several reasons, one of which is the linearity of the display presentation.

Figure 3 shows the elementary block diagram for the character generator and video system. The principle components are the memory, a buffer latch, the actual character generator circuit, and the video composite circuit.

The memory section is used to hold the data to be presented on the screen, and will consist of as many 7 bit locations as needed. The size of the memory will depend upon the number of characters to be displayed. In the case of a display that will handle 64 characters per line, and 16 lines per page, there must be 16 X 64, or 1024, memory locations.

There are two approaches to the video terminal memory. In the memory mapped system, either a real location in the computer's main memory, or some memory located at the terminal, is used. The video terminal is treated by the computer *as a location in memory*. The programmer must keep track of the characters and the location to which they were written. This method uses the computer's memory to write instructions to send characters to the TV display.

The other approach is to treat the video terminal as a peripheral, and send it data through a regular output port. This I/O approach requires the memory for the display be local to the terminal, and will write data to the terminal using I/O instructions.

The timing circuit will sequentially scan the memory, causing the contents of each successive location to be output to the intermediate latch on each cycle of the timing clock. The

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latch is a single location of 7-bit memory that will temporarily hold the code of the character being displayed at that instant.

The character generator section will contain several digital I.C.s, one of which is a read only memory (ROM) chip. The ROM is a special type of memory chip that is permanently programmed; it will not allow write operations, only reads. The bit pattern for the matrix display of the character is stored in the ROM, and is then output through the rest of the logic.

Transistor Q1 serves as the video output amplifier. There are two inputs to the base of this transistor. One is the video character information signal, which is the inverted output of the character generator (NAND gate G1 is connected to operate as an inverter). The other input is a combination signal containing both the vertical and horizontal synchronization pulses for the TV receiver.

The horizontal and vertical frequencies are generated by digital counter circuits. One system uses a 12.395 MHz crystal oscillator, followed by a divide-by-8 counter, and two divide-by-10 counters (total divide-by-800) to produce a horizontal frequency fo 15,494 Hz. This value is close enough to the ordinary television horizontal frequency (15,734 Hz) that most TV horizontal oscillators can be adjusted to lock-in on the signal from the video terminal. The vertical frequency will be 59 Hz. For this reason, most closed circuit TV monitors will work nicely with computer video outputs.

Extended bandwidth

There is a matter of bandwidth to consider, however, when using remote video monitors. Not all black and white closed circuit monitors have sufficient bandwidth to accommodate the video signal from the computer! The more characters one finds on the screen, the more that are packed onto each line, the wider must be the monitor bandwidth. Let's make a simple calculation for one system. Assume that we are using a 7X9 dot matrix, meaning that each character may have up to 7 blips of light on each horizontal scan line. Let's assume our line size is 64 characters, and the designers have followed the normal procedure of scanning only 2/3 of the CRT screen. Each line takes approximately 64 microseconds, and we have a dark space between characters with a width equal to *two* blips. What bandwidth is needed? AT a 2/3 scan of 64 uS each, we scan each line of characters in (0.66) (64), or 42 uS. Each character requires a total of 9 blip-spaces (two dark, plus seven lighted, maximum), that must be scanned in 0.67 microseconds. This works out to a video "blip rate" of 13,400,000 blips per second, or a video bandwidth requirement of (13.4/2) MHz = 6.7 MHz.

The bandwidth required for our hypothetical 64 character per line display must be 6.7 MHz, which is a little high for some black and white closed circuit monitors. Note that it is relatively easy to purchase monitors with this bandwidth (indeed, up to 15 MHz is commonly available), but some of the lower cost models will not offer this bandwidth. Also, R.F.-entry for this bandwidth is a little difficult to achieve, so most will be direct entry.

One will immediately notice the results of limited video bandwidth on a computer terminal: all of the characters will appear smeared and fuzzy. If you have been a TV repair technician this symptom should sound suspiciously the same as limited-bandwidth problems in ordinary television applications.

There is, however, one other problem that will cause smearing of the characters: improperly matched monitor input. The video level from the computer must be matched to the input level expected at the video monitor, and the impedance must be matched. Most video monitors will use a 75 ohm impedance, and will match nicely to the 75 ohm coaxial cable used to interconnect the video source and the display. But, in cases where the video input impedance of the monitor is high, there will be substantial standing waves on the line, and these will cause smearing of the characters. Note that some video monitors have a high-Z/75-ohm switch that will allow setting of either condition.

The TV section

Most ET/D readers are familiar with the workings of the standard television receiver and closed-circuit monitor. The TV-electronics of the computer terminal are very much the same, and will often have the same types of problems: no raster, blooming, out of sync oscillation, etc. There is little that will surprise most TV technicians.

Figure 4 shows the video board from a Heath model H9 video terminal. The vertical output amplifier is a complementary symmetry push-pull amplifier consisting of transistors Q305 and Q306. Output to the deflection yoke is taken from the junction of the emitters of these transistors, through capacitor C309. The push-pull output amplifier bases are driven in parallel, the usual manner for comp sym amplifiers, with a biasing diode improving the crossover distortion by applying a small forward bias. The drivers are a class-A bipolar stage and a Darlington oscillator. The input amplifier is a common-emitter, class-B amplifier for the sync pulse. A current-source-connected transistor in the collector of the sync amplifier provides the height control.

The horizontal section uses a Darlington power transistor device (much like some TV receivers) as the final horizontal power amplifier. This transistor drives both the horizontal deflection yoke and the high voltage "flyback" transformer. The horizontal oscillator is a Motorola MC1391 integrated circuit, with the timing set by R325 and capacitor C312.

The video amplifier is also on this same board. The composite video signal is applied to the base of transistor Q309, which is connected also to a current source Q308.

There is little in the television section that should give most technicians problems troubleshooting. Most of the circuits are standard and well-known. As might be expected, the high power, high voltage, video circuits often provide most of the service jobs.

Other terminals

The standard "dumb" video computer terminal will be a relatively simple device. When a key is pressed, the computer must be ready to accept its data, or the data will be lost. Similarly, the video terminal memory must be capable of updating any time the computer decides to output a signal to the terminal.

Some terminals are a little smarter; they will provide keyboard memory and handshaking with the computer. They have an *enter* key that will allow all of the keyboard data appearing on the CRT to be transmitted as a mass block to the computer. In a typical application, the operator will enter all of the characters on the 256, 512 or 1024 character "page," and then press enter. This will grab the computer's attention and then allow

continued on page 47

Troubleshooting microprocessors

Fault isolation

Fault isolation in any digital system comprised of a large number of integrated circuits in parallel may seem initially to be a task of insurmountable proportions. However, once basic system familiarity is attained, it usually resolves itself into an algorythmic routine of checking for permanent high or low states at a particular pin and then doing something about it.

By John E. Cunningham

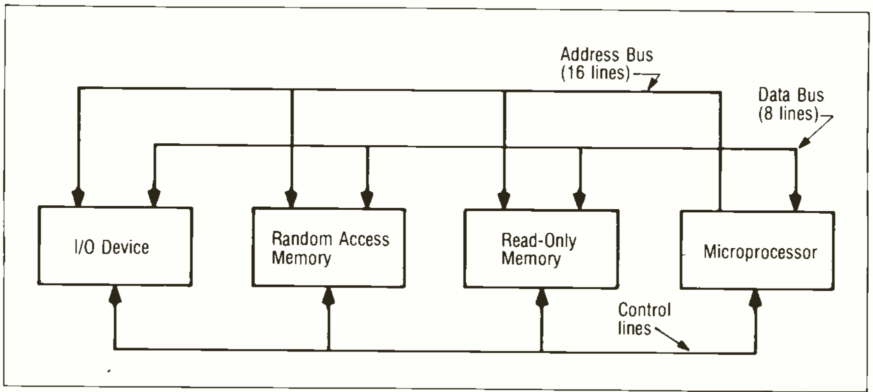

Fig. 1 Block diagram of a microprocessor system

One of the most confusing tasks facing the electronic technician today is troubleshooting a piece of equipment that incorporates a microprocessor. There seems to be no way to avoid the task because the microprocessor is being used in almost every type of electronic equipment from TV sets to cash registers. In fact, almost every electronic system of any complexity at all either now uses a microprocessor or soon will.

There are three ways in which servicing microprocessor-based equipment differs from servicing older more familiar equipment. In the first place, in a microprocessor based system, several large scale integrated circuits are all connected to the same lines, in parallel. This makes it very tricky to isolate faults to a particular IC. Secondly, although the individual operations in such a system are very simple, there are very many steps in accomplishing even the simplest operation. This makes the operation of the system appear to be very complicated. Lastly, and certainly very important is the fact that few technicians have had the opportunity to become familiar with the microprocessor.

There is a great tendency on the part of almost everyone to confuse what is really difficult with things that are merely unfamiliar. Many branches of technology seem to be very difficult when they are first approached, but experience often shows that the apparent difficulty was merely lack of familiarity. In general, this is true of the microprocessor. Once a technician has had an opportunity to gain a little familiarity with the new systems much of the difficulty will disappear.

Although it is generally agreed that the best approach to troubleshooting is to first become familiar with the details of system operation, the microprocessor is proliferating so rapidly that the first exposure many technicians have to it is in a piece of defective equipment that they must not only fix, but fix quickly.

Fortunately, the situation isn't as bad as it first appears. Most microprocessor systems have enough in common so that it is often possible to isolate faulty components without ever learning all of the details of system operation.

Most microprocessor systems have a block diagram something like that shown in Fig. 1. The thing that makes the system unique is not the way in which the electronic components are connected together, but in the program that is stored in its memories. Thus several different systems that have completely different functions may have nearly identical circuit diagrams. This can work to the technician's advantage, because his task usually ends up in replacing one or more faulty components.

Troubleshooting tools

Several very sophisticated test instruments have been developed specifically for work on complex digital systems such as microprocessors. Usually these are excellent instruments and when properly used will simplify troubleshooting. Unfortunately, most such instruments are priced well beyond the reach of the average technician. Unless a large number of systems are to be maintained, the cost of elaborate test equipment which runs into the thousands of dollars is rarely justified.

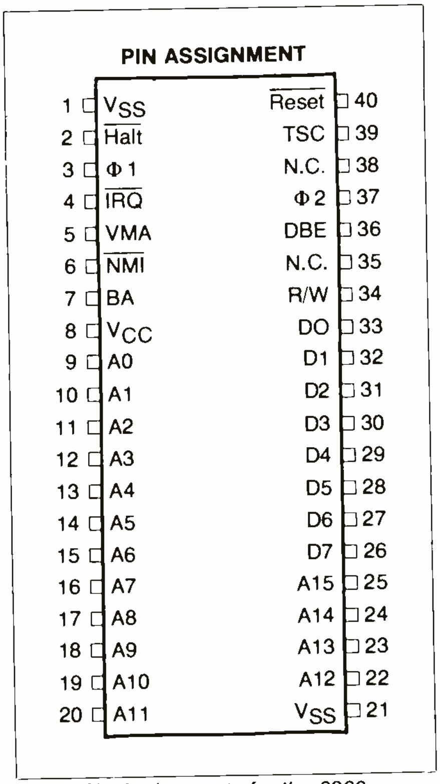

Fig. 2 Pin Assignments for the 6800 microprocessor

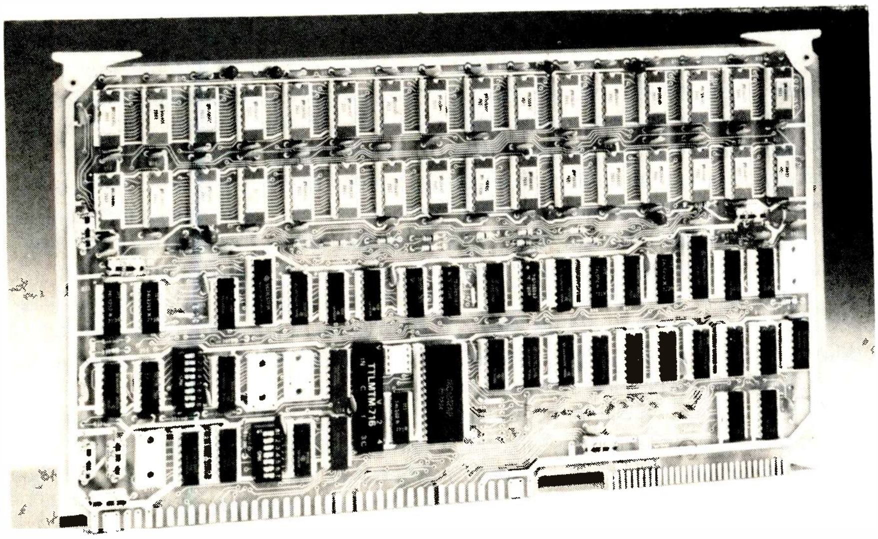

Fig. 3 Troubleshooting anyone? Electronic circuits like this 48K multibus RAM board from Electronic Solutions, Inc., are sure to become more and more popular with time. Digital theory, manufacturer's instructions, and a logical approach to troubleshooting are what you'll need to handle them.

This is not meant to deprecate specialized instruments such as logic analyzers. They are excellent instruments and certainly should be used whenever the cost can be justified.

Fortunately, specialized equipment usually isn't required to isolate a faulty component. The triggered-sweep oscilloscope in the hands of a skilled technician is often all that is required.

In addition to the oscilloscope, the troubleshooter also needs as much information as he can get on the system. Usually, the more information that is available, the better. Some systems not only have very complete manuals, but even have built in programs that will enable the system to troubleshoot itself. At the other extreme, we find systems that were built by companies no longer in business and we are lucky to have as much as a block diagram of the system.

Where do I start?

Troubleshooting an unfamiliar system is always confusing. Just where to start looking for trouble is often a major question.

One thing that must be borne in mind is that all electronic systems, regardless of their complexity, are subject to many of the same faults. Such simple things as poorly soldered connections, bridges on printed circuit boards, and faulty connectors are frequently the cause of trouble in even the most complex systems. In fact, faulty printed circuit board connectors are probably the most common cause of trouble in microprocessor systems.

It is always a good idea to start the troubleshooting procedure by looking for these simple, easy to understand faults. Once we are satisfied that none of the common simple faults is present we must resort to more specialized troubleshooting techniques. The way that we tackle the problem depends to some extent on the amount of information we have on the system. If the manufacturer has provided troubleshooting procedures it is a good idea to follow them.

The troubles encountered in microprocessor systems fall roughly into three categories. First there is the system that doesn't work at all. There is no output and nothing happens when the system is turned on. Then there is the system that shows some signs of activity, but doesn't operate properly. Usually in such cases the system will behave consistently. Finally, we have the situation where the system operates properly some of the time, but occasionally fails. This is the most difficult fault to locate. It is similar to tracking down an intermittent component in a TV set.

Once we have eliminated faults in the wiring and connectors, we can assume that the trouble is caused by one or more faulty ICs in the system. The problem is to find out which one is defective.

Sometimes a great deal of time can be saved by merely feeling each of the ICs, looking for a hot spot. Most of the large ICs will run warm, but none of them should be hot to the touch. If a hot IC is found, it is usually the culprit.

Checking the micro

Inasmuch as the microprocessor is the heart of the system, it is probably a good place to start troubleshooting. Fig. 2 shows the basing diagram of a typical microprocessor, the Type 6800. By checking the signals and logic states at each of its pins, we can usually narrow down the trouble.

We know that a microprocessor must have a clock signal in order to operate. If the system isn't working at all, it is a good idea to check, after power supply checks, of course, to be sure that both phases of the clock signal are present. Fig. 2 tells us that we should find a clock signal at pins 3 and 37. This signal will usually be in the order of 500 KHz to 2 MHz. The manufacturer's information will tell the exact frequency. We can check for the presence of this signal at pins 3 and 37 with an oscilloscope. Note that it isn't necessary to properly synchronize the oscilloscope to merely check for the presence of the signal. If the scope isn't synchronized, the display won't hold still, but we can definitely tell that a signal is present. At this point we are only interested in whether or not the signal is present. We will get to the details later.

If one or both of the clock phases is missing the trouble is either in the microprocessor or in the circuitry that generates the signal. Usually if one phase is missing, the fault is in the microprocessor, so replace it. In either case, we have narrowed the fault down to a small part of the circuit where we can isolate it quickly.

If the clock signal is present and the

system isn't working at all, we should start looking at some of the other pins. A good place to check next is with the HALT pin, pin 2. The line over the word halt tells us that the microprocessor will be kept from operating when this pin is in a low state. If the line were not present, the operation would be halted when the pin is in the high state. In this case we are looking for the pin to stay in the low state all of the time. This would keep the system from operating and would be caused by something connected to the pin. Again we have narrowed the fault down to a few components.

A very similar approach can be taken to the READ/WRITE pin, pin 34. This pin will change state during changes in mode between read and write. If it stays in the same state all the time, the fault is either in the microprocessor or in something else that is connected to this pin.

The next place to check with the scope is the address pins, pins 9 through 20, and 22 through 25. These pins carry the addresses to which the microprocessor is sending data or from which it is receiving data. They normally change state during operation. Pin 9 which carries the least significant bit of the address will change state most frequently, so it is a good idea to start here. Similar checks should be made of the DATA pins, pins 26 through 33. If there are signals on all of the pins, and the system isn't working at all, we can usually be sure that the microprocessor itself is O.K. and that the fault is somewhere else. The logical place to start checking is the output device.

By using these procedures we can usually get a good lead on the faulty component when the system isn't working at all. Now let's move on to the situation where the system is working, but isn't working correctly. Now we have to be a little more careful in making tests. There are two types of faults that we will look for. One involves the timing of the system. This means that one or more of the pulses in the system either has the wrong shape or occurs at the wrong time. We can check these pulses with a dual trace, triggered-sweep oscilloscope.

The other type of fault can be thought of as one of the pins of one of the ICs in the system being struck in either the high or the low state.

The manufacturer's literature shows the timing of the various pulses in the system. These pulses can be checked with an oscilloscope. If a dual trace scope is available, both phases of the clock signal can be displayed at the same time. Sometimes a dual trace scope isn't available, so the job must be done with a single trace scope. Probably the best way to display the waveforms is to use external triggering so that the scope is triggered by phase 2. Phase 2 is then displayed using negative slope triggering. The trigger level should be adjusted so that the trace starts just as the signal starts to go negative. Then all of the critical parts of the waveform can be checked against the manufacturer's specifications.

Phase 1 is checked by connecting the input of the scope to phase 1, while leaving the external triggering on phase 2. Improper clock signals are often the cause of incorrect operation. If the clock signals are not correct, the fault can be either in the microprocessor or in the clock-generating circuitry. Often clock signals become marginal when additional peripheral devices are connected to the system without buffer amplifiers.

Usually waveforms are published for memories and input/output devices and these can be checked in a similar way.

The other type of fault that we will look for is a stuck pin. The best place to check for this type of fault is on the address and data lines. If the system has an input terminal where we can enter data and addresses, the task is much easier. We can simply place known data, such as all 1's and all 0's on the address and data lines and check for them with the oscilloscope. If the system doesn't have such a provision, we can use the oscilloscope to see that each of the address and data pins changes state at least occasionally when the system is in operation. Usually, we will find that one of the address or data pins stays in one state. This narrows the trouble down to one line, which is a great help. Often the faulty IC can be found by unplugging the various ICs one at a time until the pin changes state.

Using the system

It is often possible to use a system itself to help to locate faults. Many systems have diagnostic programs built into them. For example, a system may have one program that will load all 1's or all zeros into the RAM. Another program will permit looking at all of the memory locations to verify that they were properly loaded. Similarly, the manufacturer may publish a list of all the data stored in Read Only Memory and the system may have a program that will permit looking at each of these locations to be sure that the memory contents haven't changed.

Even without diagnostic procedures, there are other techniques that can be used to check the system. Suppose, for example that a microcomputer is programmed to display the letter "R" when it is reset and ready. A faulty system displays the letter "S". Checking the ASCII code we find that R is represented by 1010010 and S is 1010011. We might suspect that whatever is connected to the data bus at this time has the pin carrying the least significant bit stuck in the high state. The next thing to do is to get into the circuit with an oscilloscope and verify this condition.

This is a simplified version of using the faulty output of a system to isolate a fault. It may be necessary to trace data through many parts of the system to find what causes the faulty display, but if the fault is consistent, it can usually be located with a little thought and effort.

Intermittents

As with any other type of electronic equipment, the intermittent fault is usually the most difficult to locate. Probably the place to start is with the soldered connections and the PC board sockets. A faulty connection has the habit of failing occasionally. In a device such as a microprocessor system, faulty connections can cause annoying problems that are not encountered in other systems. If the faulty connection is in series with a line where pulses are counted, each break of the circuit caused by the poor connection will be counted as a separate pulse. This can introduce all sorts of errors into the system.

The next thing to look for is a thermally related fault—a component that fails when it is too hot or too cold. Often an intermittent fault can be located by carefully directing a blast of hot air from a hair dryer on the various components one at a time. Similarly, the coolant sprays that are used in TV troubleshooting can also be used to make a marginal component fail, or begin to operate properly.

If these approaches fail to disclose anything, the fault may be caused by interference. The interference may come from the outside world, or the system may actually interfere with itself. Unfortunately, many systems using microprocessors are not adequately shielded. In such systems outside interference often causes problems. The SCR type of light dimmer has been known to cause serious problems.

Locating interference is indeed a time

continued on page 47

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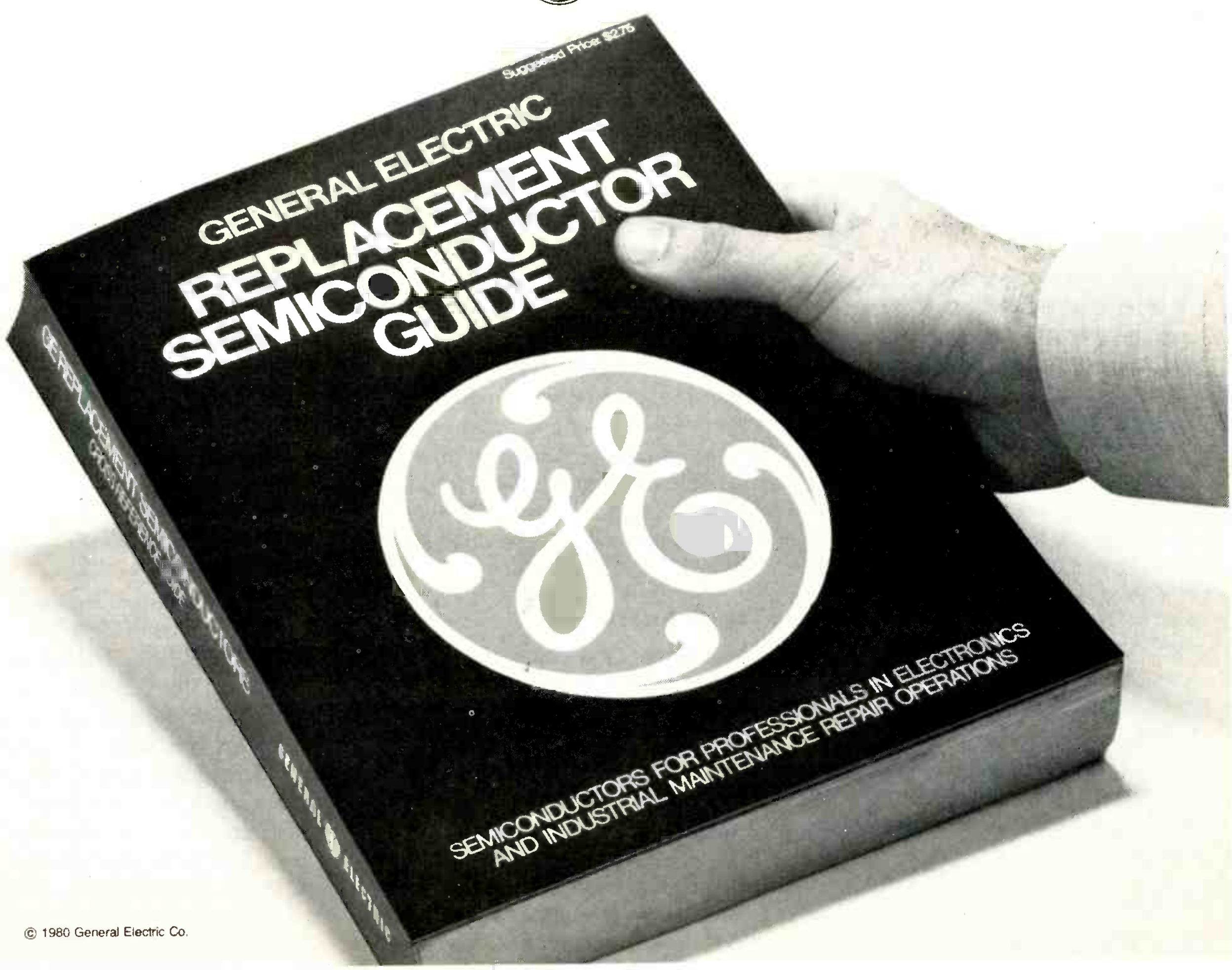


AM Stereo

It's on its way

On April 9th, the FCC after several years of deliberation selected the AM-stereo system proposed by Magnavox. It will be some time before you see the first AM-stereo receiver, but now's the time to begin to learn how the system will function.

By Walter H. Schwartz

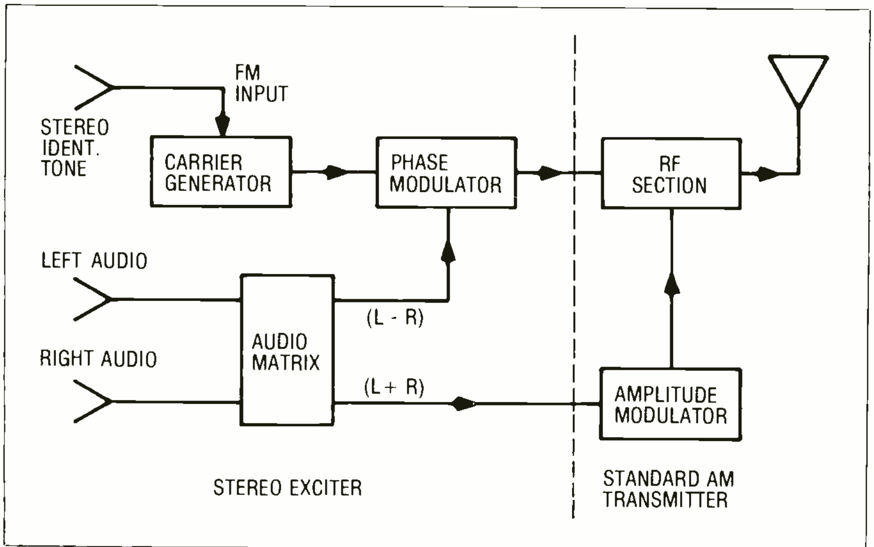


Fig. 1 Block diagram of an AM-Stereo transmitter.

First let us review a few specifications of AM broadcasting. Although channel spacing is 10kHz—9kHz is proposed—the audio frequency response is not limited to 5kHz. The frequency response *required* of AM stations is ± 2dB from 100 to 5000Hz, it must be measured to 7500Hz and stations are allowed to transmit frequencies to 15kHz. The potential fidelity of AM broadcasts is therefore quite good, at least when receiving local stations; because of the channel spacing, receiver bandwidth must be restricted when receiving stations with adjacent channel neighbors of sufficient strength to cause interference. The potential of stereo and these factors may soon result in the production of quality AM receivers for the first time in many years.

Magnavox's AM-Stereo

The AM-stereo system proposed by Magnavox uses both amplitude modulation and phase modulation. Left and right program material is matrixed into a left plus right signal which amplitude modulates the carrier and is compatable with mono receivers and a left minus right signal which phase modulates the carrier. A low frequency, 5Hz tone frequency modulates the carrier to serve as a stereo identification tone.

The transmitter

To implement the stereo system the transmitter's oscillator stage would be disabled and the transmitter would be driven by a special exciter.

The carrier in the stereo exciter is first modulated by a 5Hz tone to a deviation of about ± 20Hz (approximately 4 radians), to generate the stereo identification signal. This signal is then further phase modulated with the left minus right audio to a peak deviation of one radian. The exciter output is then fed to the broadcast transmitter to replace the disabled oscillator and amplified to full carrier level. The carrier is then amplitude modulated by the left plus right audio by the existing modulation equipment. A delay network in one or the other audio lines (L+R or L−R) may be necessary to compensate for unequal audio delays in the two, L+R and L−R, audio signals. (See Figure 1.)

Magnavox assembled an exciter (Fig. 2) which was used for test purposes at WFWR (1090KHz, Ft. Wayne, Ind.). Assembled from GR1061 frequency synthesizers and other available equipment, plus some special items, it is considerably more elaborate than necessary. It contains audio altenuators, a matrix network similar to those used in FM-stereo, audio metering, and delay networks that can be switched in and out of either the L−R or L+R audio lines to compensate for transmitter circuit delay. Left plus right audio output is available to drive the existing amplitude modulation system of the transmitter.

A 3.69MHz crystal oscillator is frequency modulated by the 5Hz identification tone. The GR1061 synthesizers have phase modulation capability. One of them is phase modulated by the left minus right audio and also is used to heterodyne the 3.69MHz oscillator output into the broadcast band. The other GR1061 heterodynes a separate 3.69MHz output also into the broadcast band for test and monitor purposes; it is not necessary for broadcasting. The signal after passing through a lowpass filter is then available to drive the broadcast transmitter.

The receiver

A receiver for AM-stereo is quite simple in concept (Figure 3). The amplitude modulation can be treated conventionally to produce the left plus right mono audio. A phase detector is necessary to demodulate the left minus right audio. A matrix combines the two for left and right outputs.

Magnavox built a test receiver, that is approximately equivalent in sophistication to a medium priced FM-stereo receiver, for their system field tests (Figure 4).

The receiver uses a ferrite rod antenna, a FET RF stage and apparently uses bipolar transistors for the balance of its stages. The IF section (455kHz) offers normal and fidelity (6kHz and 12kHz) bandwidths by means of switchable filters. It uses a dual AGC system and both signal level and center tune meters. A full wave envelope detector recovers the mono (L + R) signal.

A phase modulation channel (taking off the signal just ahead of the AM detector) first strips off the amplitude modulation with an IC limiter and then uses a phase locked loop to recover the phase modulation (L −R audio and stereo identification tone). The L −R audio is derived from the error output of the phase detector and the stereo identification tone is obtained from the signal drive to the VCO.

The two L −R and L +R signals are equalized in level and fed to a matrix network to develop the left and right audio signals. The L +R is delayed before matrixing by 16 microseconds to compensate for delays in the L −R circuitry. The L −R signal is muted by a squelch circuit in the mono mode (and while tuning, to avoid odd noises and confusion). ETI/D

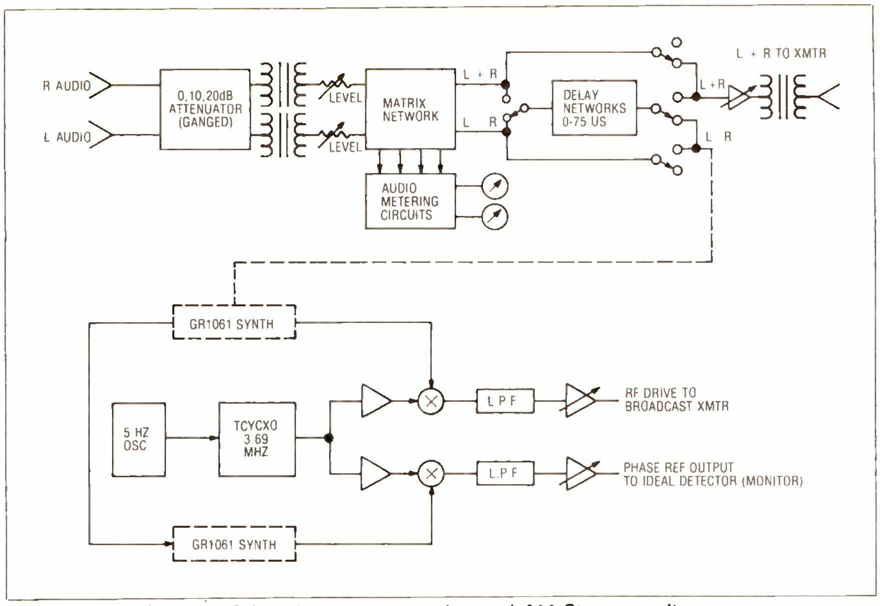


Fig. 2 Block diagram of the Magnavox experimental AM-Stereo exciter.

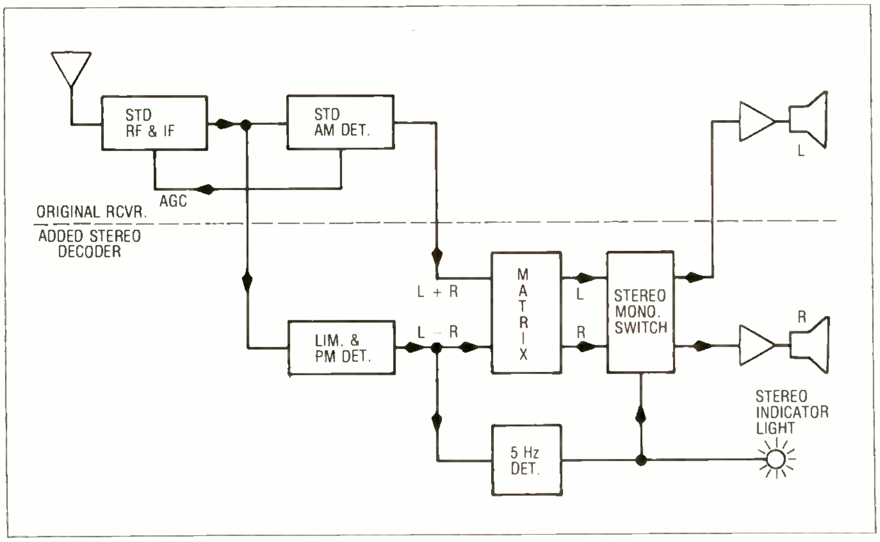


Fig. 3 Block diagram of an AM-Stereo receiver.

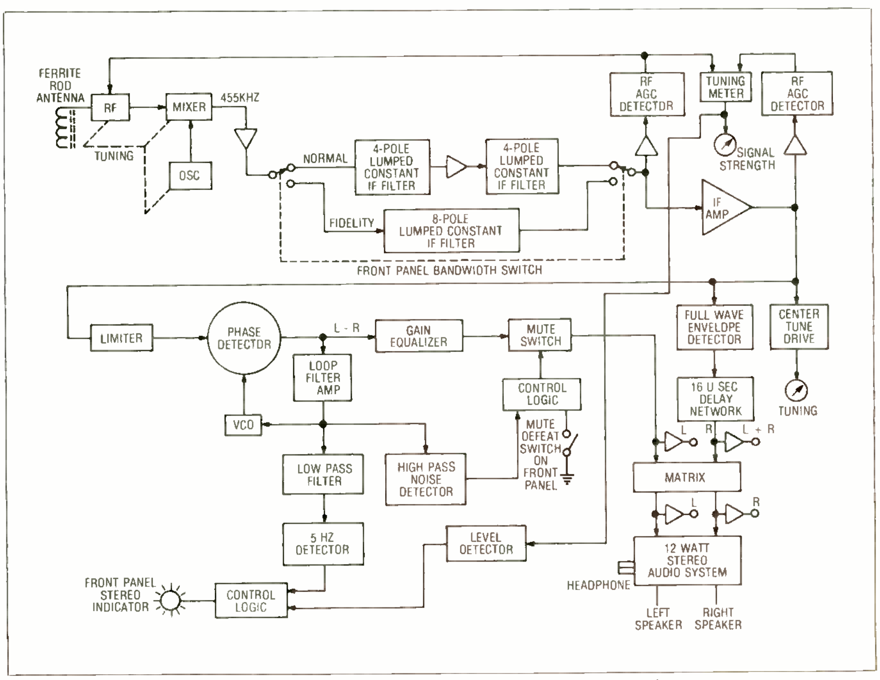


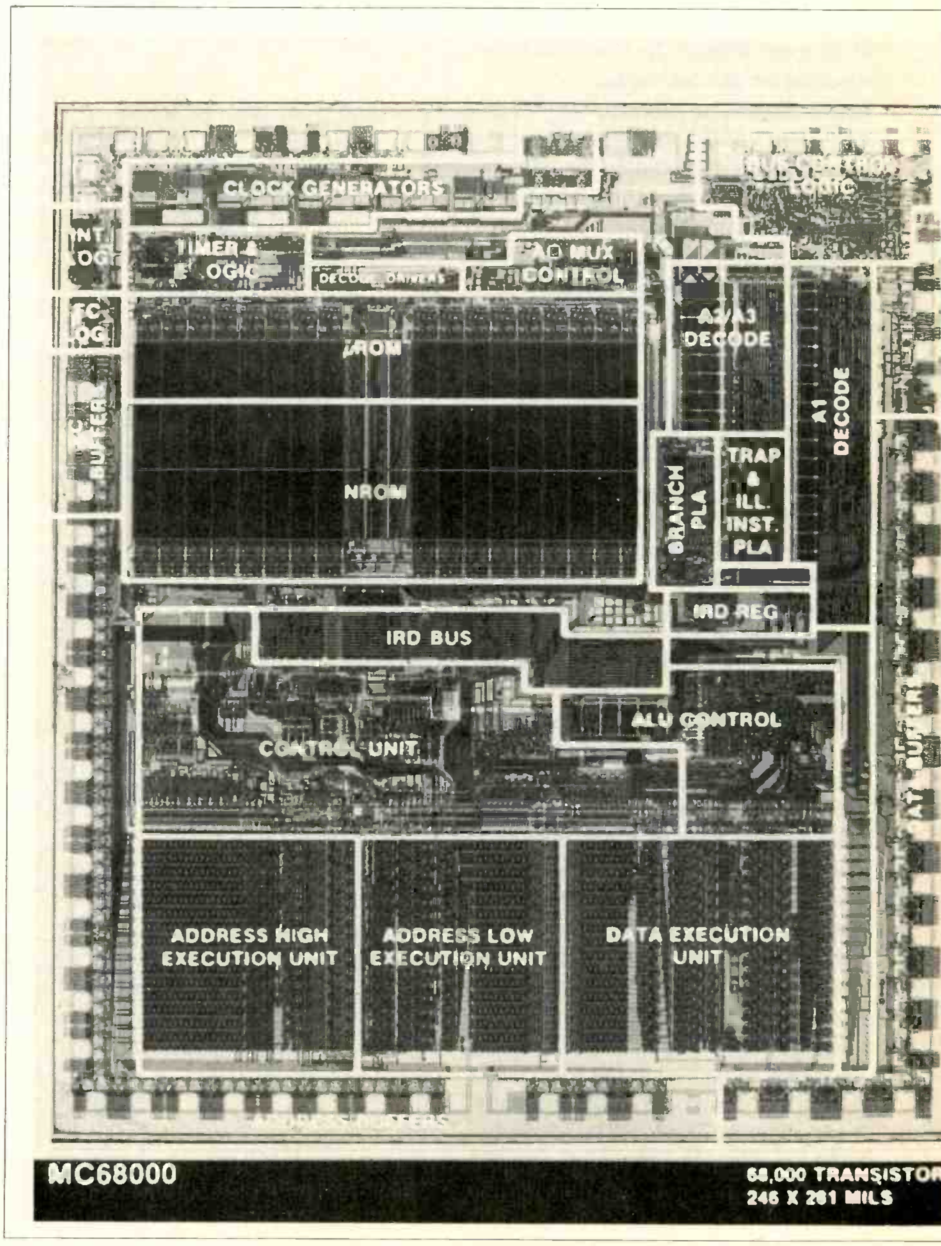
Fig. 4 Block diagram of Magnavox's experimental AM-Stereo receiver.

Microprocessors part VIII

Microinstructions ... building blocks for programs

In the eighth and concluding part of his series on the theory and operation of microprocessors, the author examines the function of microinstructions and the role they play in making the system work.

By Bernard B. Daien



The new Motorola MC68000 is a 16 bit, high-level-language oriented microprocessor. The various functions areas are mapped out on this photo of the approximately one-fourth inch square device.

The seven preceding articles in this series discussed the various major parts of the microprocessor, and their use. but the MPU is really a series of coordinated *actions,* under control of the Control Unit's microinstructions. This eighth article discusses the microinstructions which enable the MPU to perform the macroinstructions in the computer program, so that the MPU *system* can be better visualized ... because ... the MPU is really a *complex system!*

Upon completion of this article, the reader should be able to understand the MPU literature available from the various manufacturers, and distributors, and pursue a course of further self study.

Since this is the last article in the series, we will first consider some items which did not fit into the earlier articles, either because of context, or space. After these, we will go on to the main theme of Part VIII.

Buffers

The word "buffer" is often encountered in MPU literature. As generally defined, a buffer is an amplifier which isolates one circuit from the loading of another circuit ... but, if you recall that many of the MPU circuits are "tri-state" and have an "enable" input, you will realize that tri-state buffers can also pass along, or stop, the flow of information through them. Since the "enable" input is under the influence of the "Control Section" of the CPU, such buffers implement the control section commands. This fact will be very important in the material presented later in this article.

"Slice" MPUs

The MPU we have been talking about all along, provides the programmer with accessibility to the CPU, but *not directly into the control unit,* because the microprogramming (instruction set) is fixed by the designer, and held in ROM. There is another type of MPU, called a "Slice" MPU, which *is* micro-microprogrammable, by programmers who understand, and can do, this very precise task. Slice MPUs are beyond the scope of this article, but you should be aware that they exist, and are very useful for certain tasks which the usual MPU is not well suited to. (Sometimes the name "Bit Slice MPU" is given to the slice MPU family.)

The condition code register

The condition code register (CCR), also called status or flag register, is another register which has several names ... including "status register," and, most aptly, "flag register." As the latter name implies, this register is a group of "flags." In computer terminology, a flag is a flip-flop that indicates the result of a particular operation. A few examples: One of the flags in the CCR is the "zero" flag (Z). This flag is said to be "set" (the "one" binary state), if the result of an operation is zero (00000000). Since the accumulator holds the results of data operations, the zero flag tells us that the accumulator is empty. If the results of the operation are not all zeros, the accumulator holds a number other than zero, in which case the zero flag would be "reset" (cleared), and be in a zero binary state.

You may be wondering what the difference is between a flag, and a latch. Once more, the difference is in the use. If a flip-flop is used to hold a bit of data, it is called a latch. If the same circuit is used to hold a bit which indicates the *status,* or condition, of a circuit, it is called a "flag." (All through this series we have been reiterating that there is a lack of standardization in MPU literature, and that the same circuit may have different names, depending upon use. Further, different literature will define the same thing differently, depending upon the users schooling. Unfortunately, each user seems to sincerely believe that his usage is the only correct one, and that any other variation is an error!)

Another "flag" is the "negative" flag, (N), which indicates, when set, that the results of an operation are a negative, or "minus" (−) number, held in the accumulator. If the number in the accumulator is a positive number, the N flag is reset.

The CCR may have up to 8 flags, constantly monitoring the status of the MPU. This is necessary, because often an operation to be performed is dependent upon the results of previous operations, which the MPU can instantly ascertain from the contents of the CCR. Most text books do not dignify the CCR with the name "register," referring instead to "the zero flag," or, "the negative flag" etc.

Instruction cycles

"Instruction cycles" are executed in two main steps, termed "fetching," and, "executing." *Each of these steps in turn consist of one or more "machine cycles."*

Fetching is defined as reading the desired instruction out of the memory, and transferring it into the instruction register, (which was defined earlier in the series). Remember, we can have a one, two, or even a three byte instruction. On many MPUs, one machine cycle is required for each byte.

The execution step varies considerably in the number of machine cycles required, depending upon the particular instruction fetched. (Some instructions require many machine cycles for writing into memory, reading out of memory, dealing with I/O devices, etc.)

The total number of machine cycles in an instruction cycle is the sum of the required fetch and execution cycles. These can be broken down into even smaller steps. Remember the "clock" discussed previously? Microprocessors use a *multi-phase clock.* The period of a phase is called a "state." *A machine cycle usually consists of 3 to 5 states.* (And that is about as close as we can get to giving you a "feel" for the machine cycle within the limitations of this series.) It was not necessary to cover this particular point earlier in this series, and since it would have been confusing at that time, it was deferred until now.

Now let's examine what happens when you program the MPU. I am going to make a rather surprising statement: "If you think about it, the Control Unit, (which we are about to discuss), is basically *a program held in ROM* (a microprogram)!" A microprogram is made up of a series of microinstructions which are performed in sequence. Every "instruction code" in the programmers macroprogramming, causes the execution of a microprogram stored in the control ROM. The microprograms held in the ROM cannot be altered, but a practical program as written by a programmer, almost always includes some data, and, since data is variable, the macroprograms have to utilize some form of memory that can be altered ... the RAM. A computer program therefore incorporates the microinstructions in the control ROM within the control unit, *plus* additional information held in the RAM.

The control unit

The control unit synchronizes the actions of the various parts of the MPU by sending control signals to them. Remember the tri-state devices? The control unit provides the control signals that turns them on and off ... (and the same thing happens with the other circuits with "strobe" or "enable" inputs). In turn, the control unit operates under direction of the macroinstructions loaded into the external RAM (during programming), which results in the use of the series of macroinstructions held in the control ROM inside the CPU.

This is done as follows: The macroprogram, which has been entered into the external RAM in a series of *program instructions,* is read out of the RAM, during the "fetch cycle," one location at a time. Since the control unit *deals with instructions (op codes), the op code* called for by the macroprogram is fetched from its memory address, which is held in the program counter. The program counter then increments to the location of the next instruction.

Remember, the programmer entered his *program instruction* in two parts, the op-code (instruction), and the operand (data). When the program is run, it is run in the sequence in which the programmer numbered it. As each program instruction is run, in turn, the op-code byte, (which we have been talking about), is fetched for the use of the control unit. The op-code is transferred to, and held in, the instruction register. During this fetch cycle the various status flags in the CCR are examined. The contents of the CCR (condition code register, flag register, status register) provides information which enables the control unit to decide when, or if, some actions can take place. For example: Information cannot be transferred into a register which has been filled with previous information. The CCR tells the control unit when the register is clear.

Decoding

The macroinstruction which has been fetched from the RAM is then decoded into a series of microinstructions required to execute the macroinstruction. Once this has been accomplished, the second macroinstruction is automatically fetched (due to another microinstruction), and the process is repeated.

We just used the word "decoded." Decoding is accomplished by the use of a "decoder" ... a circuit that converts binary into some other system of numbers. The "instruction decoder" is a binary coded decimal (BCD), to decimal, decoder. Each op-code which has been fetched from RAM, is inputted to the instruction decoder, resulting in an output on one of the decoders output lines (instruction lines). (Note: The series of microinstructions required to complete a macroinstruction is sometimes referred to as a "microroutine.") *Stated another way, the instruction decoder recognizes the MPUs basic "instruction set," and generates the internal commands required to execute them.*

Each individual step, such as moving data from the data bus to the accumulator, is the result of a microinstruction from the control unit. By generating the proper sequence of control signals, which control the various circuits of the MPU, the control unit is able to cause the sequence of microinstructions which are, in total a macroinstruction.

The end

You have been introduced to the MPU ... from the "buzz words" of the business, through the MPU's internal architecture, to the workings of the MPU as a system. We started with the assumption that the reader understood the basics of electronics, a little bit about binary, and nothing at all about computers. Since the MPU becomes a computer once it has been expanded into a working system with RAM, interfaces, etc., there is no good reason why you cannot advance into larger computers via self study, and I would recommend that you do so by reading a few pages a day on a continuing basis, now that you have begun.

This has been an electronics era for many years, but now it has become a *digital electronics* era, with great rewards for those who resolve to continue on into digital. You have taken the first steps ... Good Luck on your journey ahead! ET/D

VCR video circuits

Here's how they work

Imprinting the broadcast video signal on recording tape is a task seemingly devised by Satan himself. For a look at the intricacies of both Beta and VHS luminance and chroma operation the author has painstakingly analyzed each of the separate steps associated with the record and playback modes.

By Martin Middlewood*

All VCRs record three types of signals: audio, control, and video. All three signals are either present in the broadcast signal or are derived from it, as is the case with the control signals. Each signal needs special circuitry to process it. The audio record and playback circuitry processes the audio signals. The servo system processes the control signals while the video circuitry processes the two video signal components, luminance and chroma.

Remember the picture on the television screen contains 262½ horizontal lines in each of the two fields. Each line is made up of hundreds of tiny dots just like a newspaper picture. These dots contain the chroma and luminance information determining their color and brightness. Because of the limitations imposed by a magnetic recording medium, the two component signals are processed individually.

After signal processing, the video record heads apply the luminance and chroma signals to the video tape. Circuitry in the chroma block lowers the frequency of the incoming chroma signal to keep it in a range best suited for video tape recording. Because the chroma signal is now low (below 1 MHz), it uses the luminance signal as a bias signal during recording. Previous to this a frequency modulator in the luminance block modulated the luminance signal. When the two signals are recorded on the video tape they form a frequency modulated square wave.

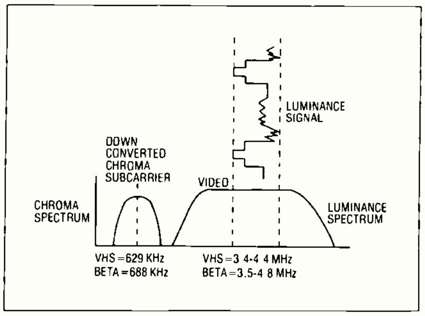


Fig 1 The information recorded on a video tape includes a "down converted" chroma subcarriers and a luminance signal. Down conversion of the chroma is necessary to record it on video tape because of the tape's response characteristics.

Both the VHS and Beta VCRs have basically the same luminance circuits (Figure 2). The luminance record section contains five basic blocks: a low pass filter, an automatic gain control (AGC), a white and dark clipper, a frequency modulator, and a record amplifier. In addition, it contains electronic switches that control whether the picture is in black and white or in color.

The function of the luminance record section is to receive the broadcast television signal (or the camera or VCR input) and process out the audio and chroma components. It also controls the level of the luminance signal, modulates the signal, and provides a bias signal for recording the "down converted" chroma signal.

The low pass filter rejects the high frequency portion of the broadcast signal containing the 3.58 MHz chroma subcarrier and the 4.5 MHz audio carrier. The automatic gain control maintains a constant level output regardless of the change in luminance amplitude. White and dark clippers remove the overshoots and undershoots (positive and negative pulses) to prevent picture distortion. The FM modulator is a stable multivibrator which deviates the frequency in direct proportion to the level of the luminance signal. Any variance here produces varying levels of picture brightness. Finally the record amplifier applies the FM modulated luminance to the video record heads.

Luminance record

The VCR applies the video signal to the video processing section. Here the luminance and chroma paths split. The luminance signal passes into an AGC amplifier, which maintains a constant output in spite of any increases in the input signal strength. The AGC sometimes contains a non-linear network that boosts the high frequency portion of the signal. This boost is needed because the narrow track width in the LP mode (a track-width decrease of over 20% in both formats) requires a higher pre-amplifier response to get a better signal-to-noise ratio. This response should change according to the input levels. Lower level signals

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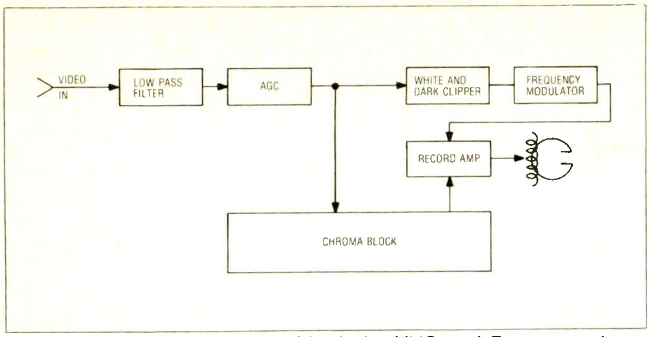


Fig 2 The luminance blocks of both the VHS and Beta recorders are about the same and consist basically of those shown above. The luminance signal recorded on tape is an FM square wave.

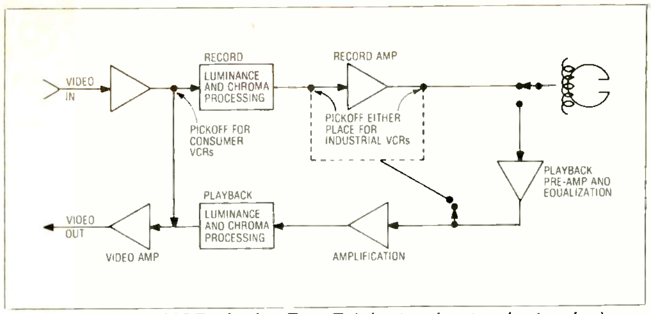


Fig 3 Unique to VCRs is the E-to-E (electronics to electronics) circuit. This circuit allows operational checks of the video input and output in consumer VCRs and most of the record and playback circuitry in industrial units.

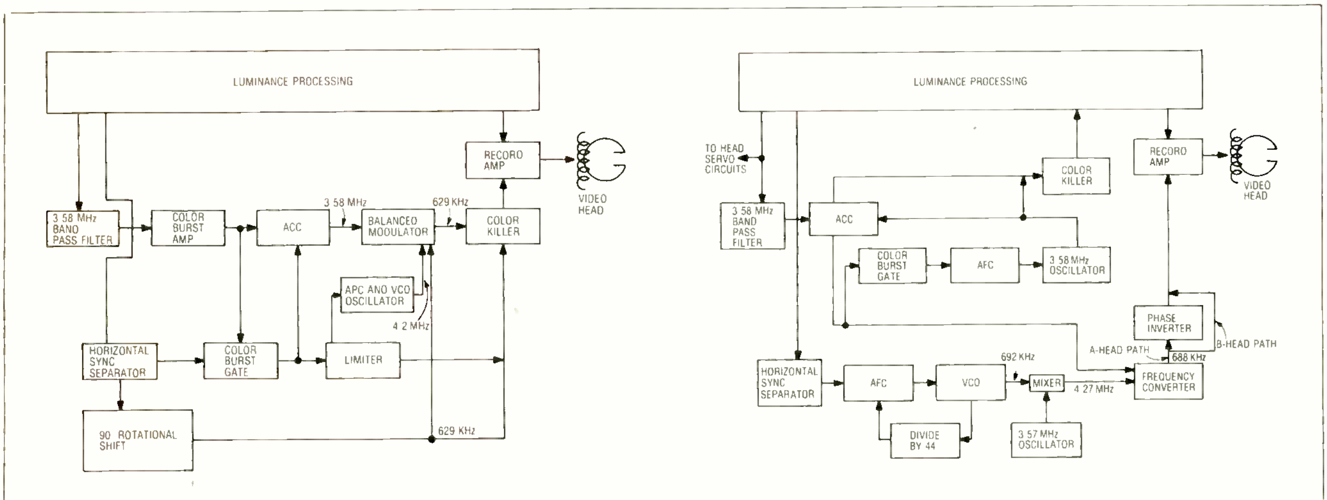


Fig 4 The simplified block diagrams shown above give a basic concept of the similarities and differences between the VHS (4A) and Beta (4B) chroma record operation.

(narrower track widths equal lower signal levels) receive more emphasis than higher level ones in the AGC. This block automatically provides the needed changes in response.

The output of the AGC then passes through electronic switches that determine SP/LP and black and white/color operation. The signal emerging from this block contains overshoots and undershoots that the dark and white clipping network clips to pre-determined levels. By setting the levels of the over-and-undershoots, this network improves the signal-to-noise performance and picture definition.

The frequency modulator, an astable multivibrator, receives the clipped spikes and oscillates at the required rate (3.4 MHz for VHS and 3.6 MHz for Beta) whenever an input corresponding to the sync tip level is present. The variation from the unmodulated frequency is directly proportional to the luminance signal level and the rate of variation is governed by the rate of variation within the luminance signal. Large variations improve the signal to noise ratio so the deviations in the modulator aren't severely limited. But because the video tape must record the signal a certain degree of limitation is necessary.

Leaving the FM modulator, the signal can approach 4.4 MHz (VHS) or 4.8 MHz (Beta) and is a square wave. The output of the FM modulator combines with the chroma signal before both are amplified to the level required to drive the record heads. Out of the record amplifier, the FM luminance signal is mixed with the chroma signal so that it acts as a bias recording signal.

Chroma record

In record, the functions of the chroma block are to process the chroma signal, to "down-convert" it, to control its signal level, to process the signal so that cross-talk can be eliminated during playback, and to apply the signal to the record amplifier.

For the most part, both the VHS and Beta recorders separate the chroma record and playback electronics from the luminance record and playback electronics. But, while the luminance section is basically the same in both formats, the chroma section is quite different. Each VCR accomplishes the same thing, but in different ways. Each, for example, has its own means of handling chroma crosstalk. This means that while the two systems share some of the same general blocks, there are several that aren't the same. Even those that are the same have dissimilar signals paths between them.

Chroma common to both

In the chroma sections of both formats, you'll find a 3.58 MHz band pass filter, an automatic chroma control (ACC), a color burst gate, a color killer, a "down conversion" network, a horizontal sync separator, and a crosstalk control network. Except for the crosstalk control network, these components operate similarly. (Refer to Figures 4A and 4B.)

The 3.58 band pass filter passes the chroma subcarrier and its sidebands. One of the reasons that the consumer VCR's aren't suited for broadcasting, according to the Federal Communications Commion (FCC), is that this bandpass filter limits the chroma signal to 500 KHz above and below the subcarrier frequency. This is less than the FCC standard for the full NTSC (National Television Systeme Committee) signal. In most cases, however, this difference doesn't materially affect the quality of the various hues due to limitations of the human eye.

The ACC is similar to the ACC you'll find in a television receiver. It maintains an overall constant color signal level. The incoming color burst signal switches the VCR to color operation and controls the gain of the ACC. The ACC has two outputs. The first controls the color killer. A second output aids in down converting the 3.58 MHz chroma subcarrier to below 1 MHz.

The color killer eliminates color signals during monochromatic operation. It switches a 3.58 MHz trap into the luminance channel during color recording so that only one color signal appears at the output during playback and switches it out during monochromatic operation, which improves the black and white resolution.

The color burst gate is a network for extracting and delaying the horizontal sync pulse in order to position it over the blanking area occupied by the chroma burst.

The horizontal sync separator simply strips away the horizontal sync pulse from the rest of the chroma signal. This allows it to be used to maintain the chroma phase relationships during down conversion so that the down converted chroma subcarrier has the same relationships as did the 3.58 MHz subcarrier. It is also the reference signal during playback allowing the up-converted carrier to have the same relationships as the original subcarrier.

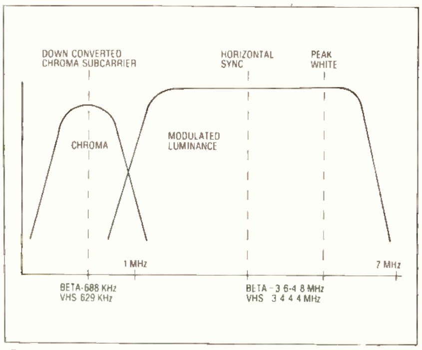


Fig 5 Hetrodyning, the process by which two frequencies are beat against one another to produce their sum or difference, lowers the chroma sub carrier so that it occupies the 1MHz region below the luminance signal. The luminance signal then acts as a bias signal when the "down converted" chroma is recorded.

Chroma differences

During recording, both formats begin processing the chroma signal to avoid crosstalk. The Beta system does so by inverting the phase of the subcarrier for every horizontal line that the A-head records. A center tapped transformer with its center tap grounded produces the inversion. An electronic switch picks the signal from one side and then the other side of the transformer secondary.

The VHS system uses a 90° phase rotation method to remove chroma crosstalk. This system changes the phase of the chroma for each horizontal line. During one field, it delays the phase by 90° at the line rate and during the next it advances it by 90° at the same rate. Heterodyning, the process by which two frequencies are "beat" together to produce the sum and difference of the original frequencies, accomplishes down conversion in both formats. Down conversion produces a new subcarrier of 688 KHz for the Beta format and 629 KHz for the VHS.

Beta chroma record

The video signal comes out of the luminance section. The 3.58 MHz band pass filter eliminates the luminance components of the video signal. The 3.58 MHz color subcarrier goes into the ACC, which keeps the color level constant. It also detects the color burst portion of the chroma signal. Whenever the ACC output drops below 1 db, it activates the color killer which eliminates color during monochromatic operation. A second output from the ACC goes to the frequency converter.

The frequency converter beats the 3.58 MHz subcarrier against a 4.27 MHz signal producing the sum (about 7.9 MHz) and difference (688 KHz) of the two signals. A low pass filter blocks the 7.9 MHz signal and passes on the 688 KHz, the down-converted subcarrier.

This output of the ACC also goes on to the color burst gate, whose output goes to the automatic frequency control (AFC). The AFC output and the 3.58 MHz oscillator "lock" to the color subcarrier to provide color stability and to activate the electronic switch in the luminance circuit that determines monochromatic operation.

The video signal comes into the horizontal sync separator where it's stripped of all but the sync pulse. After being delayed, the horizontal sync pulse maintains the chroma phase relationships during down conversion.

In the mixing stage, the 692 KHz output from the VCO and the output of 3.57 MHz (correct) oscillator combine to create the 4.27 MHz signal that's beat against the chroma subcarrier in the frequency converter to create the down converter subcarrier. The phase inversion block inverts every horizontal line recorded by the A-head. The information recorded by the B-head remains unchanged because it by passes this circuit.

VHS chroma record

The 3.58 MHz band pass filter eliminates the luminance portions of the chroma signal and passes the 3.58 MHz subcarrier to the color burst amplifier, which amplifies the color burst signal and the chroma signal. Once the signal leaves the color burst amplifier, it enters the ACC which removes any variations in the chroma signal. The chroma subcarrier goes to the balanced

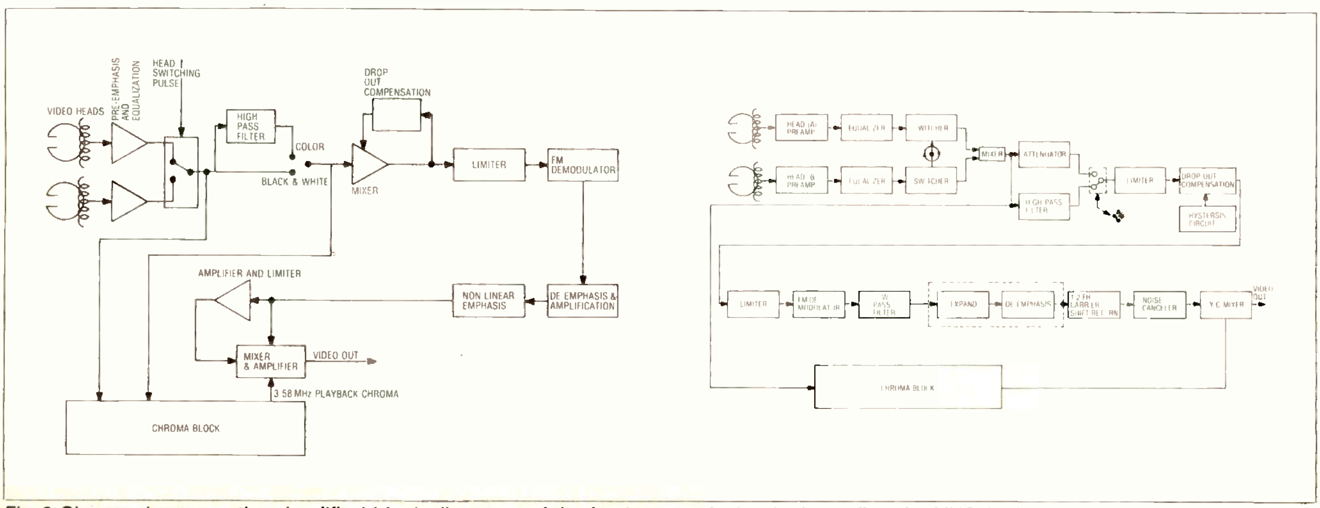


Fig 6 Shown above are the simplified block diagrams of the luminance playback signal flow for VHS (6A) and the Beta format (6B).

modulator.

The chroma leaving the luminance section is the input to the horizontal sync separator, which eliminates all of the chroma signal except the horizontal sync pulses. The horizontal sync pulse then goes on to the color burst gate, which extracts the color burst signal from the output chroma signal of the color burst amplifier, locks it to the horizontal sync, and routes it to the ACC. The other output of the color burst amplifier goes to the color killer and the balanced modulator.

In the balanced modulator the 4.2 MHz signal from the automatic phase control and a VCO beat against the 3.58 MHz signal of the ACC. This produces the 629 KHz downconverted chroma subcarrier, which is the difference between the two frequencies (4.2 MHz-3.58 MHz = 629 KHz). It is then applied to the record head through the color killer. The color killer operates like that of the Beta format. When its input falls below a certain level it activates.

The horizontal sync pulse is input to the 90° rotational shift block. When the A-head records a field, the chroma of each horizontal line is advanced by 90°; when the B-head records a field, each line is delayed by 90°. VHS calls this the "chroma rotary-phase" method of recording.

The 90° phase rotational network consists of a 2.517 MHz VCO, a divide by 44 (÷ 44) network, and a 90° phase shifting circuit. When the 629 KHz output leaves the phase shift block, it's locked to horizontal sync. Then it goes to the video heads via the color killer and record amplifier.

Playback

Recording video information is useless without the ability to recover it. The playback section recovers the recorded video information and processes the video signal for reproduction on a television monitor. To do this, playback electronics must not only recover recorded video material, but it must route it through the playback electronics, remove any crosstalk, separate the luminance and chroma signals for individual processing, return the video signal to its unformated structure, "up convert" the chroma subcarrier, amplify both signals, and mix the luminance and chroma signals before presenting them to a monitor.

The video heads pick up the formated magnetic information off the video tape and change it into electrical signals for playback. The luminance component coming off the tape is free of crosstalk because each video head is canted at a different azimuth. (Remember VHS heads are on a ±6° azimuth and Beta are on a ±7° azimuth.)

Because of recording limitations and various electronic physical phenomena, this playback signal coming off the heads must be "shaped" in the playback pre-amplifiers to compensate for the limitations of the recording amplifiers as well as the limitations inherent in video recording, such as head output characteristics. The pre-amplifier stage also balances, or equalizes, the two video head outputs so that the variations between fields is limited.

Still the incoming signal is very low. The pre-amplifiers have to increase the signal level and shape the signal for as flat a response as possible. This stage also determines the quality of the final picture and the picture's signal-to-noise ratio. Any noise introduced at this stage is critical. In order to reduce noise in this stage, the heads must be on only during the time that they're in contact with the tape. To turn the heads on and off, the pre-amplifier stages are alternately switched on as a head scans the tape and off as it leaves the tape.

Once out of the pre-amplification and equalization stage, the signals from the heads are routed to the luminance and chroma playback electronics by high and low pass filters.

Luminance playback

When the luminance signal is recorded, you might first believe that only the frequencies between the dark and white levels of the two formats (VHS 3.4 MHz to 4.4 MHz and Beta 3.5 MHz to 4.8 MHz) are frequencies recorded. This isn't so. As does any FM signal, the luminance signal produces side bands of other frequencies. These side bands consist of the sum and differences between the luminance signal frequencies and the instantaneous frequency of the modulator. This means that the luminance spectrum recorded on the tape is roughly 6 MHz wide, because the luminance signal and its side bands range from about 1 MHz to 7 MHz.

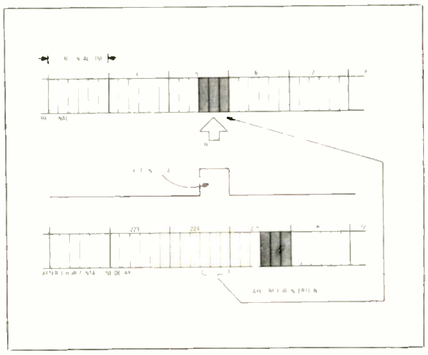


Fig 7 The drop out compensation (DOC) circuits plugs holes in horizontal lines missing video information due to tape imperfections, missing tape oxide, or dirt. The "holes" in a horizontal line are plugged with a portion of the signal from the preceding horizontal line. Most drop outs are less than one horizontal line, but VCR's can repeat a line several times.

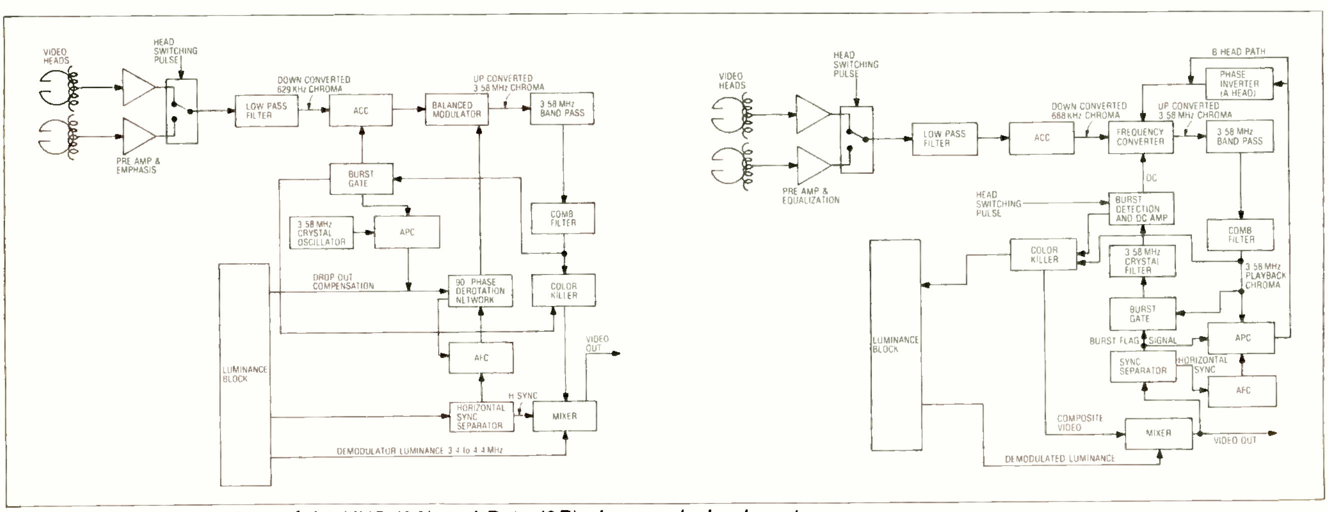


Fig 8 Block representations of the VHS (8A) and Beta (8B) chroma playback systems.

Regardless of VCR format, the luminance playback block has the same functions (see Figure 6). It receives the video signal, amplifies it, demodulates it, de-emphasizes it, replaces any missing video, and finally mixes the luminance signal with the chroma to reconstruct the original video signal for playback.

A low pass filter eliminates the chroma elements of the incoming video signal and routes the remaining luminance elements to the limiter. The limiter amplifies the FM signal and removes any amplitude variations caused by variations in head-to-tape contact, spurious signals, or noise. At first glance, the amplification and limiting functions of this block seem contradictory, but amplifying the signal and then clipping it reduces the chance of noise riding on the peaks of the waveforms.

To record the luminance signal, it must be frequency modulated. To play it back, it must be frequency demodulated. In broad terms, the FM demodulator turns FM square waves into pulses of uniform duration and amplitude that are later filtered. The density of these pulses determines the demodulator's output. With higher frequencies and higher densities, the demodulator output increases, while the reverse is true for lower frequencies and lower densities.

After it is demodulated the luminance signal still contains the pre-emphasis used during recording. Before feeding the luminance signal to an output, a de-emphasis block must remove the emphasized high frequency components. Depending upon VCR model, this is done with either an RC network or digital circuitry. Before leaving the luminance playback block through the video output jack, the luminance signal is mixed with the 3.58 MHz chroma subcarrier coming from the chroma playback section.

TABLE 1

COMPARING VHS AND BETA SPECIFICATIONS

SPECIFICATION	VHS	BETA*
Weight	most 36-40 pounds	most over 40 pounds
Tape Length SP LP	2 hour 4 hour 6 hour	Beta I Beta II† Beta III† 1 hour 3 hour 4½ hour
Tape Thickness	20 μm	20 μm
Tape Width	12.65 mm (½ inch)	12.65 mm (½ inch)
Tape Speed	2 hr 3.34cm/s 4 hr 1.67cm/s 6 hr 1.11cm/s	Beta 1 4cm/s Beta 2 2 cm/s Beta 3 1.33cm/s
Video Track Width	58 μm	58.5 μm
Guard Band Width (SP only)	20 microns	21.5 microns
Track Overlap (LP only)	about 10 microns	about 11 microns
Audio Track Width	1.0 mm	1.05 mm
Control Track Width	0.75 mm	0.6 mm
Video Head Gap	0.35 μm	0.45 μm
Video Head Gap Azimuth	± 6°	± 7°
Head Configuration	2-headed helical scan	2-headed helical scan
Tape-Head Wrap	½ wrap (180°)	½ wrap (180°)
Head Drum Diameter	62 mm	74.5 mm
Luminance Signal	fm 3.4 ∿ 4 MHz	fm 3.5 ∿ 4.8 MHz
Chroma Subcarrier	629 kHz	688 kHz

†With a 750-foot cassette

Dropouts

Dropout compensation is the process used to prevent the random loss of video that can be caused by tape manufacturing imperfections, missing tape oxide due to tape wear, or by airborne dirt and grime getting between the tape and video head. If these "holes," or dropouts, aren't "plugged" they create visible flashes and white or black streaks in the TV picture. Fortunately, most dropouts are shorter than one horizontal line and can be "plugged" rather easily by replacing the dropout with a portion of the preceding horizontal line. By sensing dropouts before they reach the video output, it's possible to do this by delaying a portion of each horizontal line by passing it through a delay line and then feeding it back into the following horizontal line when a dropout is detected. This means that a portion of our horizontal line may occur twice on the television screen. Most of the time the dropout is small enough so that this repetition goes unseen by the eye. Most video recorders can repeat several horizontal lines to take care of drop-outs.

If a dropout occurs, a positive pulse triggers an electronic switch which allows a signal delayed by one horizontal line to replace the missing signal before it reaches the mixer stage (see Figure 7). For example, assume that the playback of a video tape was fine until it reached line 225 which had a video dropout of about half a horizontal line. The dropout compensation network would repeat an equal amount of the previous horizontal line, line 224, instead of displaying the dropped out portion of line 225.

Basically, the luminance playback process is almost exactly the reverse of the luminance recording process. And both the Beta and VHS system are nearly identical at the block diagram level.

After routing the signal from the video heads, the VHS and Beta recorders run the video signal through a high pass filter to eliminate its chroma elements. In the video head pre-amplification block, the resonance of the video heads is set for a peak response of 4.5 MHz. This signal and the pre-amplifiers create the proper pre-amplification frequency characteristics to restore the sideband levels to their proper frequency relationships. The signal then passes through the limiter, FM demodulator, de-emphasis, and noise cancellation electronics on its way to the mixer amplifier, where the luminance and chroma signal rejoin before going on the television monitor.

Chroma playback

Although the chroma sections of the VHS and Beta recorders are considerably different, they perform very similar functions. The purpose of the chroma sections is to process the chroma signal for reproduction. To accomplish this it must eliminate chroma crosstalk, "up convert" the chroma subcarrier, control the chroma playback level, and correct the color. (Refer to Figure 8.)

The chroma signal can't be played back directly. Extensive amounts of signal manipulation, or color correction, are needed in order to produce an acceptable color picture. The reason that the chroma needs correcting is because it contains what's called "time-base errors." Time-base errors are slight variations in the timing of the chroma signal due to humidity and temperature, stretched tape, worn mechanical parts, and minute mechanical instabilities (like wow—cyclic fluctuations below 3 Hz—and flutter—clutter fluctuations between 3 and 20 Hz), as minor mechanical imperfections. Even slight variations in the video head speed, which occur when the head drum is running at its "constant" speed of 1800 rpm (30 Hz) create the need for color correction. The things mentioned here cannot be controlled by mechanical means, so manufacturers have devised electronic means of compensating for the color problems.

Time base errors

The chroma signal and its side bands contain all the time base errors that will have to be removed when they come off the tape. To color correct the chroma signal, the down converted subcarrier is first separated from the luminance elements of the video signal by a low pass filter. The low pass filter passes the subcarrier because it's below 1 MHz and blocks the luminance because it's above this.

Up converting the chroma subcarrier by heterodyning is the next step in restoring the color to its broadcast level. The third takes place in the color correcting circuits of the ACC, AFC, and APC (automatic phase control). Here the processing and correction of the time base errors is based on a premise that time base errors are constant over the entire horizontal line. (This premise serves to produce acceptable color correction, although it isn't strictly true.) Furthermore, the premise assumes that the same errors are the same in the burst portion of the playback signal as they are in the rest of the signal and that any changes in the next burst will be too minor to affect the playback color. Accordingly, the burst signal is separated from the playback signal and used to create a color correcting signal that's applied to an entire horizontal line. The process sounds simple enough, but is quite complex and needn't be discussed in detail for this overview.

Luminance crosstalk is stopped by the different azimuths of the video heads. Chroma crosstalk must be eliminated electronically. Both formats have different means for eliminating crosstalk, the first steps of which occur during the recording process as already discussed.

The comb filter

The VHS recorders eliminate crosstalk by derotating the chroma when it comes off the tape and then running it through a comb filter. The Beta recorders, on the other hand, run the signal from the A-head through a phase inverter so that every other line recorded by the A-head is returned to its original phase. The output of the B-head bypasses this inverter. But the output of both heads is run through a comb filter to remove crosstalk.

As in the record chroma electronics, the chroma playback electronics of both Beta and VHS formats contain similar blocks. Some of these function in both operational modes. Those involving color correction have already been discussed, so the following discussion focuses on those not yet described. Remember that although the end result is a video picture, and although similar blocks may be used to accomplish this end, the signal paths between these common blocks are different.

The essence of getting the chroma playback signal upconverted so there is an acceptable picture on the monitor is to have the 688 KHz (or 629 KHz) input to the balanced modulator contain the same jitter component as the 4.27 MHz input. When these two signals jitter together, their proportional difference stays the same and jitter doesn't cause playback problems. The APC and AFC stages ensure that these signals maintain a proportional jitter component. Keeping this in mind, let's look at the rest of the chroma playback system.

A low pass filter blocks the luminance signal coming off the video heads while passing the chroma. The ACC, which has a range similar to that of the ACC in a television receiver, regulates the level of the chroma and keeps the color burst signal level constant. The down converted subcarrier input and output of this block is 629 KHz for VHS recorders and 688 KHz for Beta recorders.

The ACC output goes to the balanced modulator in the VHS systems and to the frequency converter in the Beta systems. Both these blocks have the same function. They convert the chroma subcarrier back to its original 3.58 MHz level by heterodyning two frequencies. The VHS system beats its 629 KHz carrier against a 4.2 MHz signal; the Beta system beats its 688 KHz carrier against a 4.27 MHz signal.

In playback, as in record, the chroma subcarrier is related to the horizontal sync of the luminance signal. During playback, horizontal sync aids in reconverting the chroma signal back to the original carrier frequency without changing any signal relationships. In both systems, a comb filter eliminates chroma crosstalk after the chroma signal has been returned to its original phase. The comb filter routes one of its outputs to a color killer, which eliminates the chroma information during black and white operation.

The APC consists of a phase detection network, a 3.57 MHz crystal oscillator, a reactance network, and a burst gate. It uses the output of a 3.58 MHz crystal controlled oscillator as a phase reference. The APC only makes phase comparisons with the burst signal which makes the APC phase detection signal available only at that time.

Record playback problems

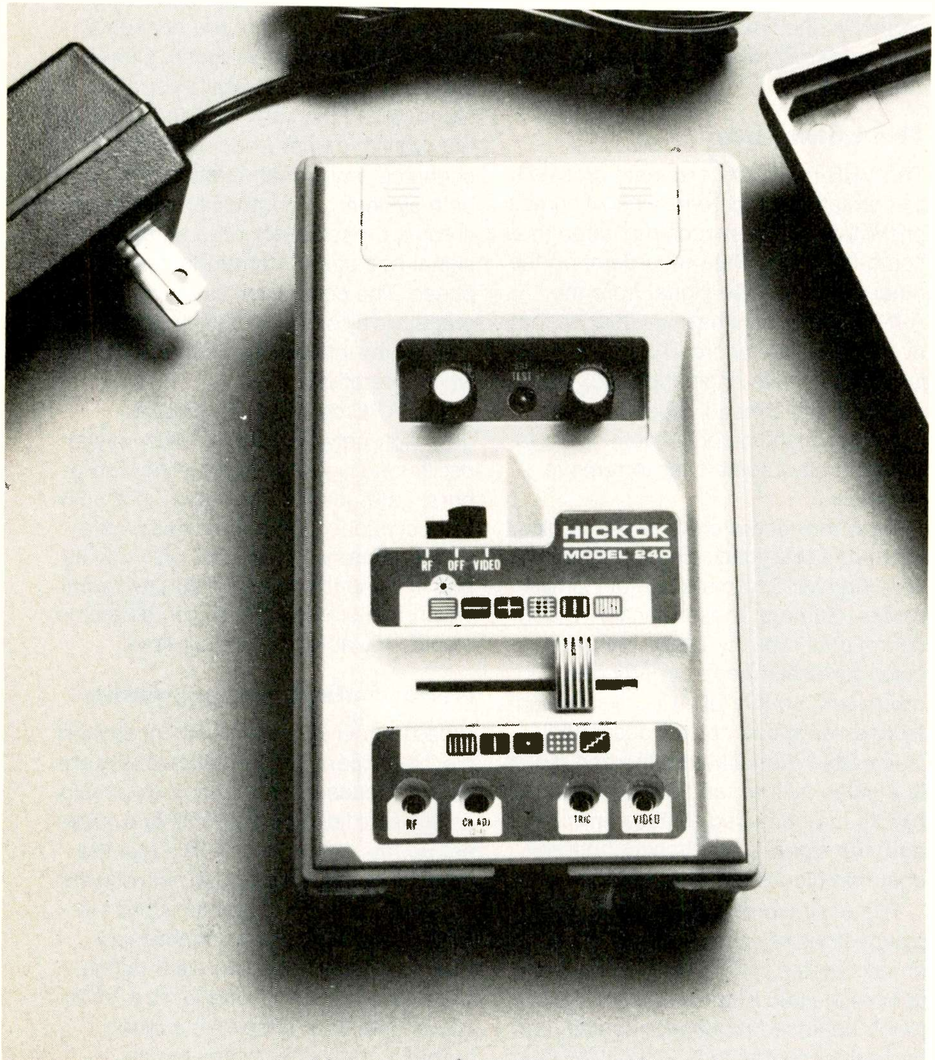
Video problems occur in both record and playback operation. Sometimes they are operator caused. Something as simple as failure to fine tune the VCR-television set up has sent many VCR's into the repair shop. As a repairman, you need to be aware of such "operator faults" in order to save yourself unnecessary troubleshooting time. So such things need to be checked whenever a VCR comes into your shop with a video problem, especially while you are a novice at VCR repairs.

The VCR is a complex electro-mechanical machine whose systems are closely interdependent. When you see a set of symptoms on the TV monitor, don't jump to obvious conclusions. Don't insist that the fault *has* to be a particular stage or a particular section. Look at VCR repair as a detective would a criminal case. Line up several suspects and eliminate them one by one by thorough investigation. Study the symptoms and decide what could possibly cause such problems. Remember that a record or playback problem might reside somewhere other than in these sections. It could be the result of a servo problem.

continued on page 47

TEST INSTRUMENT REPORT

Here's a real handful of video patterns, probably more features per cubic inch than anything we've seen before. The Hickok 240 measures 5-7/8 × 3-3/8 × 1-3/4 inches, a little large for a shirt pocket but easy to stow in a caddy or tool case and offers eleven display patterns at either RF or Video as well as a composite sync trigger output.



For more information circle number 150, Reader Service Card this issue

Hickok's Model 240

Patterns aplenty

By Walter H. Schwartz

The various patterns available, selected by an eleven position slide switch include; standard gated rainbow color bars; a three bar, red, blue and blue-green pattern also derived from rainbow display; a ten bar gray scale; dots, 15 ×21 and single; crosshatch, 15 ×21 lines and single intersecting lines; vertical lines, 21 and single, and horizontal lines, 15 and single. All of these patterns are available as RF output on channels 2, 3, or 4 (screwdriver adjustable from the front panel), or as composite video with negative going sync. Both video and chroma level controls are available. The chroma level is adjustable from 0 to 150% (normal 100% level is at 2/3 maximum); the video can be varied from 0 to 2.8V peak-to-peak open circuit or to approximately 1V peak-to-peak into a 75 ohm load. Reversing the output leads provides positive going sync; the trigger cannot then be used as it uses the same common as the video.

The 240's trigger output is a composite sync signal consisting of 10 μsec horizontal sync pulses and 190 μsec vertical sync pulses with an amplitude of +11 volts. The patterns are derived from a master control oscillator, a crystal at 377.4kHz; the chroma carrier is crystal controlled at 3.563795MHz; the RF oscillator is as mentioned earlier tuneable through channels 2, 3, and 4.

The Model 240 has, as well as the gated rainbow patterns for chroma troubleshooting, and dot and crosshatch patterns for convergence, the only grey scale staircase in its price class that I am aware of. This pattern consists of ten bars of decreasing luminance level and increasing screen height (overscan may reduce the number of bars visible). The bars vary from 100% white, to black level in 10 IRE unit steps. This pattern provides an excellent means of testing and adjusting video monitors for closed circuit TV systems allowing optimum settings of brightness and contrast levels. It also provides a distinctive waveform for signal tracing video circuitry. The equal spacing of the ten levels will show up compression, clipping and non-linearities. The steps' fast rise time will show ringing, overshoot and reflections. Poor low frequency response will tilt the top of the steps; poor high frequency response rounds the corners of the steps.

Power for the Model 240 is two 9 volt alkaline (NEDA 1604) batteries for portable operation, or the Hickok RC-5 ac adapter (which is included with the 240) Battery life, Hickok indicates, is about 30 hours on RF output but only about one half that on video. Also included with the 240 are two output cables, one terminating in spade lugs, one terminating in miniature alligator clips. All cables terminate at the instrument in 2.5mm subminature phone plugs. One could carelessly plug the ac adapter into the video, RF or trigger outputs but a look at the schematic shows that no harm is likely to result.

The 240's manual is excellent. It includes, along with operating instructions and maintenance and calibration information, a very complete applications section.

The model 240 with ac adapter, test leads, instruction book and a 1 year warranty is priced at $159.00. ET/D

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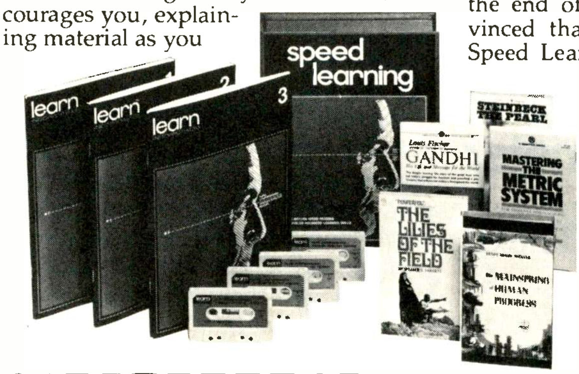

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TEST INSTRUMENT REPORT

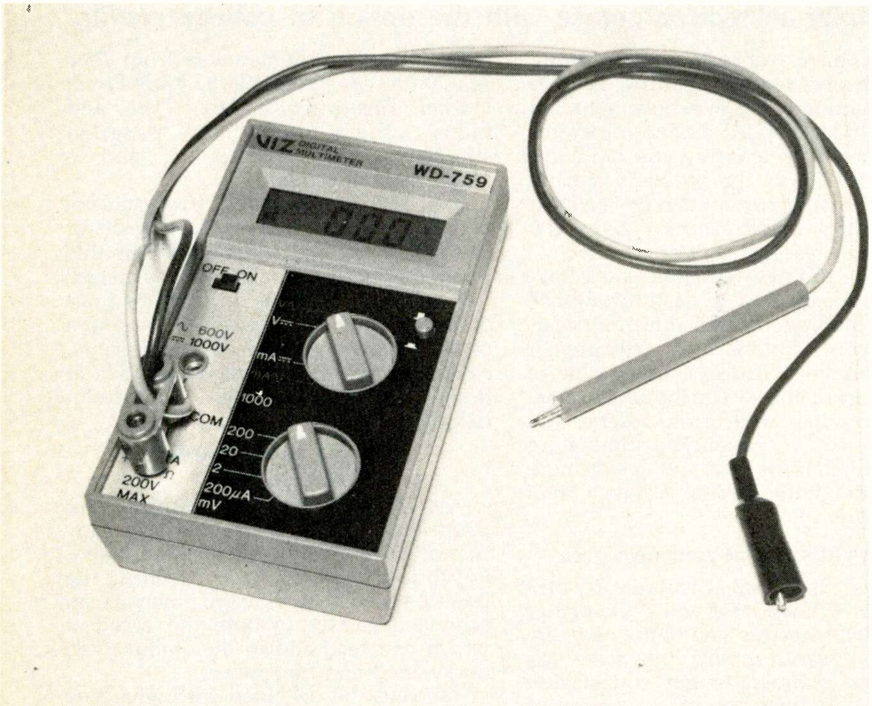
VIZ's New Digital Multimeter

Another LSI "Hand held"

By Richard W. Lay

Among the latest additions to VIZ Manufacturing's lines of bench/portable digital multimeters are two extremely easy to use "hand helds" designed to make life easier for the troubleshooting tech.

With either of these 3½ digit units, the WD 748 or WD 759, all functions and ranges are controlled via two front panel rotary dials that make it a no muss, no fuss, piece of equipment ideally suited for either the industrial or consumer service environments.



For more information circle number 151, Reader Service Card this issue

The basic difference bertween the two is that the 748 is equipped with a LED readout while the 759 sports LCD display. Depending on your own service environment (sub freezing or extremely high light levels) you'll have to make up your own mind about the two. However, the 759 has another feature that makes it an industry first in its price range ($159.95) and that is a full LCD readout of both the function you are working with and the range you're in, on the LCD display. There just isn't any guesswork with this DMM. If you are working in the mV/mA range, the display actually shows the mV/mA reading. Similarly the function switch setting activates a "DC" or "AC" or "ohms" display right on the LCD. Thus, at a glance, you are able to determine whether the ;meter is set on AC, DC, or Ohms and whether in the mV, mA, ohms, Kohms, Megohms, or volts range.

Another industry first for both meters is the full range (five ranges) capability of the "high" or "low" ohms function. The high or low ohms mode (either 3.2V or .3V) across the component under test, is controlled by a front panel pushbutton in the upper right hand corner.

The meters are powered by four 1.5V "AA" cells providing an average life of 30 hours for the LED readout and at least 200 for the LCD. (Optional accessories, of course, include an AC Adaptor).

These automatic zeroing, auto polarity meters provide a basic .1% accuracy across the board, according the the manufacturer. One of the handiest applications I found with this unit (I worked with the 759) was the ease in setting proper DC bias levels in calibration work. It's hard to imagine needing more than four digit accuracy when working in the millivolt range.

Both meters provide 10 megohm input impedance on both AC and DC modes to minimize circuit loading effects. Also, a 1 amp, 250V fuse protects the internal circuitry in AC/DC current ranges with a maximum of 250 DC/rms permissable.

Three front panel jacks are used as the volts, amps, ohms and common inputs, the selection of which is determined by usage conditions and whether you'll need maximum readings over 200 volts or up to 1000 (600AC).

Once again in these two VIZ meters we see the benefits of space age technology reaching the consumer service bench. The heart of both the 758 and 759 is a large scale integrated circuit. This IC includes analog to digital conversion, the BCD to seven segment decoders, the display drivers, a clock and reference voltage. Discrete circuits handle the AC to DC conversion, range switching, ohms to volts conversion and protection.

Accessories supplied with the units are a wire tilt stand, test leads, spare fuse and batteries.

Optional accessories for both the WD-758 or the WD-759 include: a high voltage probe, WG-297 and multiplier resistor, WG-242A, for measurements to 50 KVDC; an over the shoulder carrying case, WG-446 (designed so that the meter can be used while in the case); and, for bench use, the AC adapter WG-497.

The manual contains operating instructions, theory of operation, schematics, parts lists, circuit board layout and some maintenance information, though from the nature of LSI, serious maintenance and calibration problems perhaps should be left to the factory.

The price of the WD-758 is $149.95; the WD-759 is $159.95. ET/D

This magazine gives you good reading, good writing and good arithmetic.

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BULLETIN BOARD

New oscilloscopes, function generators, and video generators, are among the featured products in a new 40-page full line catalog issued by *Leader Instruments Corp.* The new catalog details features, specifications and applications of more than 50 test instruments in addition to a selection of probes and other test accessories. Among the latest products found in the Leader test instruments group is a 20MHz field service oscilloscope offering lightweight, battery operation and 2mv sensitivity. A total of 11 oscilloscopes ranging in bandwidth from 4 to 30 MHz are included in the Leader line. Two new professional video generators designed for nonbroadcast applications are also included and a full feature 2MHz function generator is introduced. Leader also offers 3 frequency counters ranging from 80 to 520 MHz and groups of 14 audio test instruments; 3 video generators, including a battery operated unit; 5 RF test instruments; 2 transistor checkers; and a CATV field strength meter. The catalogs may be obtained by contacting any Leader Instruments Corp. distributor or by writing Leader Instruments, 380 Oser Ave., Hauppauge, NY 11787.

A new test and measuring instrument catalog containing information on and technical specifications and illustrations of all current Philips products marketed by *Philips Test and Measuring Instruments* in the U.S. and Canada is now available.

Product groups include oscilloscopes, counters and timers, pulse generators and a new logic analyzer and logic scope. For a free copy write: Philips Test and Measuring Instruments, 85 McKee Dr., Mahawh, NJ 07430 or call 800/631-7172.

A catalog of micro electronic accessories has recently been issued by *GC Electronics*. It features a line of over 150 parts and tools, including wire wrap tools, wire dispensers, IC insertion and extraction tools, cables and connectors. For a free copy see your GC Electronics distributor.

A twenty page catalog describing *Visual Methods Inc.'s* line of **CCTV access control and surveillance products** is now available. Included is the VMI TWINGUARD, pinhole and wide angle surveillance lenses, television housings, and many special application items. The catalog includes individual product specifications, drawings, photographs and a short description to help in writing specifications or giving sales presentations. Individual data sheets for most products are available on request. Write: Visual Methods Inc., 35 Charles St., Westwood, NJ 07675.

Electronic hand tools are featured in a new catalog from *Electronic Production Equipment Corp.* Included are tools for cutting, stripping and forming leads; a thermal wire stripper, a 30 gauge stripper, soldering aids, solder feeders, flux dispenser, a slide along assembly station and a number of other assembly and production tools. For a free copy of Catalog 180 write: Electronic Production Equipment Corp., P. O. Box 5238, Manchester, NH 03108.

Nearly 100 advanced design, state-of-the-art, electronic test instruments are being featured in a new, 16 page, short form catalog recently published by *The Instrument Mart.* The publication details key features and specifications of the test equipment produced by 14 separate manufacturers, thus providing a choice for engineers and technicians to meet most non-esoteric, electronic test and measuring requirements. Product groups offered include: oscilloscopes, digital multimeters, frequency counters, function and pulse generators, audio analyzers, NTSC generators, power supplies, digital thermometers and more. Manufacturers represented in the publication are: John Fluke Manufacturing, Philips Test & Measuring, Gould, Leader, B&K Dynascan, Beckman, Weston, Simpson and others. For a free copy contact: The Instrument Mart, 295 Community Drive, Great Neck, NY 11021.

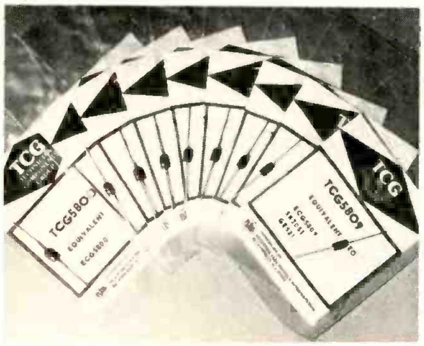
The full line of electronic instruments, including over seventy of the company's products, is illustrated and described in *VIZ Manufacturing Co.'s* new 44-page 1980 catalog. Complete information is given, including major features of interest to users, detailed description, and complete technical specifications—performance ranges and limits, power required, weight and physical dimensions. The VIZ line of electronic instruments includes digital multimeters, solid state VoltOhmyst multimeters, VOMs, power supplies, Isotap isolation transformers, signal generators (including the new color bar Signalyst), tube tester, transistor tester, frequency counter, sound level meter, RF wattmeter and accessories. A free Copy of the catalog may be obtained from any VIZ electronic distributor or by writing to VIZ Mfg. Co., 335 E. Price St., Philadelphia, Pa 19144.

The 1980 edition of the *Klein* **Tools & Occupational Protective Equipment Catalog No. 123** is 96 pages long. It contains descriptions of over 1,000 available products. The products are organized into seven basic sections: 1) hand tools; 2) tools and equipment for iron workers; 3) wire pulling grips for utility workers; 4) tool belts and pouches; 5) utility linemen's accessories; 6) occupational protective belts and harnesses; 7) linemen's body belts and climbers. The catalog includes informative descriptions of various hand tools with respect to finishes, usage, construction and nomenclature. It also includes pertinent OSHA and ANSI editorial treatment concerning the use of tools and protective equipment such as belts and harnesses. The catalog is indexed numerically and alphabetically for references. It reportedly incorporates dozens of new tools introduced since the release of the 1979 edition. See your Klein distributor or write: Klein Tools, 7200 McCormick RD., Chicago, IL 60645.

A new catalog of **tools for electronic assembly** and precision mechanics is offered free by *Jensen Tools Inc.* The contents include more than 2000 tools of interest to field engineers, technicians, instrument mechanics, locksmiths, watchmakers, and electronic hobbyists. Major categories covered are: Microtools, test equipment, soldering equipment, tweezers, screwdrivers, cutters, drafting supplies, power tools and a complete line of tool kits and tool cases. To obtain your free copy write: Jensen Tools Inc., 1230 S. Priest Dr., Tempe, AZ 85281.

Many new additions to the *O.K. Machine and Tool* line of **wire-wrapping tools,** machines and associated products are included in the latest edition of Catalog 80-36N. An illustrated section on the technology of wire-wrapping makes this catalog of interest to the design, packaging or manufacturing engineer as well as to purchasing and production personnel. This 60 page catalog has been expanded to include the complete line of industrial and hobby products. Catalog 80-36N is available free of charge from OK Machine and Tool Corp., 3455 Conner St., Bronx, NY 10475. ET/D

NEW PRODUCTS



Three-Amp Silicon Rectifier

Circle No. 121 on Reader Inquiry Card

New-Tone Electronics International has announced the availability of the company's Technician Components Group (TCG) Series 5800 three-amp silicon rectifiers. The TCG 5800 Series includes nine three-amp- silicon rectifiers, all with axial leads. The type numbers and peak reverse voltage for each are: TCG 5800 50V; 5801 100V; 5802 200V; 5803 300V; 5804 400V; 5805 500V; 5806 600V; 5808 800V; and 5809 1000V. Each TCG replacement semiconductor device comes packaged in its own polyethylene bag, with TCG type number and replacement types clearly listed. Suggested distributor resale starts at $.34 for the TCG 5800 silicon rectifier, and delivery is from stock.

Interchangeable Screwdriver Kit

Circle No. 122 on Reader Inquiry Card

Vaco Products Company recently introduced a new Interchangeable Screwdriver Kit No. 90050. This all-purpose kit contains an assortment of the most frequently used Phillips and slotted blade styles, all interchangeable into one full-size handle. Blade sizes include 3/16 inch, ¼ inch, and ⅛ inch slotted and #1 and #2 Phillips. All five blades snap in and out of handle quickly allowing conversion to five different screwdrivers. All components are featured in a vinyl pouch for your workbench or to roll-up and store in your tool box.

Tool Cases

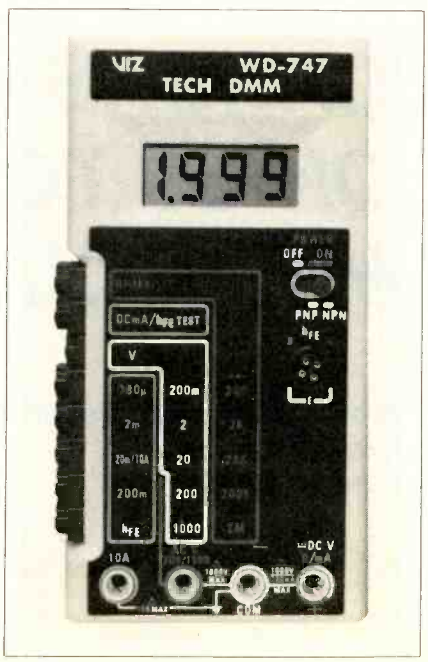
Circle No. 123 on Reader Inquiry Card

Two compact, zippered tool cases have been introduced by *Howe Industries*. Designed to each contain a number of small tools these brown Marvelon™ cases measure approximately 8 ×10 ×2¼ inches and 11 ×13 ×2¼ inches.

3½ Digit Multimeter

Circle No. 124 on Reader Inquiry Card

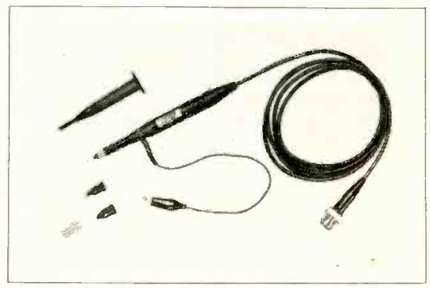
A new hand-held 3½ digit DMM has just been introduced by *VIZ Mfg. Co.* priced at $89.95. "Tech DMM" Model WD-747 comes in a compact, bright orange, high impact plastic case. It may be used to measure DC and AC voltage, DC current (Up to 10 amps), resistance and transistor h_{fe}. The WD-747 has a built-in socket and circuitry for testing transistor h_{fe}—reportedly the only 3½ DMM which does. Other features are ½ inch LCD readout, side buttons for one-hand operation, resolution down to 100 microvolts, accuracy reportedly better than 0.8%, dc input impedance of 10 megohms, auto-polarity, auto-decimal and full overload protection. All functions are color-coded to reduce risk of operator error. The unit comes complete with 9V battery, deluxe test probes and spare fuse.



Instrument Probe

Circle No. 125 on Reader Inquiry Card

A new wideband instrument probe has been announced by *B&K-Precision/Dynascan Corporation*. The new probe, Model PR-40, is designed for use with oscilloscopes and frequency counters in applications through 100MHz. The PR-40 is a slim-body probe with a three-position switch which selects either a 10:1, a direct mode or a reference position that grounds the tip through a 9M resistor. Accessories supplied with the PR-40 include a

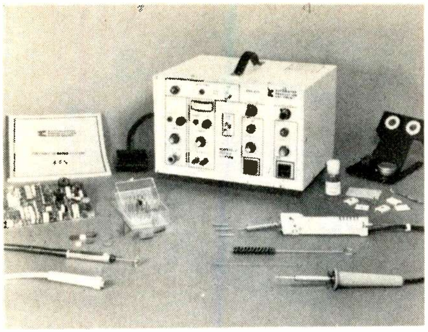


spring-loaded retractable tip-cover, insulating tip, a snap-on ground clip, BNC tip adapter and an IC tip. The insulating tip is designed for probing solid-state circuitry with no danger of shorting nearby components. For interface with test points or output jacks, the BNC adapter converts the probe tip into a push-on BNC connector. The IC tip guides the probe contact onto any pin of a standard DIP, eliminating the possibility of shorting the pins of an IC. The PR-40, complete with accessories, has a user price of $34.00.

Circuitboard Repair & Rework Station

Circle No. 126 on Reader Inquiry Card

Complete functions for PC board repair and rework are reportedly provided in the new Model PRS-475 Station announced by *Automated Production Equipment Corp*. It is portable for use in field repair stations as well as on the production lines and includes

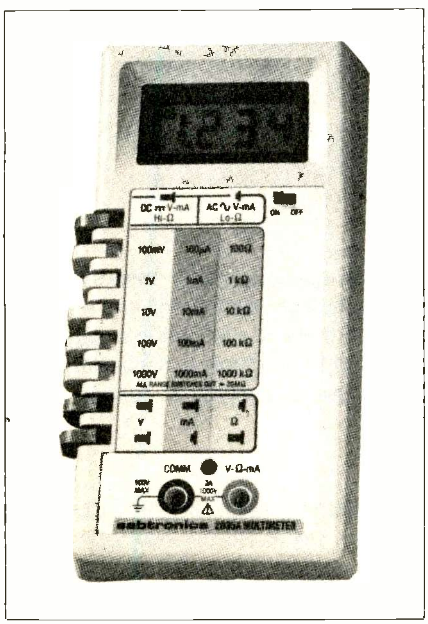


equipment for desoldering components from PC assemblies with both controlled heat and vacuum for sucking up the molten solder. A pump provides both vacuum and pressure; a controlled temperature pencil soldering iron is included; a variable speed handtool (400-12,000 rpm) is provided with a kit of tools to drill, cut, deburr, mill, rout, etc.; a Thermtool Heater provides up to 50 watts of controlled-pulse heat output for removing coatings, or circuit removal and replacement; the self-standing dual tool holder with tip cleaner brush and sponge will hold both the desoldering handpiece EX-1000 and pencil soldering iron; a reflow soldering practice kit is included; a technical manual contains detailed instructions on each function.

DMM Kit

Circle No. 127 on Reader Inquiry Card

A full featured DMM in kit form has recently been introduced by *Sabtronics*. The Model 2035A multimeter reportedly offers these measurement capabilities: ac voltage from 100 µV to 1000V in 5 ranges, dc voltage from 100 µV to 1000V in 5 ranges, ac and dc current from 0.1 µA to 2A each in 5 ranges and resistance measurement from 0.1 ohms to 20 megohms in six ranges on high or low

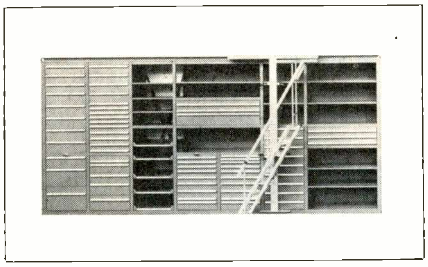


power ohms. Basic dc voltage accuracy is stated to be 0.1%. Overload protection is reportedly 1000Vdc or ac peak on all voltage ranges; ohms ranges are protected to 250V. Other features are automatic polarity, automatic zero and decimal point. The kit is assembled on a PC board. The only wires to attach are the battery leads. Kit price is $74.95 plus $5.00 (U.S.) handling and shipping.

Modular Wall Storage

Circle No. 128 on Reader Inquiry Card

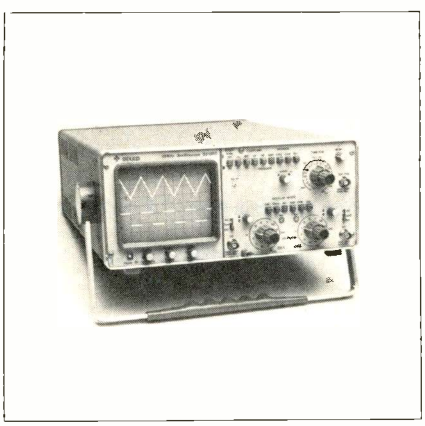
A rugged, modular wall storage system that reportedly eliminates "dead air space" between shelves is available from *Lista International Corp.* Lista storage walls are modular drawer systems with easily identified compartments that improve organization, and speed picking time. Offered in units up to 10 feet high, a track guided safety ladder equipped with handrails and brake allows access to



higher locations and folds flat when not in use. Featuring 11 gauge steel frame assemblies, Lista storage walls come in 28⅛ inch, 46⅞ inch, and 56¼ inch W × 28 inch D expandable units. Drawers are offered in 16 heights and can be mixed with adjustable shelves. Bottom perforations and slots on the 18 gauge inside drawer walls permit various partition combinations.

Dual Trace Oscilloscope

Circle No. 129 on Reader Inquiry Card

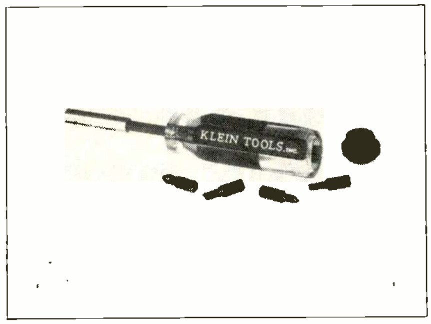


A new lightweight dual-trace 25MHz oscilloscope has recently been introduced by *Gould, Inc.* The OS1200 features a 5 inch rectangular CRT with internal graticule, a 6kV accelerating potential and signal delay lines. Time base speeds range from 200ns/cm to 1 sec/cm with a X10 expansion. Maximum vertical sensitivity is 2mv/cm. Display modes include CH1 or CH2, CH1 and CH2 alternate or chopped, CH1 + CH2 and X-Y. The OS1200 measures 5-¼ × 12 × 16¼ and weighs 17 pounds.

Multi-Bit Screwdriver

Circle No. 130 on Reader Inquiry Card

Klein Tools, Inc. has recently announced the 19510, Multi-Bit Screwdriver. A magnetic tip holds bit and screw securely. Extra bits are stored in a spe-



cial compartmented, fluted plastic handle. It comes supplied with No. 1 and No. 2 Phillips bits and two slotted bits for screw sizes No. 3 through No. 8.

Portable Soldering Iron

Circle No. 131 on Reader Inquiry Card

The Antex MLX 12, recently introduced by *M.M. Newman Corporation,* is a battery-operated soldering iron that quickly connects to any 12 volt source. It reportedly heats up to 800°F in less than 2 minutes. Fifteen foot long leads with alligator clips make a quick, simple connection. Consuming 2 amps at 12V, it utilizes replaceable, iron plated tips that slide directly over the heating element. The Antex MLX 12 volt soldering iron with 15 ft. leads is priced at $19.95.

Workbenches

Circle No. 132 on Reader Inquiry Card

An extensive line of workbenches and storage cabinets is available from *Lista International Corporation.* Standard cabinets, machine tool cabinets, workbenches, work stations, portable management centers, tool storage and transporters as well as storage walls are offered.

Communications Technician's Tool Kit

Circle No. 133 on Reader Inquiry Card

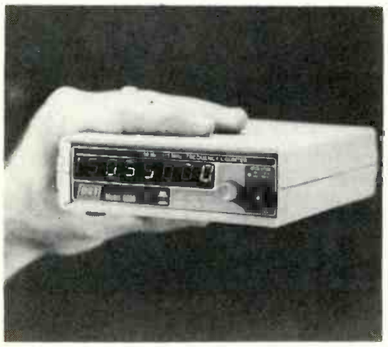
Jensen Tools Inc. has introduced a new communications technician's kit which reportedly contains virtually every standard tool needed in the RF, audio-video and 2-way radio field. The JTK-67 features more than 90 tools in a $15\frac{1}{8} \times 11\frac{1}{4} \times 5\frac{1}{4}$ inch two-pallet all-weather case. Included are alignment tools, fastening tools, pliers, cutters, strippers, wrenches, hole saw kit, soldering and desoldering equipment, solderless terminals, $\frac{3}{8}$ inch electric drill and more. In addition there is a selection of specialty and hard-to-find tools to reportedly handle almost any repair or service situation.

Miniature Frequency Counter

Circle No. 134 on Reader Inquiry Card

DSI Instruments has just announced a small (1-½ x 5 x 5-½ inches) 50Hz to

500MHz, 8-digit frequency counter with a time base stability stated to be one part per million over a temperature range of 17° to 40°C. The Model 5500 is priced at $109.95 or at $134.95 with a NiCad battery pack and ac adapter. Battery operation is reported to be approximately two hours on a single charge.



RF Absorption Milliwattmeter

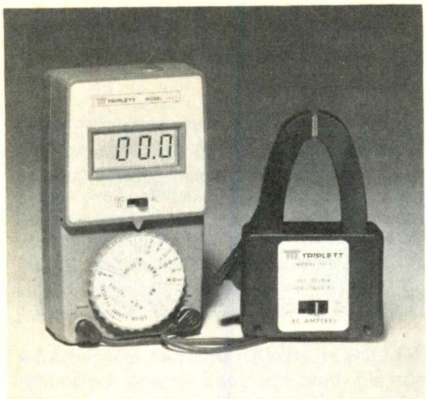
Circle No. 135 on Reader Inquiry Card

The new Model 6257 broad-band Termaline® RF Milliwattmeter by *Bird Electronics* terminates and measures the output of low power signal sources. A front-panel range-switch selects one of three ranges, 0-200mW, 800mW and 3 watts. Its wide frequency range accommodates communications measurements, from 100kHz Maritime Mobile/Maritime Radio Navigation to one gigahertz aeronautical radio navigation. The unit is designed to measure output of broad-band oscillators, signal generators, hand-held transceivers or any low-powered device. Used in conjunction with Tenuline® Attenuators, the Milliwattmeter's maximum full scale range can be expanded to 25 or 100 watts. Each of the three ranges is reportedly field-calibratable for tighter accuracy at a specific frequency. The wattmeter's diode detector also serves as a demodulator of AM transmission envelopes. The demodulated (audio) signal is available at a front-panel miniature phone jack to feed into high impedance display or analysis instrumentation. VSWR of model 6257 is below 1.1 to 512 MHz and less than 1.15 to 1000MHz in 50 ohm coaxial systems. The price is $265.

Compact AC Clamp-on Ammeter

Circle No. 136 on Reader Inquiry Card

A new Model 10-L Clamp-On AC Ammeter Adapter for current measurements without circuit interruption for the Model 3400 hand-size, 3½ digit DVOM, has been announced by the *Triplett Corporation.* The adapter is clamped around a single conductor and 0-20 amps, or 0-200 amps may be read directly as AC amperes from the Model 3400's mV scale. The Model 10-L and Model 3400 DVOM combination reportedly provides ± 5% accuracy between 5-200 amperes. This accuracy may be obtained below 5 amps by using multiple conductor turns and dividing the readings by the number of turns. The Model 3400 has .5 inch LCD display, a single range switch, 24 ranges with hi and lo

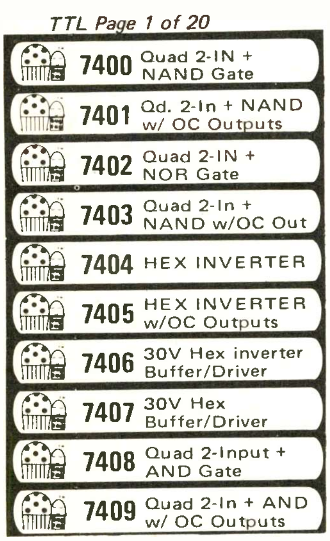


power ohms, auto-zero and auto-polarity and is overload protected up to 600 volts. Battery life is stated to be 200 hours minimum with 9V battery.

I C Labels

Circle No. 137 on Reader Inquiry Card

International Instrumentation, Inc. has developed a series of labels for integrated circuit application and storage. Bug Tags™ (illustrated) are labels for Bug Trays,™ Bug Boxes,™ or other storage bins or drawers. Bug Rugs™ are conductive plastic foam pads used to short the leads of CMOS ICs for static electricity protection. Back Pack's™ are labels which show the pin outs of ICs. Attached to the back of ICs in bread-boards or prototypes they facilitate test, checkout and troubleshooting. ET/D



VIDEO TERMINALS

continued from page 19

at one time. The computer works a damn sight faster than the human operator of the terminal, so would be wasting time if it just idled while the operator was entering data. It could use the "dead" time between keypresses to do wild and wonderful feats.

Another type of terminal goes one step further, and contains its own microprocessor. This chip will do some preprocessing of the data, and often provides some inter-action with the operator. This type of terminal is especially useful where the operator is prompted for the specific data to be input at that instant, or in "point-of-sale" type situations. It will free the main (and more expensive to operate) computer to do the main data massaging. ET/D

TROUBLE SHOOTING

continued from page 22

consuming task because first the fact that an interfering signal is present must be verified, then we must find out how it gets into the system.

One of the places where it is easiest to find interfering signals is on the power supply lines. An oscilloscope applied to the power lines will show any extraneous pulses. Inasmuch as these pulses are often related to the power line frequency, it is helpful to synchronize the scope to the power line when looking for them.

If there is nothing strange on the power supply lines, the other lines should be checked for any pulses that differ from those normally on the lines. This must be done very carefully because it is possible to introduce interference with the scope probe.

It is sometimes helpful to stop the system while probing for interfering signals. This can often be done by means of a control on the system or by temporarily tying the HALT pin to a low level. When this is done the address and data lines will not be changing state, so it is easier to spot spurious pulses. ET/D

VCR

continued from page 35

Being able to do playback and record repairs, probably depends as much on hard work as anything. This means several hours spent studying the service manuals of the VCR models you want to repair and facing several more hours attempting to solve such problems. In short, this article series can only give you a place to begin your study of VCR repair. There is no way to become a VCR expert except through experience. Before you can call yourself that you'll struggle through many hours of study and hard work. ET/D

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AD INDEX

TEST INSTR. RPT.

NEW PRODUCTS

This index is furnished for the readers' convenience. However, the publisher can not guarantee its accuracy due to circumstances beyond our control.

ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS

	SCHEMATIC NO.		SCHEMATIC NO.
SONY B&W TV Model TV-770	1846	QUASAR Color TV Chassis TS-969	1849
CURTIS MATHES Color TV Chassis CMC81-1/2/3/4	1847	PANASONIC B&W TV Chassis T801-A	1850
CURTIS MATHES Color TV Chassis CMC82-1/2	1848		

Note:

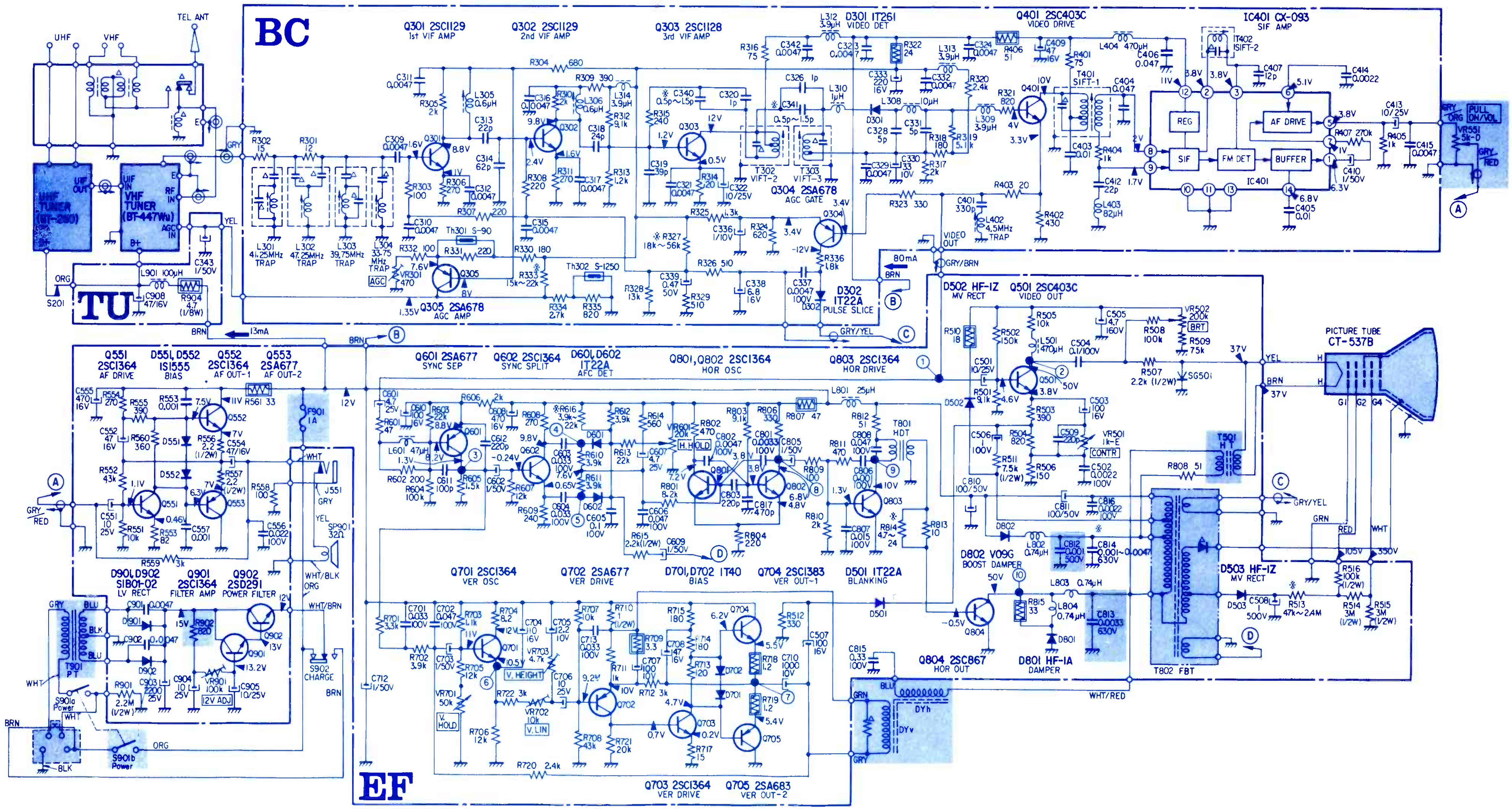
1. All capacitors are in μF, 50 V unless otherwise noted. p = $\mu\mu$
2. All resistors are in ohms, ¼ W unless otherwise noted. k = 1000, M = 1000 k
3. △ indicates internal components.
4. Resistance and capacitance values marked ※ are to be selected to yield specified operating conditions.
5. Voltages are measured from chassis to point indicated by using a VOM (20 k ohms/V) with a signal input in the EF board and with no signal input in other circuit boards. Variations may be noticed due to nomal production tolerances.
6. The circled numbers (1 ~ 10) refer to waveforms shown on the EF mounting diagram. The waveforms are taken with a signal input, and with the BRT knob fully turned counterclockwise and the CONTR knob fully turned clockwise.
7. [resistor symbol] indicates nonflammable resistors.
8. S901 and VR 551 are coupled.

Note: The components identified by shading are critical for safety. Replace only with part number specified.

1846

SONY
B&W TV Model
TV-770

JUNE • 1980

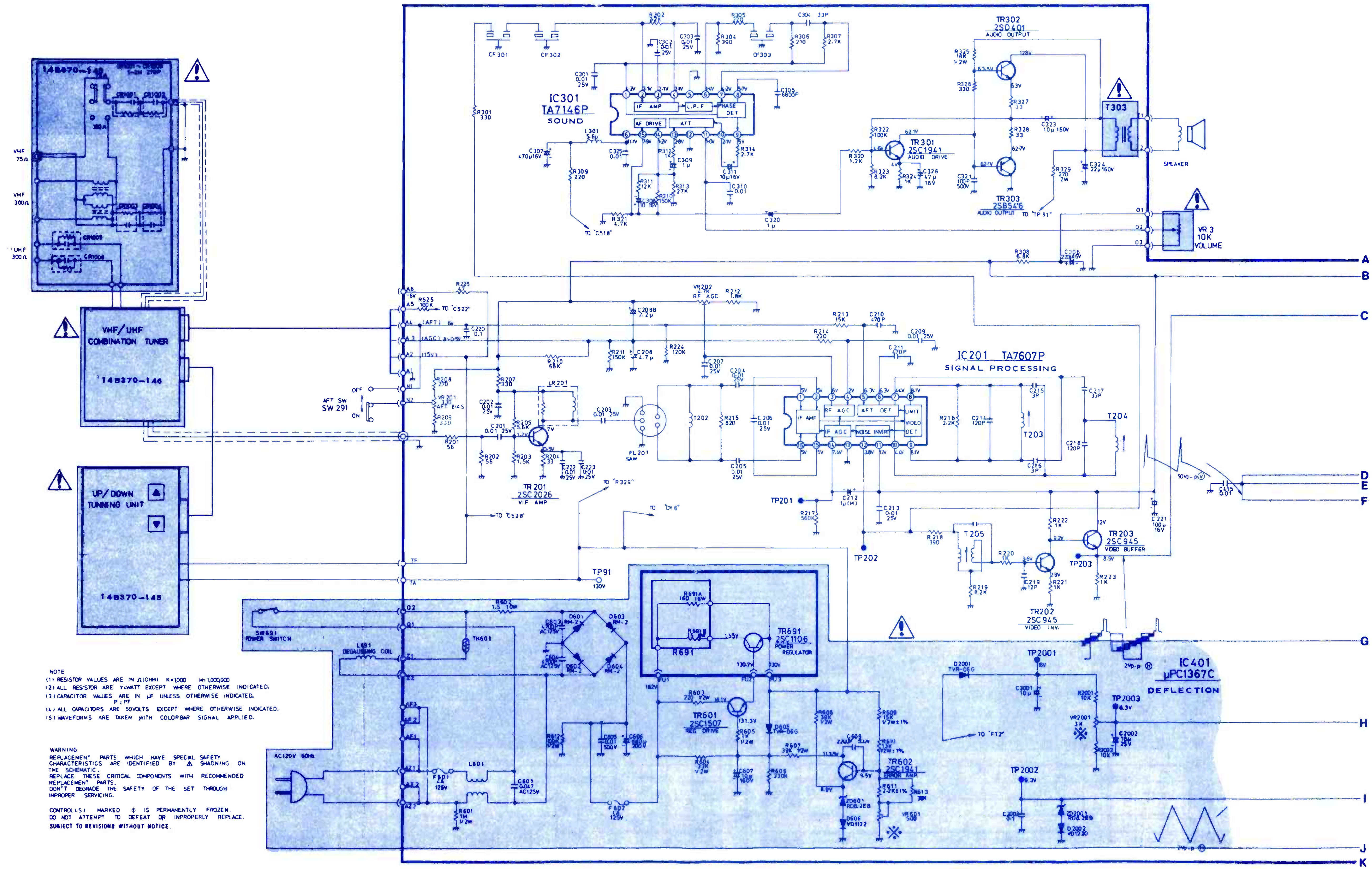


1847
CURTIS MATHES
Color TV Chassis
CMC81-1/2/3/4

JUNE • 1980

ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS



NOTE
(1) RESISTOR VALUES ARE IN Ω(OHM) K=1,000 M=1,000,000
(2) ALL RESISTOR ARE 1/4WATT EXCEPT WHERE OTHERWISE INDICATED.
(3) CAPACITOR VALUES ARE IN μF UNLESS OTHERWISE INDICATED. P = PF
(4) ALL CAPACITORS ARE 50VOLTS EXCEPT WHERE OTHERWISE INDICATED.
(5) WAVEFORMS ARE TAKEN WITH COLORBAR SIGNAL APPLIED.

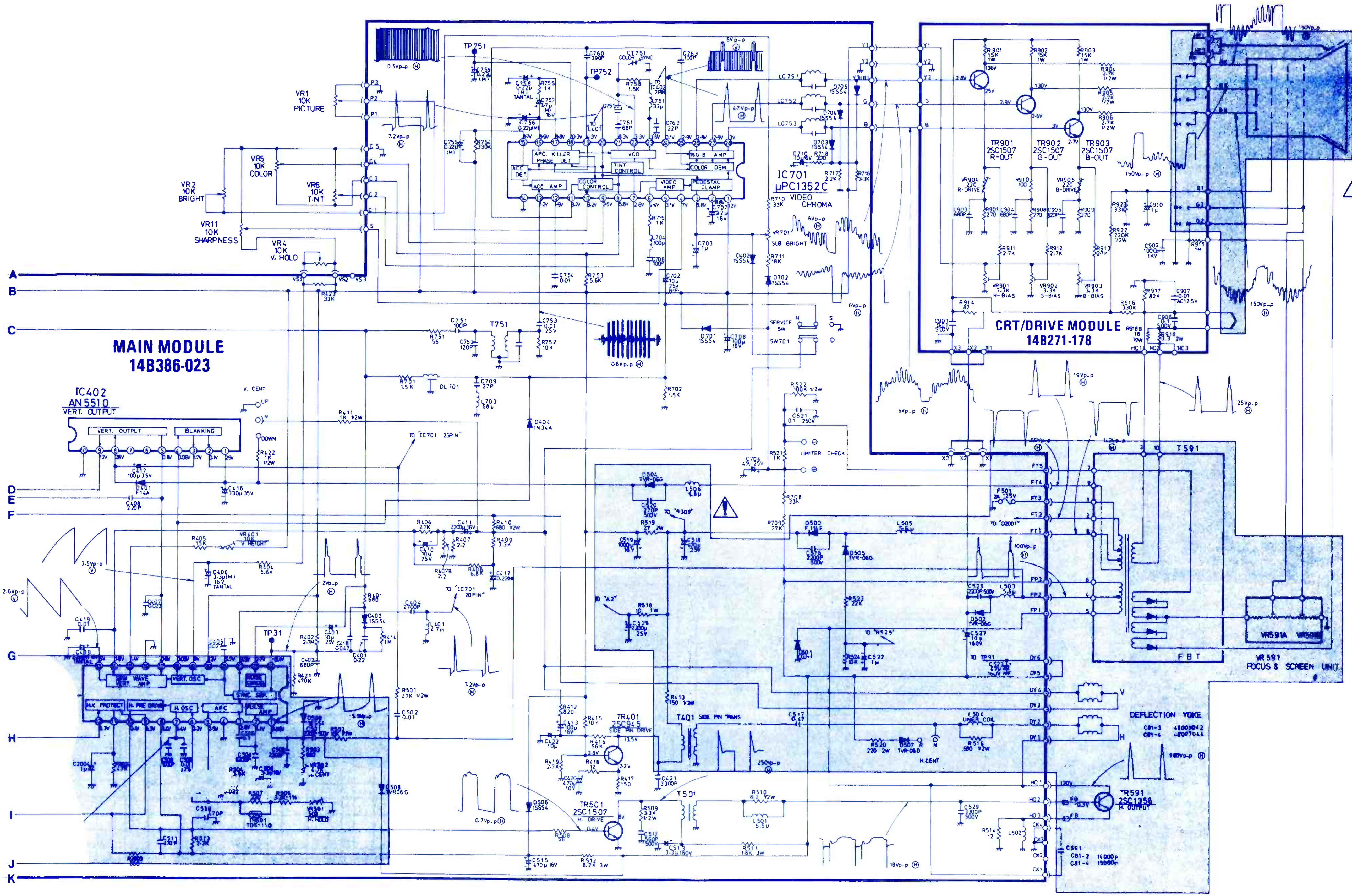
WARNING
REPLACEMENT PARTS WHICH HAVE SPECIAL SAFETY CHARACTERISTICS ARE IDENTIFIED BY ⚠ SHADNING ON THE SCHEMATIC.
REPLACE THESE CRITICAL COMPONENTS WITH RECOMMENDED REPLACEMENT PARTS.
DON'T DEGRADE THE SAFETY OF THE SET THROUGH INPROPER SERVICING.

CONTROL(S) MARKED ✻ IS PERMANENTLY FROZEN.
DO NOT ATTEMPT TO DEFEAT OR INPROPERLY REPLACE.
SUBJECT TO REVISIONS WITHOUT NOTICE.

Editor's note: Parts from: Curtis Mathes, P.O. Box 151, Athens, TX 75751 or One Curtis Mathes Parkway, Athens, TX 75751, Attn: Parts Department. Telephone: Texas 800-492-9543—rest of U.S. 800-527-7646.

Editor's note: CMC 81-1/CMC81-2 similar except for tuners.

CURTIS MATHES
Color TV Chassis
CMC81-1/2/3/4

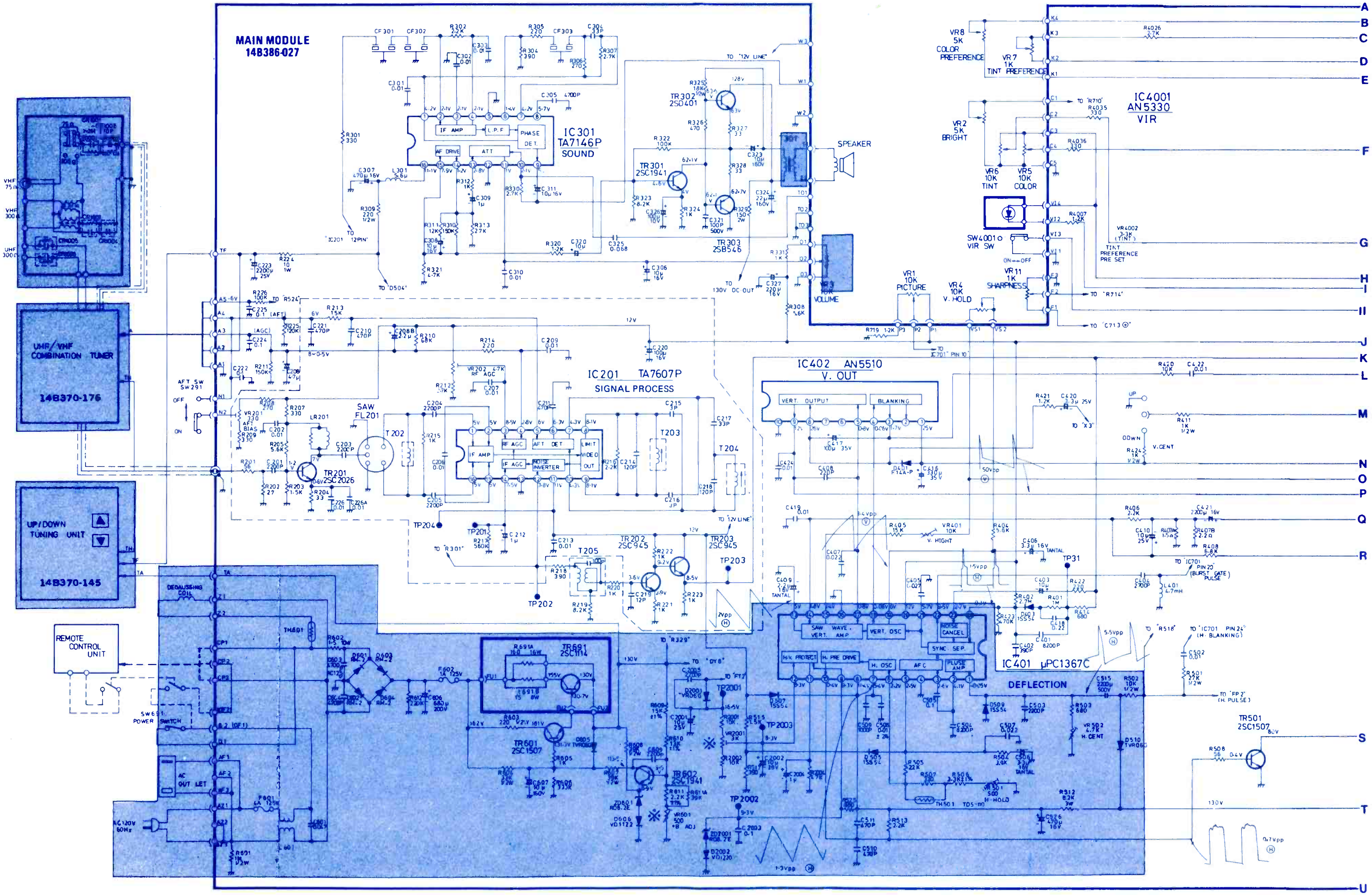


1848
CURTIS MATHES
Color TV Chassis
CMC82-1/2

JUNE • 1980

ET/D TEKFAX

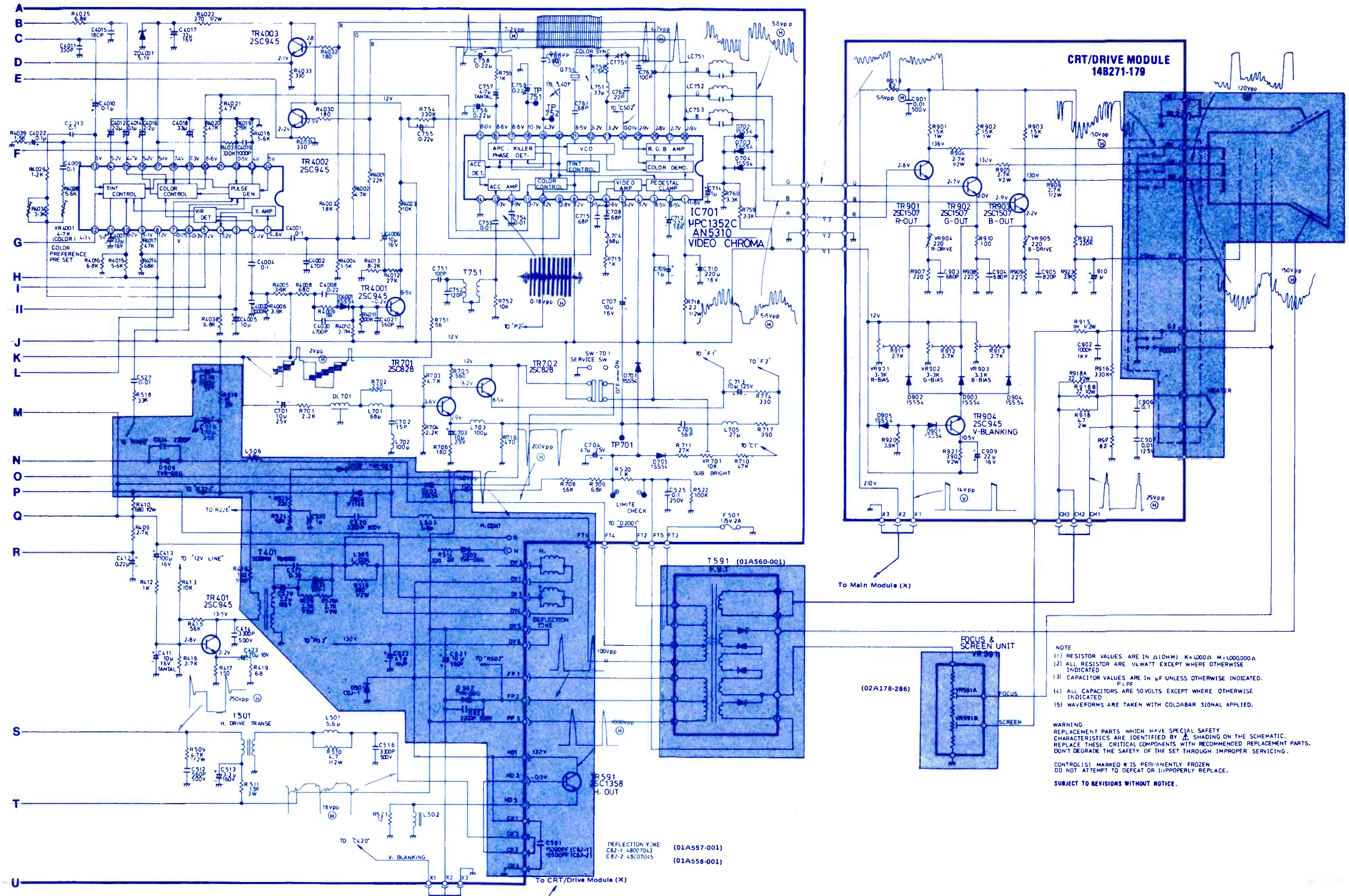
COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS



Editor's note: *Parts from: Curtis Mathes, P.O. Box 151, Athens, TX 75751 or One Curtis Mathes Parkway, Athens, TX 75751, Attn: Parts Department. Telephone: Texas 800-492-9543–rest of U.S. 800-527-7646.*

Editor's note: *CMC 81-1/CMC81-2 similar except for tuners.*

CURTIS MATHES
Color TV Chassis
CMC82-1/2



NOTE
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CONTROL(S) MARKED * IS PERMANENTLY FROZEN
DO NOT ATTEMPT TO DEFEAT OR IMPROPERLY REPLACE.

SUBJECT TO REVISIONS WITHOUT NOTICE.

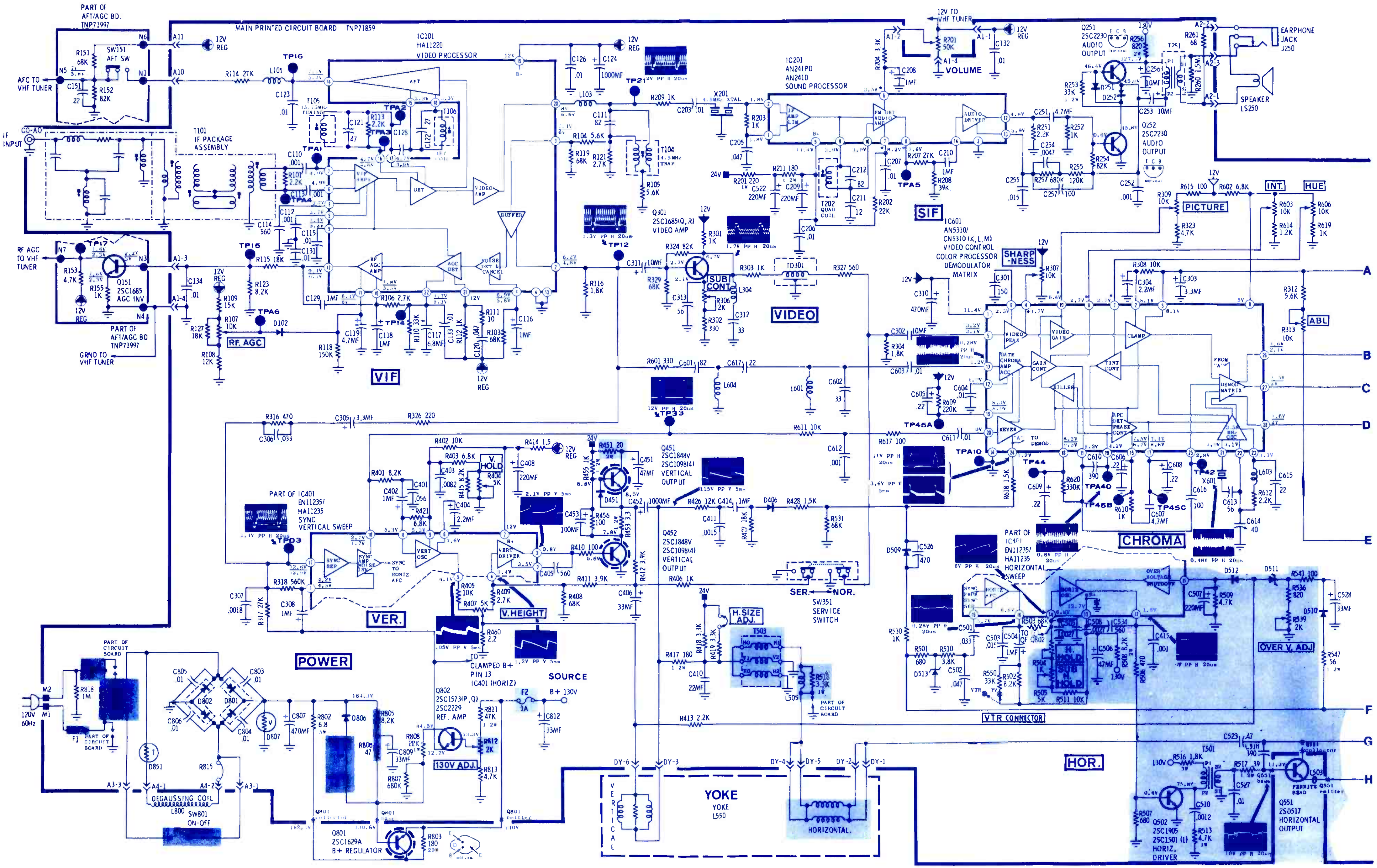
1849

QUASAR
Color TV Chassis
TS-969

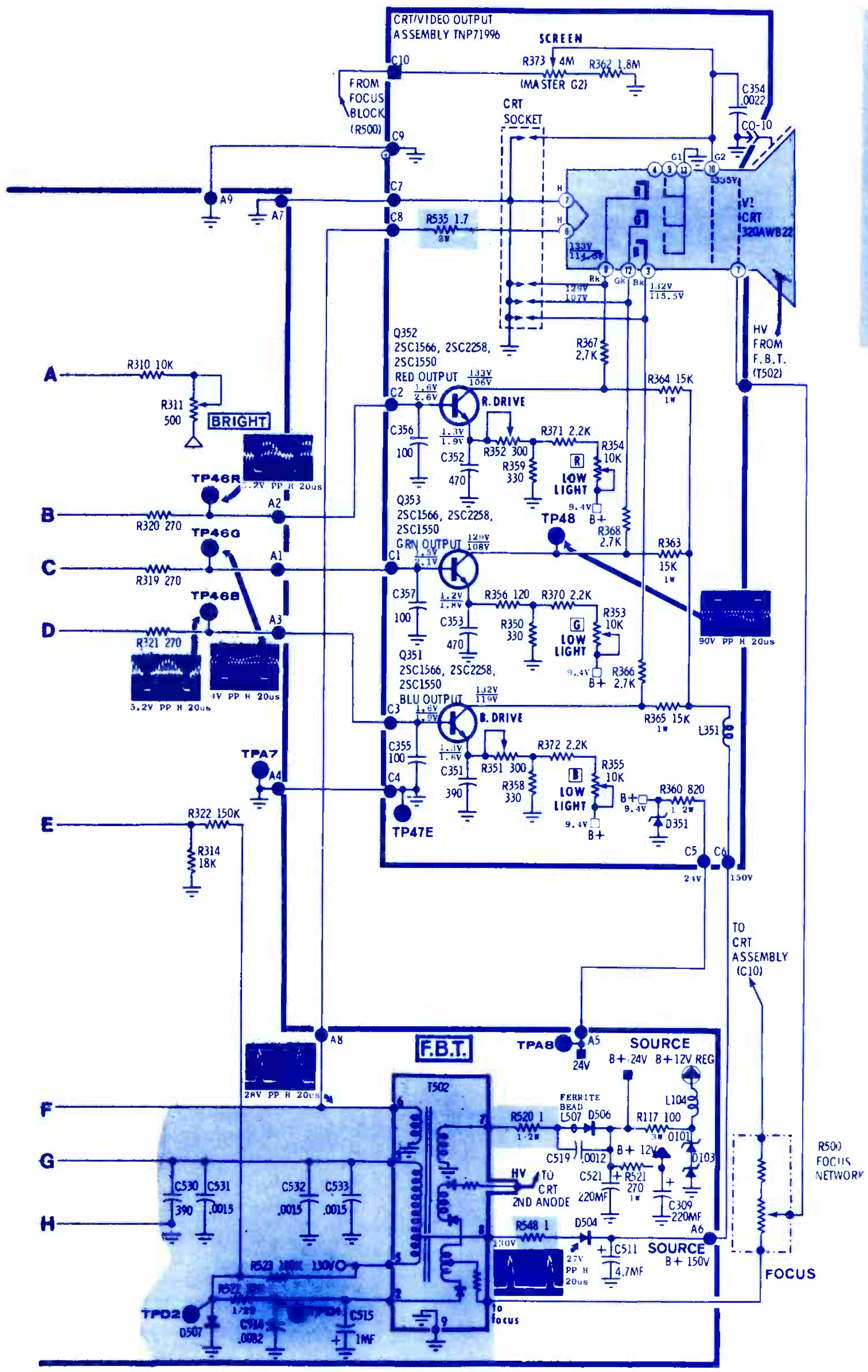
JUNE • 1980

ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS



QUASAR
Color TV Chassis
TS-969



SERVICE TECHNICIAN: IMPORTANT NOTE
THIS RECEIVER HAS BEEN DESIGNED TO MEET OR EXCEED APPLICABLE SAFETY AND X-RADIATION PROTECTION AS SPECIFIED BY GOVERNMENT AGENCIES AND INDEPENDENT TESTING LABORATORIES.

TO MAINTAIN ORIGINAL PRODUCT SAFETY DESIGN STANDARDS, RELATIVE TO X-RADIATION, SHOCK AND FIRE HAZARD, THE PARTS SHOWN IN THE SHADED AREAS OF THIS SCHEMATIC MUST BE REPLACED WITH IDENTICAL REPLACEMENT PARTS. ORDER PARTS FROM YOUR QUASAR DISTRIBUTOR USING PART NUMBERS SHOWN IN THE SERVICE MANUAL OR GIVE COMPLETE CHASSIS NUMBER AND PART REFERENCE NUMBER.

FOR OPTIMUM PERFORMANCE AND RELIABILITY, ALL OTHER PARTS SHOULD BE REPLACED WITH COMPONENTS HAVING IDENTICAL SPECIFICATIONS.

MPORTANT NOTES:

Each component is identified with a reference number and a prefix letter (i.e. R201) which is related to legend on the panels. Numbers vary with circuit association as indicated below.

ASSOCIATED CIRCUIT	REFERENCE DESIGNATION
IF/AFT	100-199
Audio	200-299
Video	300-399
Vertical	400-499
Horizontal – HV	500-599
Chroma – VIR	600-699
Pincushion	700-799
Power Supply	800-899
Tuner	000-99

1. VOLTAGE MEASUREMENTS: EXCEPT WHERE NOTED, TAKEN FROM POINT INDICATED TO CHASSIS WITH AN ACCURATELY CALIBRATED VTVM.

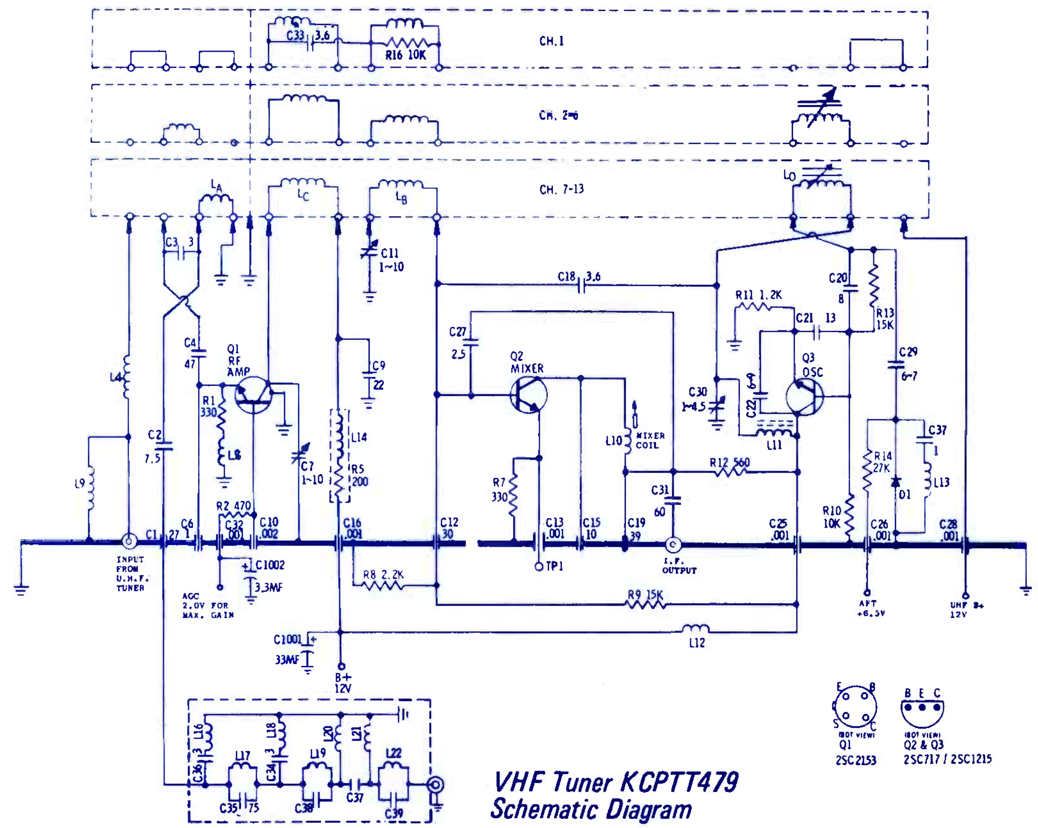
AC INPUT TO RECEIVER 120V. CONTROLS AT NORMAL SETTING. DYNACOLOR "ON". SOME VOLTAGE READINGS WILL VARY WITH ASSOCIATED CONTROL SETTINGS AND SIGNAL STRENGTH.

WHERE TWO (2) VOLTAGES ARE SHOWN, THEY REPRESENT VOLTAGE WITH AND WITHOUT SIGNAL AS FOLLOWS:
20V – ZERO SIGNAL (TUNER BETWEEN CHANNELS)
16V – AIR SIGNAL
VOLTAGES WITH * INDICATE AIR SIGNAL WITH VIR.

2. WAVEFORM MEASUREMENTS – TAKEN WITH A STANDARD GATED RAINBOW TYPE COLOR BAR PATTERN. RECEIVER ADJUSTED FOR NORMAL VIEWING AS IN TRANSMITTED AIR SIGNAL.

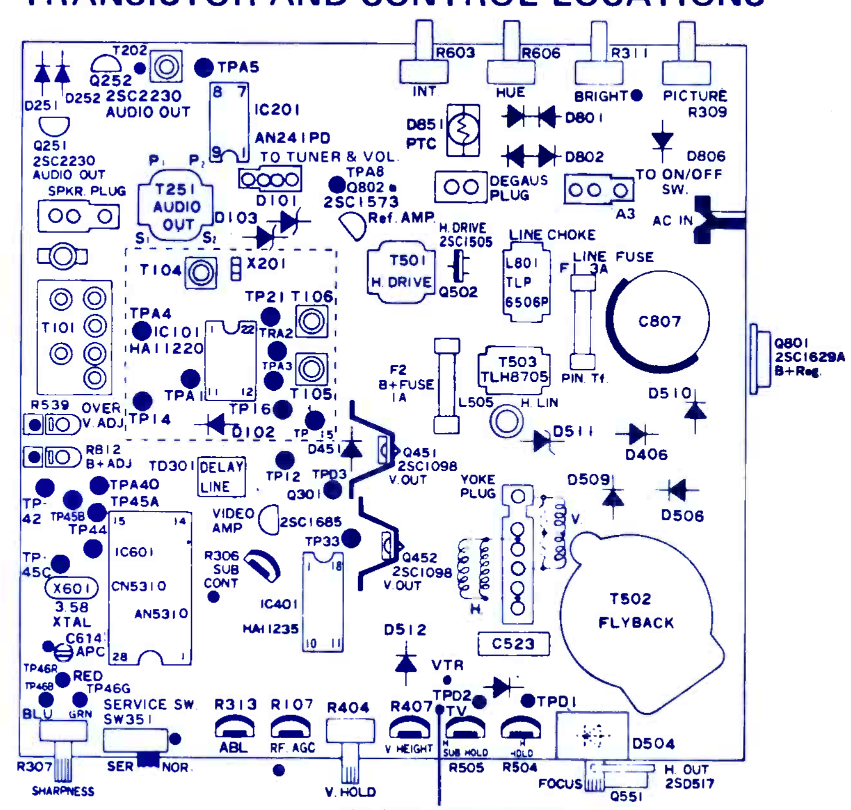
3. ALL VIDEO AND COLOR WAVEFORMS TAKEN WITH A WIDE-BAND SCOPE AND A PROBE WITH LOW INPUT CAPACITY (10 TO 1). SHAPE AND PEAK-TO-PEAK AMPLITUDES MAY VARY DEPENDING ON CALIBRATION, TYPE OF TEST EQUIPMENT USED, AND CONTROL SETTINGS.

4. UNLESS OTHERWISE SPECIFIED: RESISTORS ARE 1/4W 5%. CAPACITOR VALUES LESS THAN ONE IN MF, ALL OTHERS IN PF. CAPACITANCE VALUES ONLY ARE SHOWN ON SCHEMATIC DIAGRAM. FOR COMPLETE DESCRIPTION OF CAPACITORS, REFER TO PARTS LIST.



VHF Tuner KCPTT479
Schematic Diagram

TRANSISTOR AND CONTROL LOCATIONS



TV–VTR CONNECTOR
Set to VTR position if flagging occurs in VTR operation

1850

PANASONIC
B&W TV Chassis
T801-A

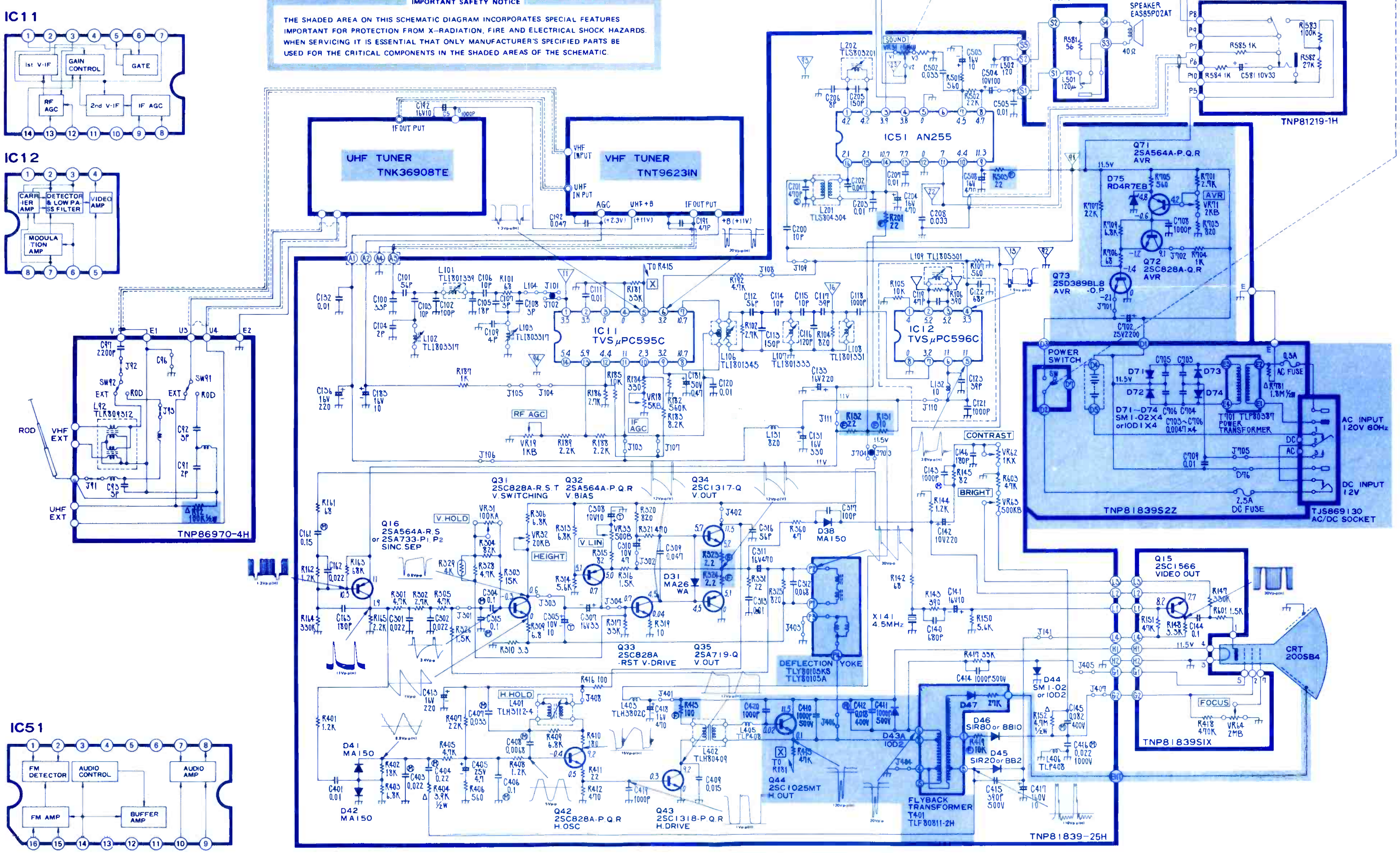
JUNE • 1980

ET/D TEKFAX

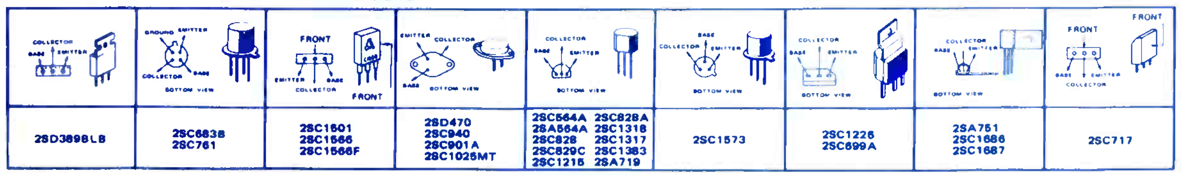
COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS

IMPORTANT SAFETY NOTICE

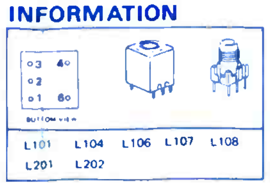
THE SHADED AREA ON THIS SCHEMATIC DIAGRAM INCORPORATES SPECIAL FEATURES IMPORTANT FOR PROTECTION FROM X-RADIATION, FIRE AND ELECTRICAL SHOCK HAZARDS. WHEN SERVICING IT IS ESSENTIAL THAT ONLY MANUFACTURER'S SPECIFIED PARTS BE USED FOR THE CRITICAL COMPONENTS IN THE SHADED AREAS OF THE SCHEMATIC.



TRANSISTOR BASE INFORMATION



TRANSFORMER TERMINATION INFORMATION



NOTE

1. RESISTOR
   All resistors are carbon 1/4W resistor, unless otherwise noted the following marks.
   Unit of resistance is OHM (Ω). (K=1,000 M=1,000,000)
   - Solid resistor
   - Wire wound resistor
   - Fuse resistor
   - Metal oxide resistor
   - Thermistor
   - Non Flame Resistor
2. CAPACITOR
   All capacitors are ceramic 50V capacitor, unless otherwise noted the following marks.
   Unit of capacitance is μF, unless otherwise noted.
   - M Polyester capacitor
   - Electrolytic capacitor
   - S Polystylene capacitor
   - T Tantalum capacitor
3. COIL
   Unit of inductance is μH
4. TEST POINT
   Test point position.
5. VOLTAGE MEASUREMENT
   Voltage is measured by a VTVM receiving normal signal, when all controls are set to the maximum position.
6. Number in red circle indicates waveform number.
7. When arrow mark (↗) is found, connection is easily found along with the direction of an arrow.
8. When schematic diagram of a board is described in more than two places, they are encircled with dotted line (— - - —).
9. This schematic diagram is the latest at the time of printing and subject to change without notice.

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JAPANESE TRANSISTOR SUBSTITUTION MANUAL

An invaluable Japanese to Japanese substitution guide for approximately 3000 transistors

- Covers the 2SA, 2SB, 2SC and 2SD series
- Introduction includes a guide to understanding Japanese transistors
- A 90 page, 8½" by 11" soft cover book

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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	3.20	3.40	3.70
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
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2SC 394	.20	.27	.30
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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
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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
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2SC 829	.20	.27	.30
2SC 830H	2.50	2.70	3.00
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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	.30	.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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