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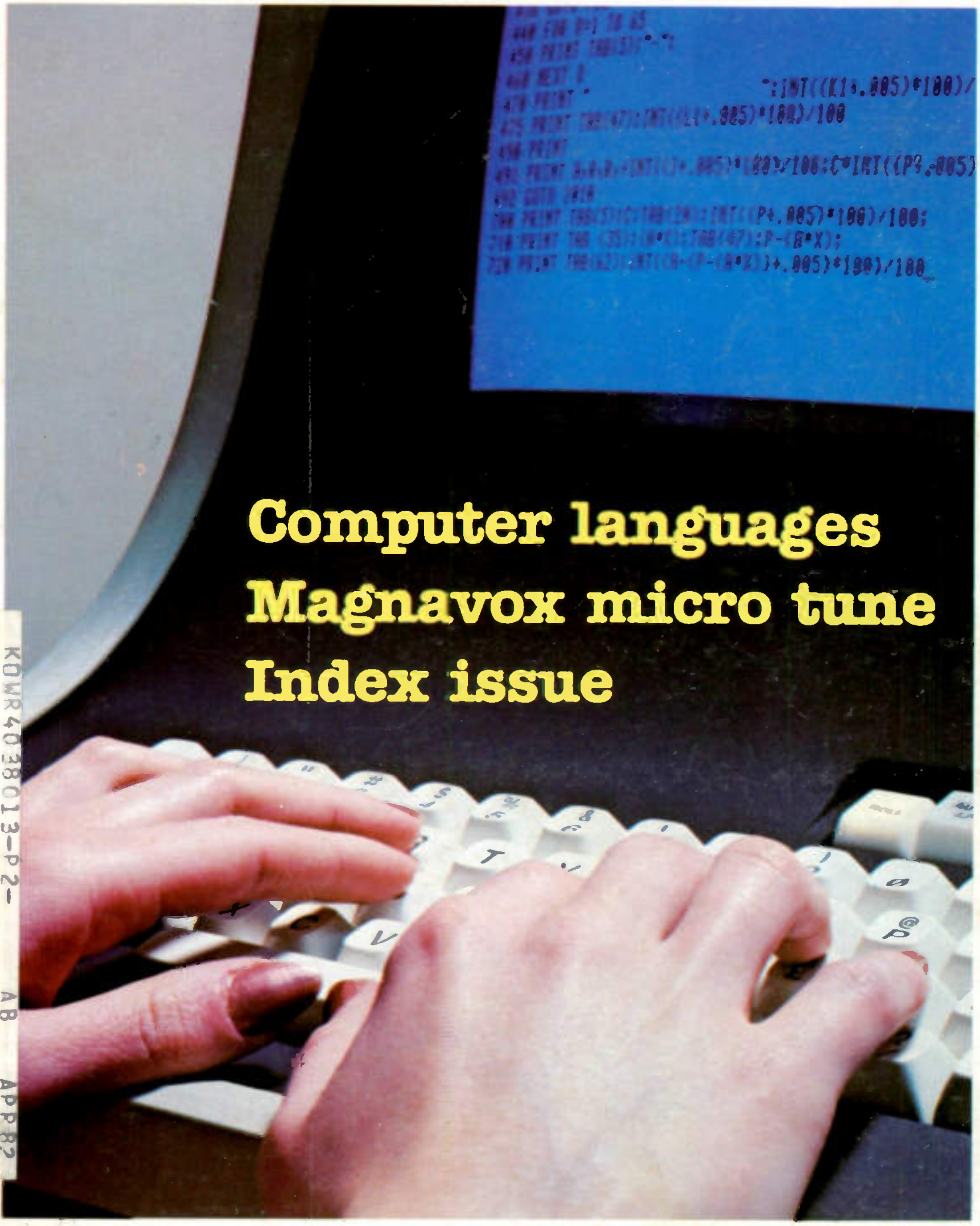

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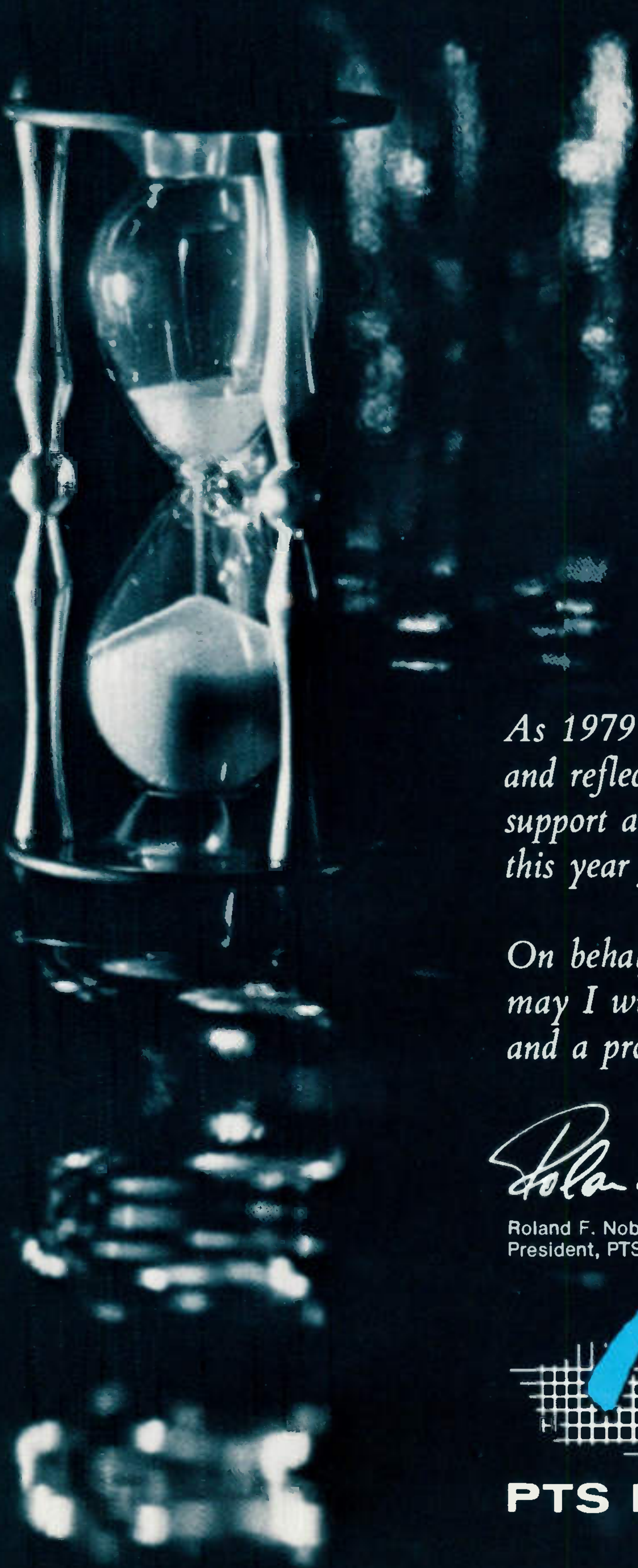

INDUSTRY REPORT

Video Disc Growth Predicted

Video disc players may have penetrated 40 million American homes by 1989, according to a man in charge of marketing such players for RCA.

In a recent statement Herbert S. Schlosser, RCA executive vice president, said "we're talking about a multi-billion dollar industry" that will have penetrated 30 to 50 per cent of the nations color television homes.

"We are beginning to see the emergence of other channels of communication to the home," Schlosser said, "the television set will be used as a 'receiving screen' for audio-visual material from many sources. Among these sources, he said, are multi-channel cable TV, pay cable, over the air pay TV, two-way interacting pay-TV, teletext, home computers, TV games, home movies on video tape, pre-recorded cassettes, and the video disc.

"Of these technological innovations, none holds more promise than the video disc in overcoming the limitations of having to appeal to a majority of the people and answering to the imperatives of advertising," Schlosser said.

The video disc will permit "narrow-casting" to smaller audiences than a large national network would be interested in catering to. "And it will be possible to make a profit reaching a fraction of the audience required for success in commercial television," he added.

He added there may also be a greater market for certain features on video disc than at the box office. Less than 10 per cent of the public sees a hit motion picture, he said, and maybe only 25 per cent see a "blockbuster."

"Now these people can see the movie of their choice in the comfort of the living room for less than the price of two tickets and the cost of a baby-sitter, gasoline and parking the car," he added.

Zenith Chairman Resigns

John J. Nevin, Zenith Radio Corporation's chairman of the board since 1971, resigned his post in a surprise move. According to Zenith spokesmen, Nevin will "pursue interests outside the electronics industry."

Nevin's position has been temporarily filled by former Zenith chairman Joseph S. Wright.

During Nevin's tenure Zenith reduced its U.S. workforce by about 25 per cent, moved its module and chassis assembly operations to foreign shores, and saw declining profits in recent years despite its leadership role in television sales.

All of this was in part generated, according to Nevin, by television "dumping" policies of Japanese manufacturers. It was Nevin's contention that the selling of Japanese television sets in this country for less than they sold for in Japan was illegal and prompted him to lead his long fight for "anti-dumping" measures. His efforts are now about to result in strong anti-dumping rules by the U.S. government. Several Nevin instituted court fights still remain to be resolved on the legal front.

Wright, who is expected to serve as interim chairman only, issued a statement following Nevin's resignation that denied Nevin was forced to resign as some newspaper stories had alleged.

ETA Announces New Exam

The Electronics Technicians Association—International has announced that it is now offering a new examination to qualify technicians with eight years or more experience into a new category.

The category, to be known as Senior Electronics Technician, will be available for technicians in a number of areas, including radio and television, audio-Hi-Fi, MATV, VTR, computer and industrial, bio medical, aviation or two-way communications.

According to ETA's Certification Director Ron Crow, a technician may qualify for the new category by passing an exam with a grade of at least 85 per cent and having schooling and work experience totaling eight years or more.

Fee for the exam is $35. Further information is avialable from Crow by writing: ETA Certification Director, P.O. Box 1258, ISU Station, Ames, Iowa, 50010.

Video Disc Training Completed

Magnavox, the first to market a home video disc player in the United States, says 42 technicians comprised the first class to complete training recently on the system, called "Magnavision."

The technicians attended a national service conference at the company's Fort Wayne, Ind., headquarters which was put on by Magnavox engineering and production groups. Magnavision, with very limited introduction in the United States thus far, is scheduled to be marketed nationally early next year.

VCR Growth Seen

A survey by Japan's Electronic Industries Association reports that expectations are for 850,000 VCR sales in the United States during 1980 but this figure should grow to 1.5 million the following year.

Additionally, the survey predicted that 50 per cent of the VCR owners will eventually buy a color television camera to go with it, but not until prices fall significantly. ET/D

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ELECTRONIC TECHNICIAN/DEALER

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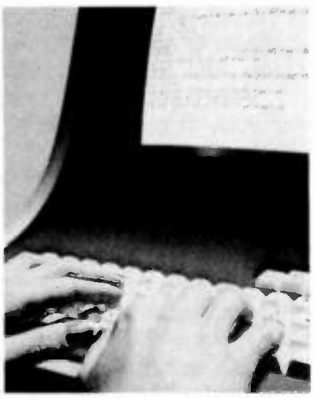

On the cover: A computer programmer "in action." This source program "typed" into the computer in high level language is ultimately translated, via the language compiler, into the binary language of the computer.

FEATURES

DEPARTMENTS

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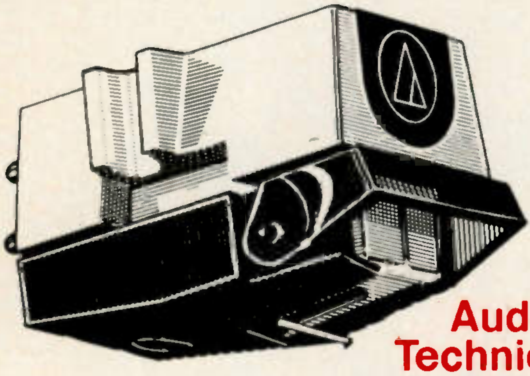

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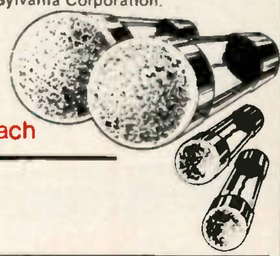

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AN246	4.40	CX131A	9.90	HA1325	2.20	LD3001	1.80	M5192P	3.60	STK013	8.00	TA7027	2.40	TA7154	4.60	UPC29C	5.30		
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AN252	2.90	CX134A	9.80	HA1339P	2.30	LD3141	1.40	M51171L	1.60	STK015	3.90	TA7054	2.00	TA7157	2.80	UPC48C	3.00		
AN253	2.20	CX135	9.80	HA1342A	2.30	LD3150	1.40	M51182L	2.00	STK016	4.90	TA7055	2.25	TA7158	3.20	UPC48C	3.00		
AN260	2.10	CX136A	9.80	HA1339A	2.30	LM320H5	.90	M51512	2.90	STK020	4.90	TA7060	.80	TA7159	1.80	UPC81C	6.00		
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AN7145	4.20	HA1149	3.60	LA3155	1.80	LM2111	1.00	STK0025	4.80	STK086	18.90	TA7122AP	.90	TA7302	1.40	UPC1008H	4.10		
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	8024A	9	26	3½	0.1%	X	Direct temperature readings; continuity/ input level detector with selectable audible signal; peak hold capability.	Available soon
BENCH/PORTABLES	8010A	7	31	3½	0.1%	X	True RMS; extra 10A range.	$239
	8012A	7	31	3½	0.1%	X	True RMS; two extra low resistance ranges.	$299
	8050A	9	39	4½	0.03%	X	True RMS; selectable reference impedances with direct readouts in dBm; offset feature.	$329

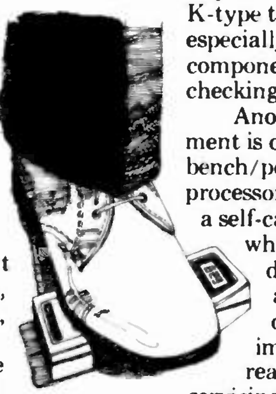
When you're looking for genuine value in a low-cost DMM you have a lot more to consider than price. You need information about ruggedness, reliability and ease of operation. Accuracy is important. And so are special measurement capabilities. But above all, you must consider the source, and that company's reputation for service and support.

Fact is, as electronics become more a part of our daily lives, dozens of new manufacturers are rushing to market their "new" DMM's. In theory, this is healthy; but in practice, crowding is confusion.

To help you deal with this flood of new products, here are some facts you should know about low-cost DMM's.

The economics of endurance.

Even the least expensive DMM isn't disposable. Accidents happen, and test instruments should be built to take the abuses of life as we live it.



Look for a DMM with a low parts count for reliability, and rugged internal construction protected by a high-impact shell. Make sure the unit meets severe military tests for shock and vibration.

Another feature to check out is protection against overloading, whether from unexpected inputs, transients, or human errors.

Just for the record, all Fluke low-cost DMM's meet or exceed military specs, and feature extensive overload protection.

The importance of being honest.

Just because a multimeter is digital doesn't mean it's automatically more *accurate* than a VOM — even though the LCD might give you that impression. The benchmark for accuracy in DMM's is *basic dc accuracy*. The specs will list it as a percentage of the reading for various dc voltage ranges.

Of course accuracy is more critical in some applications than others, and increasing precision and resolution in a DMM usually means increasing price. In the Fluke line, you can choose a model with a basic accuracy of 0.25% (the 8022A), others rated at 0.1%, or the new 8050A bench/portable at 0.03%.

Special measurements: getting more from your DMM.

Actually, for all the variations in size, shape and semantics, most DMM's perform five basic measurements: ac and dc voltage and current, and resistance. Prices vary according to the number of ranges and functions a DMM delivers.

The Fluke line includes DMM's with from 24 to 39 ranges, 3½ and 4½-digit resolution, and some unique functions you won't find in any other DMM. Additional measurement capabilities like temperature, dB, conductance and circuit level detection.

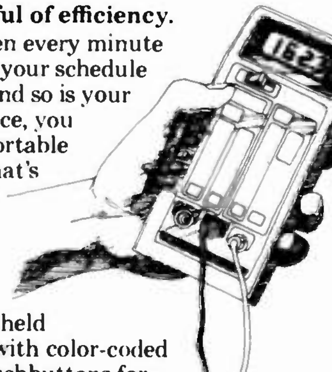
If your work involves temperature measurements, the new 8024A delivers direct temperature readings via any K-type thermocouple. This is especially useful in testing component heat rise and checking refrigeration systems.

Another talented instrument is our new 8050A bench/portable. The microprocessor-based 8050A features a self-calculating dB mode in which dBm readings are displayed automatically referenced to one of 16 selectable impedance ranges — a real timesaver when servicing audio equipment.

And of course no discussion of DMM's is complete without considering conductance — a Fluke exclusive featured on five of our low-cost DMM's — which allows you to make accurate resistance measurements to 100,000 Megohms. You can't do that with any ordinary multimeter, but it's a must for checking leakage in capacitors and measuring transistor gain.

A handful of efficiency.

When every minute matters, your schedule is tight and so is your work space, you need a portable DMM that's fast and easy to operate. We designed our handheld DMM's with color-coded in-line pushbuttons for true one-hand operation: no need to hang onto the meter with one hand while twisting a rotary dial with the other.



But there's more to convenience than fingertip control. The 8024A, for example, is also designed to function as an instant continuity tester, with a selectable audio tone to indicate shorts or opens. It also has a peak hold feature to capture transients.

A word about warranties.

Last but not least, look closely at the company that manufactures a low-cost DMM. Their service is just as important as their product. Look for no-nonsense warranties, a large family of accessories, an established network of service centers and technical experts you can rely on.

That's how you'll recognize a knowledgeable supplier of low-cost DMM's, a company with experience, resources and a commitment to leadership in the industry.

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Look for more facts from Fluke in future issues of this publication. Or call toll free **800-426-0361**; use the coupon below; or contact your Fluke stocking distributor, sales office or representative.

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☐ Please send the facts on Fluke low-cost DMM's—specifications, applications information, and selection considerations.

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ETD 12/79

For literature circle no. 109.

LETTERS

LIKES DIGITAL.

I really enjoy the articles on Digital Electronics and hope to see more in the future. Joe Carr does a very good job on the subject, he is a writer that you know where he is coming from.
Thank you.
Ed Trojan
720 Caldwell St.
Chester, PA 19013

HELP NEEDED!

I am rebuilding an old radio and I need a power transformer. I wonder if you or the readers of your fine magazine might be able to help. The radio is a Canadian made Rogers Majestic, Serial #29-1079 possibly called "The Ten-45" Serial #115v-05A-25-60C–Type 29. Below is a list of tubes used, maybe someone will know of a replacement or combination of transformers which could be used. 6A8-6K7-6B8-80-6K6.

Also, I would appreciate a schematic if anyone has one.
Wayne Carter
Carlea Electronics
55 Sharpe St.
New Liskeard, Ontario P0J 1P0

Editor: We were able to suggest a couple of likely power transformer replacements but have no schematic or other information this radio. Perhaps one of our readers could help.

I need a schematic and parts list for a Simpson Giant Set Tester Model 320 (made before World War II). I would also like to buy another 320 for parts.
Jack Smith
J.E. Smith Radio Shop
130 Cherry St.
Montezuma, GA 31063

I need a meter for a Jackson Dynamic Output Tube Tester Model #658-1.
Richard E. Napper
811 Osage
Manhattan, Kansas 66502

Can you help me? I am looking for companies that sell educational radio and television kits. I need them for a group of students.
Eric Glucksman
76-25 Commonwealth Blvd.
Bellerose, NY 11426 ET/D

ET/D welcomes letters from readers and tries to answer all requests in this column or individually.

ET/D

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FROM THE EDITOR'S DESK

The pace of electronic technology has been almost beyond reason in this decade.

Reviewing the consumer electronics decade we are about to put behind us, we note the very first issue in January 1970 stated with some element of surprise, that "many (TV) sets are going from hybrid toward all solid-state chassis with additional transistors and integrated circuits . . . (which) are creating a color picture and perform the most critical and complex job in the entire set."

And, though minuscule in nature, the early 1970s brought the introduction of electronic tuners into the American home.

By January of 1973, then Editor Phillip Dahlen was well into his six part series on Basic Digital Circuitry as the industry began to see these types of circuits move with great rapidity into the new consumer market test instruments, i.e., digital counters and DMMs. And in September of that year, this prophetic forecast appeared on page 42: "By 1980, computer assisted design, computer assisted quality control, plug in circuits, etc., will reduce malfunctions of home entertainment systems greatly. However, more and more gadgets will appear on electronic equipment to go wrong. Equipment will undoubtedly be more sophisticated, but in one sense easier to service for an outside man. Again, there will be larger quantities of electronic devices to service in the home and the outside man will undoubtedly have to be knowledgeable and versatile on all home electronic products."

In 1974 it became increasingly clear that even the "mystifying" transistor was on its way out as the staple of the television receiver. For more and more manufacturers, the Japanese with special vigor, were well on their way toward implementing the signal processing circuitry in their sets with medium to large scale Integrated Circuits.

Now servicing itself took on a new and added dimension. The concept changed from "troubleshooting" individual discrete components to observing and checking for "functional" discrepancies.

Then it happened: The advent of the home computer through a small group of dedicated and enthusiastic hobbyists who refuse to be denied. They brought to home electronics servicing—the microprocessor. What is it?, you asked. Is it important? Will it go away?

No!

By 1978 ET/D was showing you the world of large scale integrated digital circuitry through introductory articles on the microprocessor, its functions and its uses. Devices with up to 8,500 transistors "locked" inside of those little black boxes.

Now as the decade rolls to a close, we finish up the 1970s with an instructional series on this still relatively new phenomenon to consumer electronics. We also take a rather complete look at a microprocessor controlled tuning system in one of today's major brand TV receivers. A commonplace circumstance in this day and age.

What a trip. From transistors to micros in 10 fleeting years.

If indeed you've kept pace with the technologies of the decade, you're in good shape.

Richard W. Lay

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SYLVANIA GTE

All entries must be postmarked no later than midnight, December 31, 1979.

NEWSLINE

NEW SATELLITE-CABLE COMPANY FORMED. Amex Satellite Entertainment Corporation, the company formed through a venture of Warner Communications and American Express Company, will use satellites to distribute programs to the fast growing cable television market. According to new President John Schneider: "The supplying of program to cable systems has an explosive future."

SATELLITE TV FOR REMOTE AREAS. A plan for broadcasting news, sports and entertainment to remote areas of the world via satellite has been announced by Western Union and Video Communications, Inc. According to spokesmen for the project it is expected to have an immense impact on employes of subscriber companies who are stationed in remote parts of the world. The project, which will use WESTAR is scheduled to begin January 1 with 12 hours of programming per day. This will be expanded to 24-hour operation by the end of 1980.

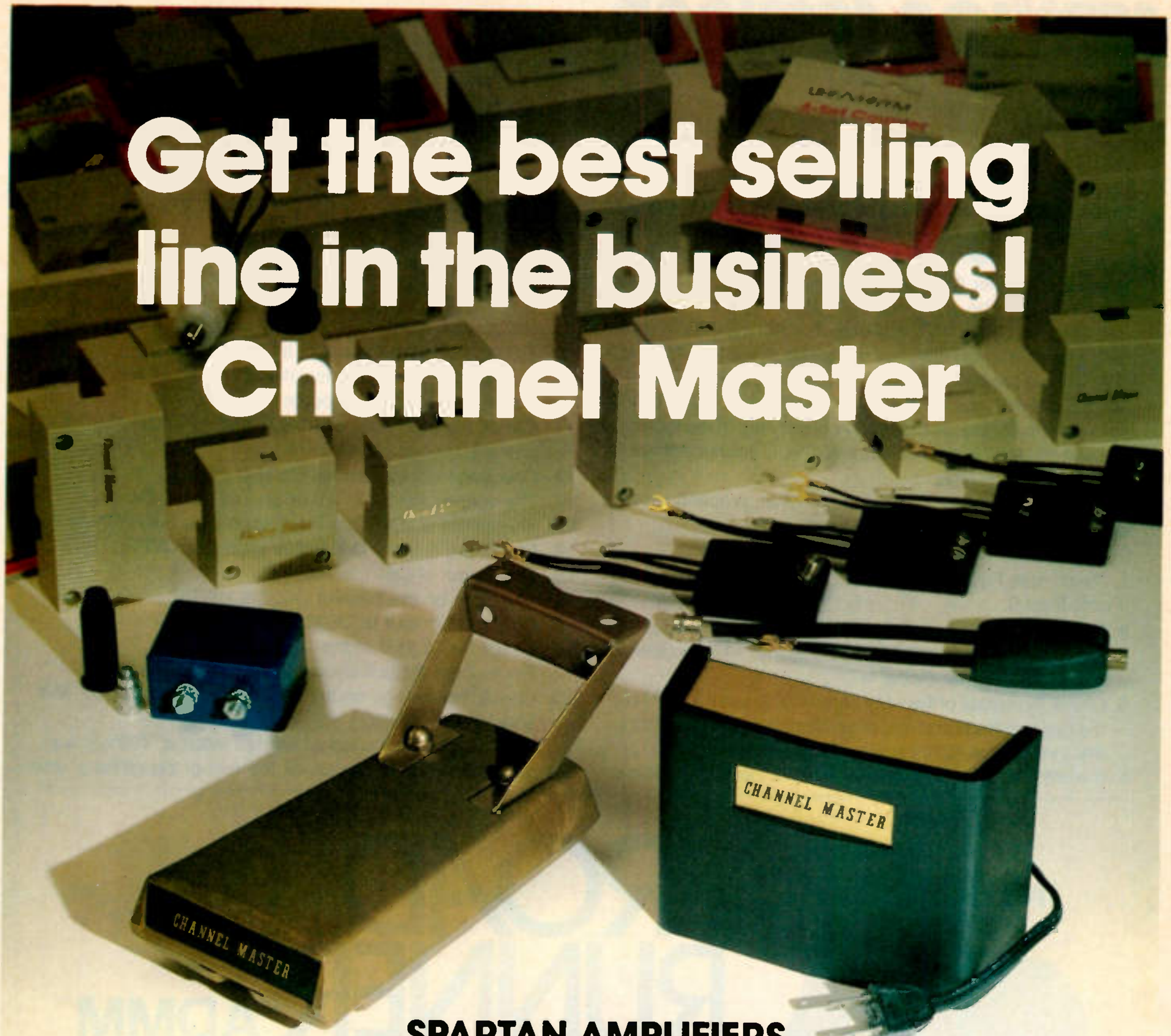
IHF-EIA MERGER COMPLETED. The proposed merger of the Institute of High Fidelity with the Electronic Industries Association's Consumer Electronics group has now been completed. The merged organization of IHF is now an operating subdivision of the consumer group's Audio Division. A spokesman says existing IHF programs will be maintained.

VIDEO JUKEBOX ANNOUNCED. Showtime Systems International, an Ohio based entertainment distributor, says it will install at least 200 video jukeboxes within the next year. The video jukebox uses a capacitance pickup system and is limited to a maximum playing time of about 10-minutes per disc--more than enough time for most pop records. A user selects one of about 50 discs for 25-cents and then watches the performance on one of several monitors. The system is made by General Corporation of Japan.

AM STEREO REPORTED A SUCCESS. Three years of testing Motorola's "C-Quam," AM-stereo system have proved it to be a feasible method. That's the opinion, at least, of the Motorola personnel who conducted the tests. According to Motorola the system has been most recently tested in live broadcasts over WGN, Chicago and WTAQ, a LaGrange, Ill., radio station. A spokesman said: "The tests... confirm that C-Quam provides ease of conversion, IPM insensitivity, excellent stereo coverage...and a self-compensating pilot tone."

HARMAN-KARDON SOLD. Negotiations have been completed on the sale of hi-fi, stereo marketer Harman-Kardon to the Shin-Shirasuna Electric Company of Japan. The deal pulls H-K away from Beatrice Food's Harman International. Shin-Shirasuna has been a major supplier of audio equipment to private label customers and this marks the first entry of the Japanese firm into the U.S. market under its name.

TECHNICIAN EMPLOYMENT POOL ORGANIZED. The Electronics Technicians Association International has announced a "Career Opportunity Program," to match good technicians with potential employers. Members can submit applications to ETA Headquarters. Employers and others interested can write: ETA, 7046 Doris Drive, Indianapolis, IN 46224, for information.



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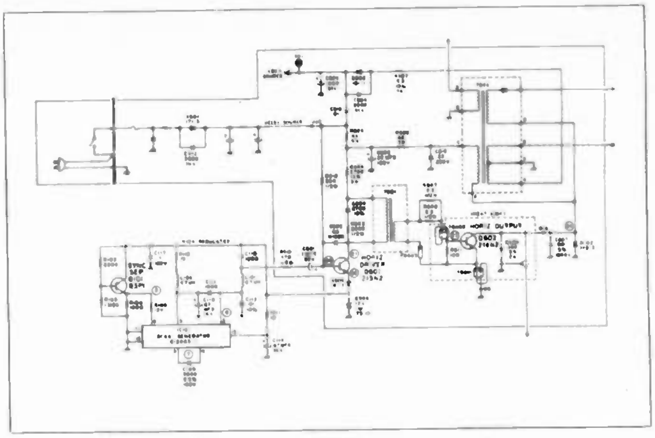
SERVICE SEMINAR

MAGNAVOX

T997 Power Supply Service
Magnavox has developed the following circuit description and troubleshooting procedure. The T997 chassis has a typical power supply that has the secondary voltages taken from the flyback transformer. The +135V source supplies the horizontal driver transistor Q601 which is in series with a 12V zener diode (D503). The +12V source taken from the zener, is applied to Pin 13 of IC101. The output on Pin 2 is 6.8VPP at the horizontal rate which drive the horizontal driver transistor with 4VPP. The drive to the base of the horizontal output transistor, Q602, is 20VPP and the output of the transistor is 700VPP to drive the flyback transformer. A secondary tap of the flyback is rectified by D502 to generate the +20VDC source voltage for the rest of the chassis.

If the T997 chassis is totally inoperative, proceed with the following troubleshooting steps:

1. Remove the cabinet backing.
2. Check fuse F301 (1.8A-125V). Don't plug the chassis in until Step 8.
3. Remove cathode end of diode D502 from the circuit board.
4. Apply an external +12Vdc supply at the +12V regulated line at D503 zener diode.
5. Check the output of the scan generator to see if 4VPP is on the base of the horizontal driver transistor 0601. (Without the 4VPP drive, Q601 and/or R604 will fail).
6. If everything has checked OK, remove the +12V source.



7. Turn the brightness control all the way down.
8. Plug the chassis into an isolation transformer and turn on.
9. Check the +135VCD source.
10. Check the +20VDC source. If the +20VDC source is present, proceed to Step 21.
11. Check the voltage across D503 (12VDC).
12. The voltage Pin 13 of IC101 should be +12V.
13. The output of IC101 on Pin 2 should be 6.8VPP.
14. Check the drive of Q601, this should be 4VPP.
15. The output of Q601 is 150VPP.
16. The drive on the base of Q602 is 20VPP.
17. Check the output of Q602, this should be 700VPP.
18. Check for 11.5KV at the CRT anode.
19. Pin 4 of the flyback should be 140VPP.
20. Check the voltage on the open end of diode D502, this should be +20VDC.
21. If the power supply checked OK, an external +20Vdc supply can be used at TP1 to check the rest of the chassis. ETD

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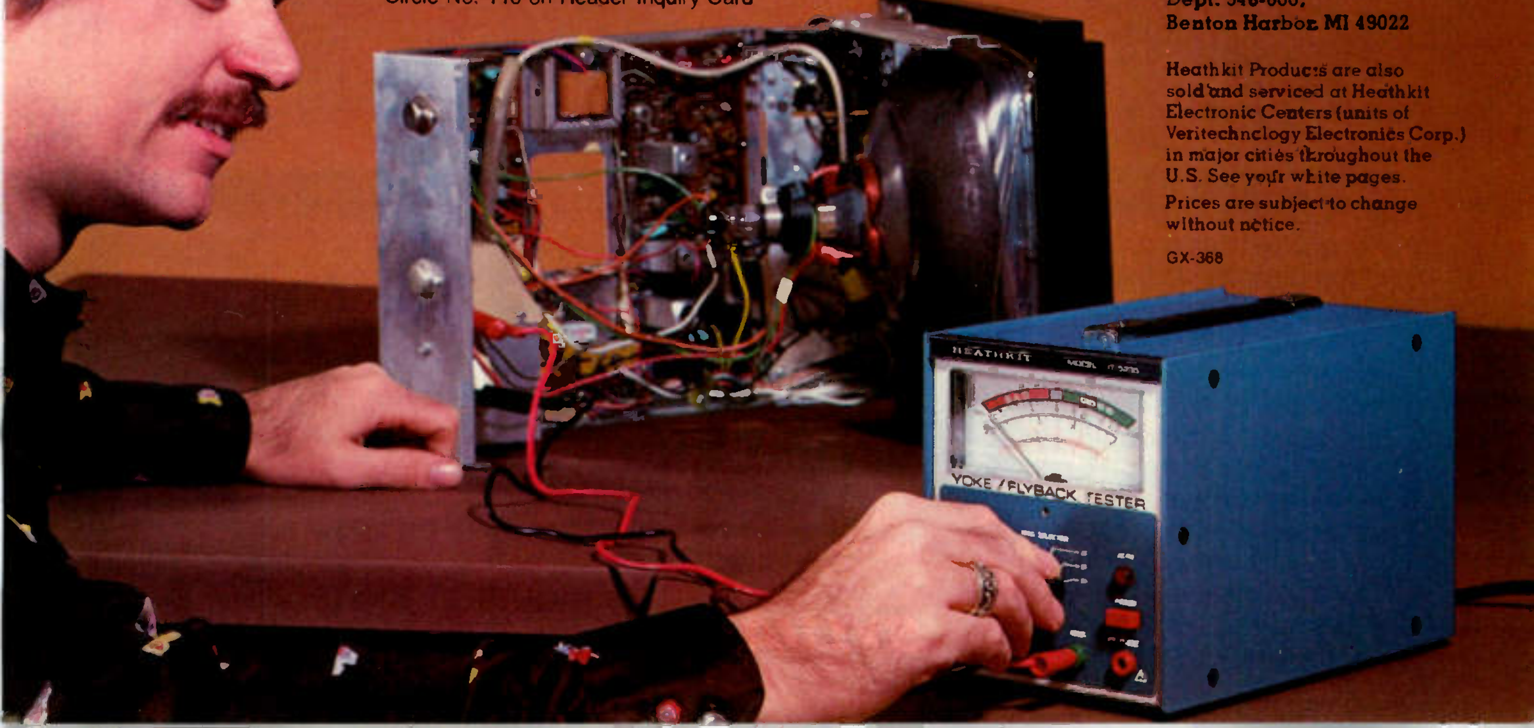

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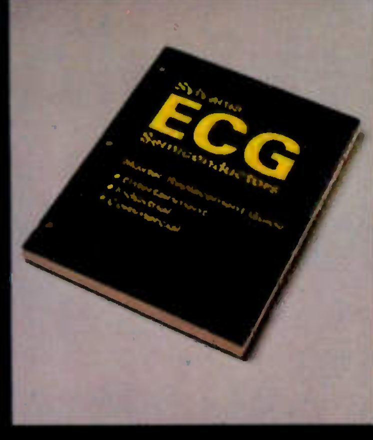

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Basic microprocessor operations

Looking at language

Machines that "speak" numbers? You bet! And you better speak "it" too if you plan on working with microprocessors. For a look at the language that computers use—and how you can get their attention—here's the second article in ET/D's series explaining how the "micro" does what it does.

By Bernard B. Daien

Since the microprocessor by itself can perform so few functions, most applications involve the MPU plus other hardware and firmware, in other words, a microcomputer or controller. This is what most people really mean when they say "microprocessor." Since the microcomputer does only what it is told to do, we must look at how we can talk to it. To do this we have to learn a few simple terms.

An "instruction" causes the MPU to perform a desired "operation" on the data. An "operation" is an action, such as moving information, adding, subtracting, accepting data from an input, delivering data to an output, etc.

The MPU requires that instructions and data be in binary form. The MPU *performs all of its operations in binary,* and data is stored in binary form. "Binary" means "two," an abbreviation for two possible states. An ordinary light switch is a binary device since it has only two states, "on" and "off." In the on state, current flows, in the off state the current drops to zero. In binary language we refer to these two states as "one" and "zero." One usually means the presence of a signal and zero the absence of the signal, though "negative" logic employs reversed meanings.

Since the decimal system of numbers in common use has ten possible states, we ordinarily require ten different numbers, zero through nine. However, in binary only two digits are required, zero and one. When we write instructions for the MPU, using 1's and 0's, it is said that we are using "machine language," since we are talking to the MPU in its own language, *binary.* Machine language is often referred to as "machine code."

Just as English is broken into letters and words, so machine language is composed of "bits" and "bytes." The smallest piece is a binary digit, called a bit, and derived from "Binary digIT." A group of bits forms a byte. The byte used by early MPUs consisted of four bits. Modern MPUs use eight or 16 bit bytes. Often two eight bit bytes are used to form a total of 16 bits. There are advantages in having longer words, as will be evident later. A group of bits, one byte or less in length, is often referred to as a "word." Often the terms byte and word are used interchangeably.

Writing programs in binary machine code is very tedious, as a result, errors creep in. For example, try writing one hundred bytes of 8 bits each, such as 10011101. Worse yet, try remembering them! Remember, most MPUs handle bytes (words) of eight bits length. In order to facilitate programming, we can reduce the number of digits in a word by using other number systems, based on 8 (octal), or 16 (hexadecimal). The reason for using systems based on 8 or 16 is that they can readily be converted into binary, and binary can be readily converted into them. (Binary can be divided into either 8 or 16, and 2×2×2 equals 8, while 2×2×2×2 equals 16.)

Machine language codes table

Decimal	Binary	Octal	Hexa-Decimal
0	00000000	000	00
1	00000001	001	01
2	00000010	002	02
3	00000011	003	03
4	00000100	004	04
5	00000101	005	05
6	00000110	006	06
7	00000111	007	07
8	00001000	010	08
9	00001001	011	09
10	00001010	012	0A
11	00001011	013	0B
12	00001100	014	0C
13	00001101	015	0D
14	00001110	016	0E
15	00001111	017	0F
16	00010000	020	10
17	00010001	021	11
18	00010010	022	12

Fig 1 A comparison of the machine language codes and their decimal equivalents.

Why hexidecimal?

In order to program in hexadecimal we need 16 different digits, and since we have no numbers larger than 9 in our decimal system of notation, we resort to the device of *combining letters and numbers* to achieve 16 different combinations. Thus after 9, we use the letters A, then B, then C, then D, then E, and last, F. F is used to denote the 16th

JUMP AND BRANCH INSTRUCTIONS (M6800)

JUMP AND BRANCH		RELATIVE			INDEX			EXTND			INHER				5	4	3	2	1	0
OPERATIONS	MNEMONIC	OP	~	#	OP	~	#	OP	~	#	OP	~	#	BRANCH TEST	H	I	N	Z	V	C
Branch Always	BRA	20	4	2										None	•	•	•	•	•	•
Branch If Carry Clear	BCC	24	4	2										$C = 0$	•	•	•	•	•	•
Branch If Carry Set	BCS	25	4	2										$C = 1$	•	•	•	•	•	•
Branch If = Zero	BEQ	27	4	2										$Z = 1$	•	•	•	•	•	•
Branch If ≥ Zero	BGE	2C	4	2										$N \oplus V = 0$	•	•	•	•	•	•
Branch If > Zero	BGT	2E	4	2										$Z + (N \oplus V) = 0$	•	•	•	•	•	•
Branch If Higher	BHI	22	4	2										$C + Z = 0$	•	•	•	•	•	•
Branch If ≤ Zero	BLE	2F	4	2										$Z + (N \oplus V) = 1$	•	•	•	•	•	•
Branch If Lower Or Same	BLS	23	4	2										$C + Z = 1$	•	•	•	•	•	•
Branch If < Zero	BLT	2D	4	2										$N + V = 1$	•	•	•	•	•	•
Branch If Minus	BMI	2B	4	2										$N = 1$	•	•	•	•	•	•
Branch If Not Equal Zero	BNE	26	4	2										$Z = 0$	•	•	•	•	•	•
Branch If Overflow Clear	BVC	28	4	2										$V = 0$	•	•	•	•	•	•
Branch If Overflow Set	BVS	29	4	2										$V = 1$	•	•	•	•	•	•
Branch If Plus	BPL	2A	4	2										$N = 0$	•	•	•	•	•	•
Branch To Subroutine	BSR	8D	8	2											•	•	•	•	•	•
Jump	JMP				6E	4	2	7E	3	3				See Special Operations	•	•	•	•	•	•
Jump To Subroutine	JSR				AD	8	2	BD	9	3					•	•	•	•	•	•
No Operation	NOP										01	2	1	Advances Prog. Cntr. Only	•	•	•	•	•	•
Return From Interrupt	RTI										3B	10	1					10		
Return From Subroutine	RTS										39	5	1	See special Operations	•	•	•	•	•	•
Software Interrupt	SWI										3F	12	1		•	S	•	•	•	•
Wait For Interrupt	WAI										3E	9	1		•	11	•	•	•	•

Fig. 2 Several of the 197 machine codes (and their meaning) available for use with Motorola's M6800 microprocessor chip.

combination. (Most people start with 1, but zero has significance . . . right?) Figure 1 shows the comparison of numbers in decimal, binary, octal, and hexadecimal codes. The eight bit byte in binary, consisting of 11111111 is the largest number that can be written with 8 binary bits, and equals the decimal number 256. We can write this same number with only 3 digits in octal, or only 2 digits in hexadecimal. Obviously this would simplify programming, reduce errors by using fewer digits, speed things up, and be much easier to remember.

It is important to point out that using octal or hex merely makes it more convenient for humans to talk to the MPU. Whether we use binary, octal, or hex, the program is ultimately converted to binary inside the MPU, since the machine does all its operations in binary. Octal and hex are to the MPU what shorthand is to dictation. The end result of shorthand is still English.

All of the popular MPUs have provisions for programming in hexadecimal as well as in binary. Even though binary is laborious, it is sometimes used in fault location.

The trouble with all machine languages is that they are merely a series of numbers, or numbers and letters, which bear no relationship to the operations to be performed. As a result they are very difficult to memorize, and must therefore be looked up repeatedly in tables, made for that purpose, by each MPU manufacturer. (See Fig. 2.) To ease this situation, other languages have been developed which ease programming considerably. The next more advanced language after machine language, is "assembly language." Assembly language uses "mnemonics," (a mnemonic is something that aids memorization). For example, the assembly language instruction for jump to another location might be, "jmp." These three, or four letter, mnemonics are obviously helpful not only to the programmer, but also to anyone else who might have to read the program later.

Assemblers

Some computers contain an "assembler program" (or simply an "assembler"), which enables the MPU to convert assembly language into the machine language used by the MPU . . . thus we use the computer itself as a translator! The assembler program is actually a "look up table" held in the MPUs memory, which is used much like a dictionary. The MPU examines each mnemonic, looks it up in its memory, and translates it into a machine code instruction. There are other "higher level" languages which offer even more advantages in programming, and we will look at them later. Assembly language is therefore classified as a "lower level" language.

The program as written in assembly language, or a higher level language, is called "the source program," because it *is* the original, or source program. After conversion back into machine code, it becomes "the object program," or "binary program," for obvious reasons. So you can see that it is the function of the *assembler* program to convert the mnemonics of a *source program* written in assembly language, into the binary *object program.* These definitions are the buzz words of the computer business, and you must become familiar with them if you wish to understand MPU literature.

The reason assembly language is considered a low level language is that the assembler translates the source program into an object program, one step at a time. One source instruction results in only one object instruction. This one-for-one relationship distinguishes assembly language from higher level languages which can order an entire series of machine code instructions performed with only a single high level instruction. Stated another way, a single high level statement is expanded into the several machine language instructions required for the complete execution of many problems. (See Figure 3.)

High level languages can "do more" with less effort . . . but the one-for-one relationship of assembly language has advantages at times. For example, it readily permits each step of a program to be examined separately for "debugging" a program.

High level variations

Higher level languages eliminate the mnemonics which were used to aid the memory in assembly language, because statements in English, or even mathematical formulae may be used directly in writing the program. Two families of higher level are frequently used with computers . . . "compiler language," and "interpreter language" . . and there are several variations of each, tailored for different types of uses.

A "compiler" (program) enables *the translation of an entire program* into machine code. Perhaps the best known compiler language is "Fortran," derived from "FORmula TRANslation," and, as its name implies, is used for mathematical statements. One Fortran statement results in all the instructions needed to completely solve a math equation! This demonstrates the fact that higher level languages are not limited to the step-by-step, one-for-one translation process of assembly language . . . a very significant improvement.

Another well known compiler language is "Cobol," derived from "COmmon Business Oriented Language," and is employed for such business uses as accounting, data handling, and inventorying. *A completed program is delivered by the compiler, and stored in memory for future execution.*

Frequently a compiler translates a high level language source program into an intermediate language such as assembly language, and then into the object program in machine code. The main advantage of compiler languages is their ease of use, and the ability to use programmers who have little knowledge of computer technology, since the source program is written in English statements, or common mathematical symbols.

An "interpreter," like a compiler, translates high level language into machine code, but the interpreter *does not deliver a complete object program.* Instead, each interpreter language statement is translated separately, *and executed in sequence, immediately.* This has some advantages.

Basic

One of the best known interpreter languages is "Basic," derived from "Beginners All-purpose Symbolic Instruction Code." Basic uses all English statements and mathematical expressions, *and is a very easy language to use.* It has wide application of educational purposes, and is the popular choice of most computer hobbyists. The fact that each source program statement is treated as an entity makes it much easier to debug interpreter language programs, and analyze the computer's operations.

PROGRAMMING CODES

High Level Language	Symbolic Code (Mnemonic)	Object Code (Hex)	Machine Language (binary)
Let X = 2	LDA #2	B6	10110110
	STA X	02	00000010
		B7	10110111
		46	01000110
		02	00000010

Fig. 3 The problems of programming. In a "high level" language the programmer would type in a single line of instruction and interpreters in the computer memory would do the rest of the translation. Using symbolic code as a programming language would take two lines to input the same information. In either hexidecimal "object code," or using machine language, the programmer would be required to input six seperate lines of information to obtain the same input as one line in the BASIC language.

Although assembly, compiler, and interpreter programs comprise the bulk of "software," there are others you should be aware of. The large general purpose computers have control panels with switches, keyboards, and displays, which permit a wide variety of manual operations, and direct observation of the results. The display is valuable for debugging, and examining the memory contents. Microcomputers based on microprocessors often do not have such control panels. Instead, we substitute software, which instructs the microcomputer to display the desired information on some *external device,* such as a cathode ray tube, or a teletypewriter. The instructions to do this must be fed into the MPU by means of some input device, such as a keyboard. The software program that enables the MPU to do this is called a "monitor" or "debug" program.

We also need to mention the "cross compiler" and its companion, the "cross assembler." The cross assembler permits the writing of an assembly language program for the MPU on another, larger computer, which is capable of translating it into an object program that can be executed by an MPU. The cross compiler works in a similar way, but higher level languages are used as the source program, and assembly language may be used as an intermediate step in generating the object program. These "cross" steps are usually required because many MPUs cannot do compiling effectively, and the answer is to do the compiling on a more powerful computer. The reason many MPUs cannot do compiling or interpreting is the limited amount of memory usually available in MPUs. Since interpreters are programs held in memory, they use up large amounts of memory, leaving very little available for other purposes.

It is necessary to emphasize an important point at this time! We have been referring to assemblers, compilers, and interpreters as if they were hardware . . . and this can create confusion. Actually, they are all programs held in memory. Think back, we started this series by stating the MPU is a versatile, programmable, IC, that can emulate other ICs. When the assembler program is utilized, the computer itself assembles the assembly language source program into a machine code program, using information stored in its memory to accomplish the task. It's like a person using a foreign language dictionary to translate a foreign language into English. You may look up each foreign term in the dictionary (memory), according to what we wish to accomplish (the instruction), and write down the translation. The word we are looking up has a definite place in the dictionary (location), which is found by looking up the page (address). So it is with an MPU, which can be *preprogrammed* to assemble, interpret, or compile. Assemblers, compilers, and interpreters are really translator programs which are held in the MPU's memory.

When "interpreting" the MPU performs the operations called for, but does not produce an object program for storage. The "compiler" however, produces a complete translation, which is then stored in the memory of the MPU (or on tape), for future use.

In this article we discussed the various computer "languages," and how they differ. Many of the "buzz words" used in computer literature were explained. Binary, octal, and hexadecimal codes were illustrated. Together, these things form the groundwork for remaining articles in this series. **ETID**

In-home module repair: Yes or no?

ET/D examines another point of view

Until recently such in-home repair was virtually impossible due to the inaccessability of modularized components. Now "extenders" have been introduced to make in-home module servicing possible. To see if they are the answer for you, read on.

By Donald M. Russell, Jr.

Small pluggable printed circuit board modules were first used on a large scale in solid state TV receivers by Motorola in 1967. Earlier, Setchell Carlson had used modular construction in all-tube type TV receivers. RCA and Zenith first produced modularized TV receivers with pluggable PC boards in 1970. Other manufacturers followed over the next few years. Modularized console color TV chassis' became the norm although many smaller portable color and most black and white TV sets continued to use single PC boards.

Most manufacturers adopted modularized construction to improve the serviceability of their solid state receivers. This was desirable because many TV repairmen at that time were not knowledgeable in semiconductor servicing techniques. The PC board module enabled a semi-skilled technician to troubleshoot and repair a solid state set using only substitution techniques.

Eventually, the set manufacturers found that modularization, while improving the serviceability of their TV receivers, also resulted in increased complexity, cost and impaired reliability. Increasing production and warranty costs, coupled with intense foreign competition, forced a reassessment of the cost effectiveness of modularization.

Modularization, introduced to improve serviceability, increased the cost of manufacture and impaired reliability because of the added interconnections. You can't have it both ways! If a modular chassis has excellent field reliability, an identical electronic design single PC board chassis could be even better! A Massachusetts Institute of Technology report entitled "The Productivity of Servicing Consumer Durable Products" made an *exhaustive* analysis of the relative values of increasing reliability compared to increasing serviceability in TV receivers. It concluded that, considering the manufacturers' options for lowering total life cycle cost, much more is to be gained by increasing reliability rather than serviceability. In the typical example given, the relative value of reliability improvement compared to serviceability improvement was 2.8 to 1.

Cost factors

Figure 1, taken from that report, summarizes the significant elements which make up the typical TV service call. A study of these elements concludes that the cost of service could be reduced *most* by decreasing the following factors, listed in order of importance (Table 1).

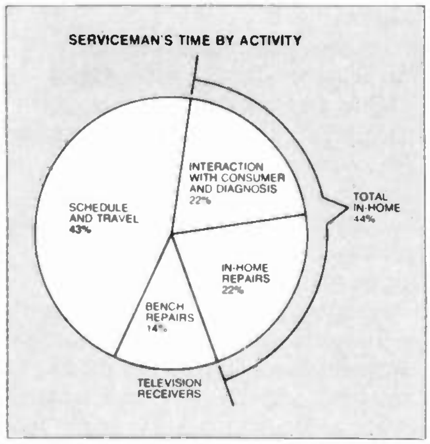

Fig. 1 The time/function relationship of a television serviceman's activities.

TABLE 1

Improvement Order of Significance	Factors (Decrease Desired)	Approx. Weight Priority
1	Travel Time	0.28
2	Dianostic Time	0.22
3	In-home repair time	0.22
4	Need for shop repair	0.18
5	No. of call backs	0.18
6	Shop repair time	0.14

As the number of knowledgeable and experienced solid state TV service technicians increased and solid state receiver reliability improved, the trend toward modularization peaked and then started to decline. Ironically, Motorola (Quasar) who was first with a solid state modularized color TV set, was also first to abandon that concept in its 1977 line. In mid-1978, although largely unheralded, RCA announced a new TV chassis which eliminated modules in favor of improved reliability. This chassis was placed in many more Color-Trak 1979 and 1980 models.

Still, there are thousands—no millions—of modules "in the field," and

(EDITOR's NOTE: *In an effort to determine the extent of the problem of "intermittents" in factory rebuilt modules, ET/D asked the nation's largest rebuilder of television modules for comment.)*

Following is the response of Richard King, Vice President, Marketing, for PTS Electronics, based in Bloomington, IN.

"We know that a television technician, particularly one unfamiliar with servicing on a particular brand of module, can spend considerable time in just locating a defective component—a very important consideration when considering replacement or repair of a module in the home. Additionally, many replacement transistors and IC's cost as much as, or more than an exchange module.

"Then the technician has to ask himself: 'Did I repair the intermittent?'"

"Since PTS pioneered module rebuilding and grew to be the largest independent module rebuilder, we have acquired years of module diagnostic experience, component failure histories, and rebuilding techniques ... the component failure history provides us with a detailed list of parts most likely to fail. We utilize this information as part of an ongoing module updating and preventive maintenance program, automatically replacing those potentially defective components to insure extended life, reliability, and performance of our rebuilt modules to equal or even exceed that of a new one.

"In effect, we are saying that replacing one component that's bad isn't going to help that much. We can spot potential breakdowns from experience and will therefore go ahead and replace three or four other components—in addition to the faulty one—at the same time."

"While I must admit that there are times when a minor module repair would seem justifiable, more often replacement of the defective module is more profitable in the long run."

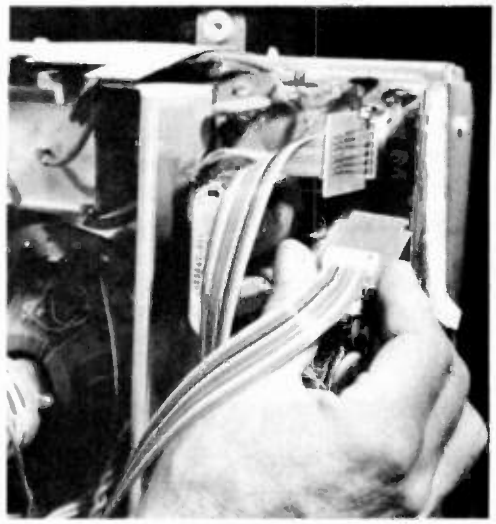

Fig. 3 Module connectors are inserted in the chassis circuit board connectors by a technician.

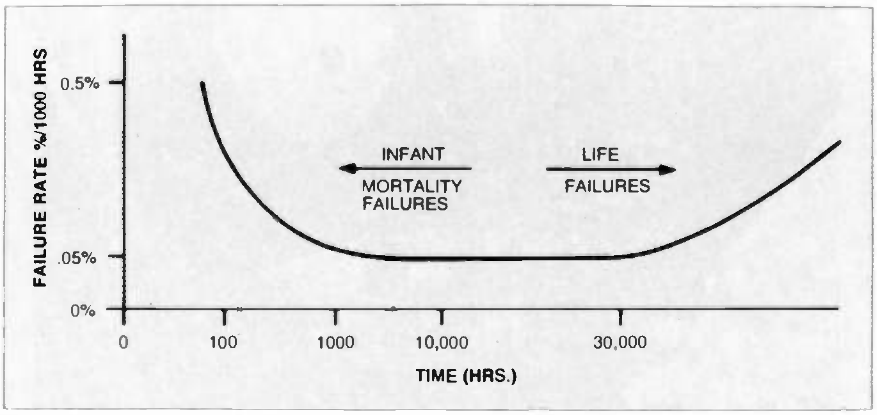

Fig. 2 A graph of typical failure rates versus operating time for electronic components.

many technicians and shop owners believe it is more cost-effective and profitable to replace defective modules rather than repair them. The purpose of this article is to examine the case for TV module repair.

The definition of a "Module" is not consistent from manufacturer to manufacturer but, in this article, a module is considered a separate group of circuits on a PC board that can be readily installed or entirely removed from the main chassis without using a soldering iron (some manufacturers consider tuners, convergence assemblies, main frame power supplies, etc., to be modules). Sets which have electronic tuning and remote control options require additional circuits which could be considered "Modules" but in most cases these are hardwired to the main chassis or not built on pluggable PC boards.

From the introduction of modularized solid state color TV to date, the number of pluggable modules used in different receivers has varied widely and has gradually declined, ranging from a maximum of 12 to a minimum of 1, the average being about 7. An estimated 15.5 million modularized color TV receivers, produced from 1967 through 1978, are still in service. Thus, more than 108 million modules, still in use, may need service in the future.

Replacement or repair?

As mentioned earlier, skilled or semi-skilled technicians can repair a modularized TV set by substituting a new module for the defective module and making any required ancillary adjustments. The same receiver can also be repaired through standard signal tracing and diagnostic techniques as used on conventional single PC board sets. It is commonly believed that the fastest, least expensive overall method of servicing a modularized TV set is to substitute a new or rebuilt module for the defective one. However, this is not always true for the following reasons:

1. Lack of exact replacement module (type and modification) at time of home service call.
2. Cost of maintaining a large inventory of replacement modules.
3. Cost of making minor field change retrofits to a replacement module to make it like the module removed from the set.
4. Possibility of initially defective, intermittent or poor reliability of the new or rebuilt replacement module.

These reasons increase call backs, and service costs, for both service shop and customer. Such additional costs, associated with the substitution of a replacement module for the original, theoretically can be eliminated by repair of the defective module on the spot by an experienced technician. Many service shops are aware of potential added costs caused by the problems listed above. Many have experienced operational problems with replacement modules but have not seriously considered the cause nor how this additional cost of doing business could be eliminated.

Consider, for instance, the problems caused by module substitution if a set fault is improperly diagnosed. I refer now to a case where two modules were replaced unnecessarily, necessitating *two* call backs—the cost of which were borne by the service shop.

This case raises some interesting points on modular servicing which are worthy of comment to show why repairing the defective module, rather than substituting a new or rebuilt one, would have been the least expensive method in the long run. Another point to be taken into consideration is that rebuilt panels have been intermittent, or just did not work, on occasion.

Generally, servicemen who repair modules send their "tough dog" intermittents back to the manufacturer or module rebuilder. There they are tested, cleaned, adjusted and sometimes resold with a built in intermittent. Most intermittents are time, temperature and voltage dependent. Even exhaustive tests, conducted for a short period in the factory, fail to reveal these problems. Modules that are dead on arrival often are only slightly different versions of the module being replaced plus or minus a resistor; capacitor, jumper, etc., and/or have been labelled improperly. Alas, all factories occasionally "goof" and ship small amounts of defective product.

Generally speaking, most people consider a brand new module to be more reliable than a rebuilt one. This is not always true. All *new* electronic components have infant mortality potential. Those which have operated for several years in a set are inherently more reliable. There is, therefore, more chance for failure of a brand new module than a repaired module. If not for the possibility of the potential intermittent failure just mentioned, a factory rebuilt module would be a better risk and value even at the same price than an all new module. Thus, from a reliability standpoint, it could be better to fix the existing module in the set and replace the defective components which caused the known failure, if all of the defective components are identified. A typical electronic component "bathub" failure rate curve versus operating time is shown in Fig. 2.

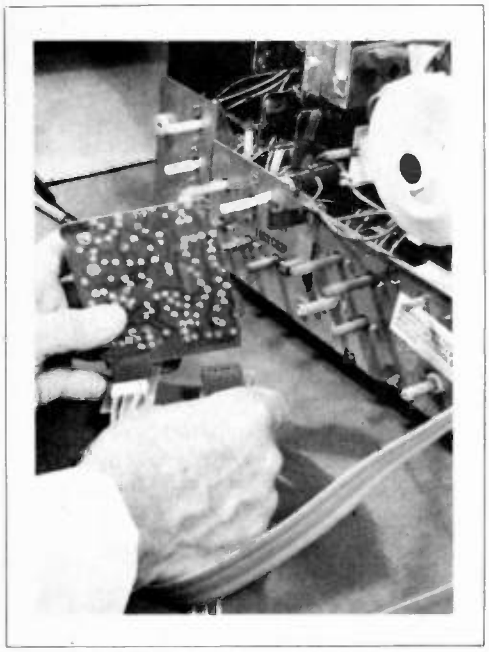

Fig. 4 The circuit board, having been removed, is connected to the opposite end of the Chek-A-Board extenders, thus permitting operation of the television set while troubleshooting the module from either side.

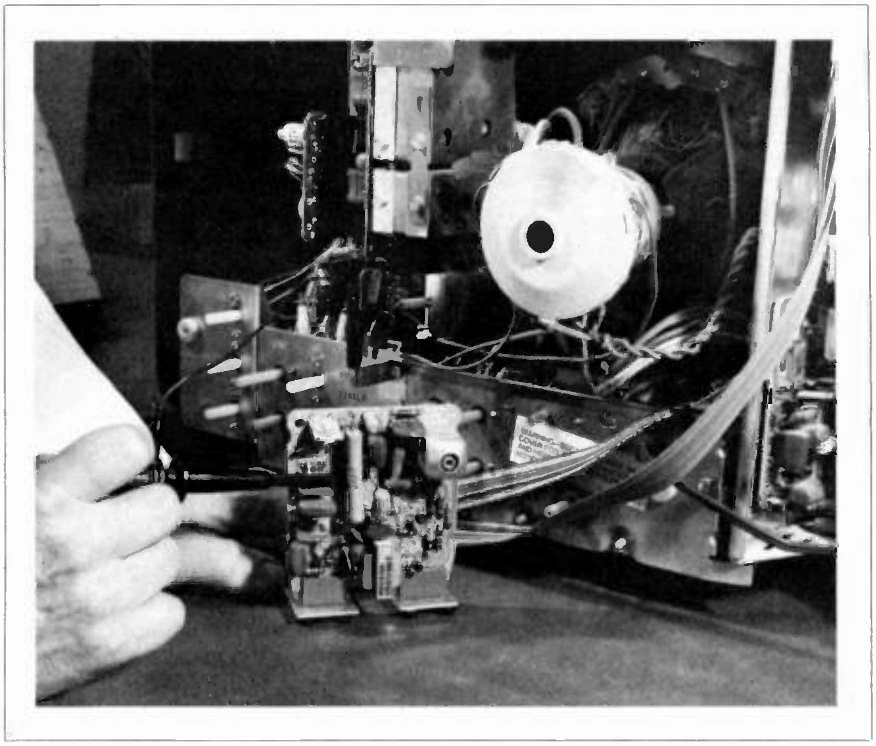

Fig. 5 Troubleshooting with Chek-A-Board Extenders. All components become easily accessible.

Lowering failure rates

The failure rate for any equipment is the sum of the failure rates for the individual parts. That's why high-reliability military and industrial equipment manufacturers not only buy high quality components but have them "burned-in" or operated at normal or higher than normal operating conditions (temperature, current and voltage) for several hundred hours or more so that any potential component failures will occur prior to delivery to the customer. Overall reliability of the remaining units in the lot will be improved by removal of the "weak sister(s)." Burn-in, however, is too costly for most consumer electronics.

Many technicians actually prefer to repair their own modules, but have found this road difficult, if not impossible. In practice, it is very difficult to get at the modules in some modular sets to perform standard in-circuit resistance, voltage, temperature or signal tracing check from one or both sides of the board. But, something has been done about this through the introduction of Sylvania Chek-A-Board module extension cables. They allow a technician to service a suspect module up to two feet away from the set, permitting operational tests from either side of the board and easy contact with test equipment probes. The technician can flex the board and apply heat or cold easily as an aid in detecting intermittents. In addition, the technician can service the module without pulling the chassis, a decided advantage over regular non-modular set repair—whether the set is serviced in the home or in the shop.

It is no secret to any shop owner, manager or technician, that the highest cost of most repair jobs is the labor factor. Most shops find that an accurate diagnosis by a skilled technician offers the lowest total cost of repair in the long run. Sylvania Chek-A-Board TV module extension cables permit easy operational troubleshooting and signal tracing without pulling the chassis in the home or shop. This can save considerable service time, result in lower parts inventory costs and less probability of a call back than if the original module is replaced.

Some service shops are reluctant to repair modules for both valid and invalid reasons. The objective of this article is to indicate where really significant costs occur and what to do about them. In summary, the service shop's manager should concentrate in reducing the labor content of the following service tasks, listed in order of importance.

1. Travel Time (one round trip)
2. Diagnostic Time
3. In-home Repair Time
4. Need for Shop Repair
5. Number of call backs

Sylvania believes that, in most cases, it is more cost effective to repair the existing TV module than to replace it with a new or rebuilt one. The Chek-A-Board series of module extension cables can significantly reduce the labor content in such repair jobs. **ETD**

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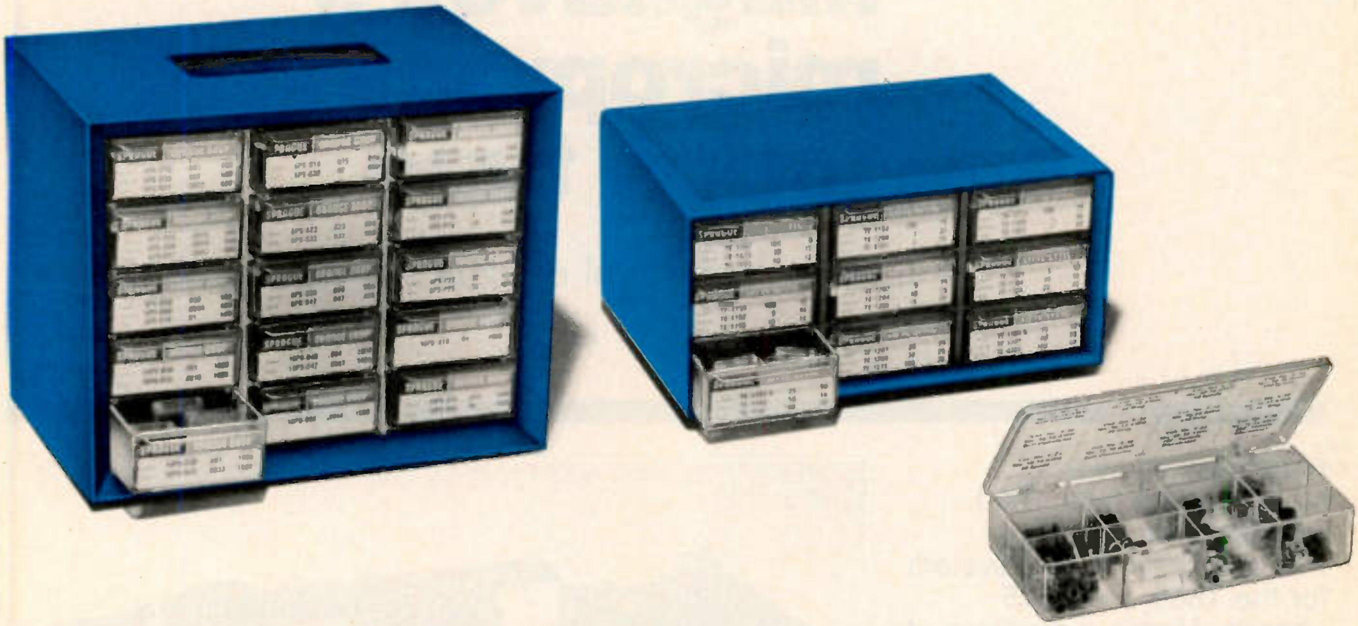

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G-A & High-K Ceramic Disc Capacitors	KC-24	215	27
Aluminum Electrolytic Tubular Capacitors	KE-11	61	27
Epoxy-coated Mylar® Film Capacitors	KF-19	136	18
Film-wrapped Mylar Tubular Capacitors	KF-33	36	18
Polypropylene/Polycarbonate Film Capacitors	KF-34	44	18
Miniature Axial-lead Mylar Capacitors	KF-35	72	27
Film-wrapped Metallized Mylar Capacitors	KF-36	18	18
Ultra-miniature Single-ended Mylar Capacitors	KF-37	110	22
Dipped Radial-lead Mica Capacitors	KM-11	64	22
Radial-lead Solid Tantalum Capacitors	KT-11	90	25
Carbon-film Resistors, 1/4 Watt	KR-16	171	27
Carbon-film Resistors, 1/2 Watt	KR-17	171	27
15-DRAWER STEEL CABINET			
Vertical-mounting Electrolytic Capacitors	KE-21	102	42
Aluminum Electrolytic Tubular Capacitors	KE-22	93	30
Aluminum Electrolytic Tubular Capacitors	KE-23	30	30
Dipped Tubular Radial-lead Film Capacitors	KF-32	139	33
Flameproof Film Resistors, 1/4 Watt	KR-18	180	30
Flameproof Film Resistors, 1/2 Watt	KR-19	180	30
Flameproof Film Resistors, 1 & 2 Watt	KR-20	90	30
HINGED-LID CLEAR PLASTIC STORAGE CASES			
Terminals (Rings, Spades, Butts, Disconnects)	KST-1	80	12
Terminals (Rings, Spades, Butts, Disconnects)*	KST-5	121	13
Terminals (Bullets, Disconnects, Taps, Splices)*	KST-7	79	13
Terminals (Butts, Rings, Spades, Disconnects)	KST-10	400	24

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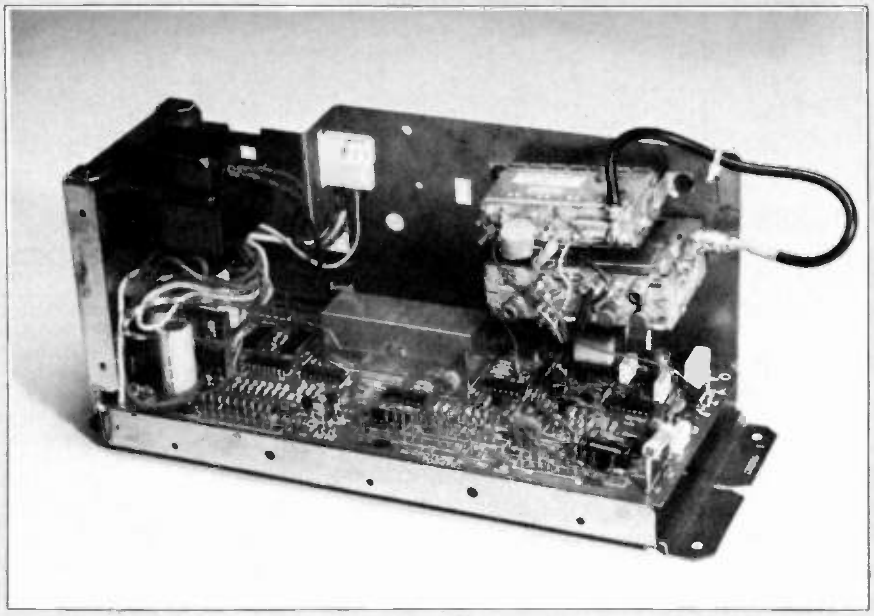
Magnavox's microprocessor touch tune

More high level electronics for the home

Magnavox's newest innovation for their 1980 television line is a microprocessor tuning system for the T809 and T815 chassis. Here's a rundown of the main operational characteristics of this equipment along with some troubleshooting tips.*

By Richard W. Lay, Editor



Magnavox has introduced a microprocessor controlled varactor "Touch Tune" system as the major innovation on their 1980 television line that indeed brings another layer of "computer technology" into the American living room. The new device, called appropriately enough, Microprocessor Touch Tune, is being introduced in conjunction with the T809 and T815 chassis introduced last year, and the system is designed as replacement for Magnavox's VideoMatic Touch Tune.

Which brings me to the observation that anyone out there in consumer servicing who still has doubts about the intrusion of this high technology, digital electronic circuitry into their lives has just lost the ball game. It's here now not only through Magnavox, but if you've followed ET/D you know similar technology abounds through other manufacturers, i.e., Sanyo, Zenith, RCA, GE, etc., etc., etc.

Special thanks go to Chester F. Dunn, Magnavox, for information received at his Service Training Serminar.

Once you've mastered the "ins" and "outs" of this piece of large scale IC circuitry, you'll definitely have moved your career, fullfledged, into the age of microelectronics. Quite frankly, the microprocessor chips in the tuning units on the market today are, save for their limited memory storage capacities, just as sophisticated as any microprocessor chip found in any minicomputer system in use today.

Once again, welcome to the age of microelectronics. Read on as we delve into the mysteries of Magnavox's 703954 remote microtune circuits.

The 703954 is the remote version of the microprocessor controlled tuning system and works in conjunction with the standard (9volt battery operated) transmitter. This has 10 digit buttons, a power button, channel up and down buttons, and up and down volume control. There is also a mute pushbutton.

The tuners in this unit are standard varactors, the bandswitch and tuning control voltages being displayed for your information in Figure 1. Since the operation of varactors or varicaps whichever you prefer is fairly well known, we will not go into their operation in this article.

The TV receiver's front control panel contains 10 numbered digit pushbuttons plus volume up and down. This panel also contains Videomatic and secondary on and off buttons. A swivel door on this panel allows customer access to the master power switch, plus two switches which control the *fine* *tuning* and a *memory programmer*. While the system is programmed with precise channel tuning information at the factory, the latter two switches are for use where incoming signals may be "off frequency," for instance in some CATV installations. Through the use of the fine tuning adjustment, the customer is able to compensate and then program the "off frequency" channel information into the microprocessor's memory through activiation of the Memory Control switch.

Before moving into specific details of how the system operates, let's take a look at what it does and the role of the microprocessor, which incidentally is a Mostek MK3870 chip, capable of storing 2,048 8-bit words of instruction.

A simplified block diagram is seen in Figure 2. All of the necessary information to operate the tuning system is stored as instruction sets in the microprocessor's ROM (Read Only Memory). This memory is inactive most of the time, being brought into play on three occasions only: 1—when selecting a channel; 2—immediately after set turn on; and, 3—when depressing the Memory Control Button behind the set's front panel. In the first two instances tuning data is being read from the memory, and in the latter case it is being written (programmed) into the memory to compensate for "off-channel" signals. Searching the memory immediately after the set is turned on permits the set to tune to the same channel it was tuned to when turned off.

The microprocessor

All microprocessors are, in essence, small scale computers (Fig. 2). The major differences between micro chips being the use to which they are put, some being for a wide range of varied tasks in which case they require vast amounts of RAM (Random Access Memory) and ROM; while others such as the MK3870 chip, are said to be "dedicated and consequently require correspondingly smaller complements of RAM and ROM."

In the first case such microprocessors are user programmed and reprogrammed often to meet user requirements. In the latter case, programming by the user is limited. In regard to the Micro Tune System, programming occurs when the user is activiating the Memory Control Chip to compensate for "off channel" tuning requirements.

Most of the program instructions found in the Magnavox system are programmed at the factory and are

CHANNEL		TUNING VOLTAGE		
		MIN	TYP	MAX
BAND I	2	4 1	4 5	4 8
	3	5 5	6 8	8 0
	4	8 2	9 3	10 5
	5	13 4	14 7	16 1
	6	21 0	22 0	23 0
BAND II	7	8 9	11 0	13 0
	8	9 6	12 1	14 4
	9	10 5	13 1	15 5
	10	12 0	14 4	16 8
	11	14 5	15 8	17 4
	12	17 0	18 0	19 3
	13	21 0	22 0	23 0
BAND III	14	1 5	2 4	3 2
	20	2 9	3 8	4 6
	25	4 0	5 0	6 1
	30	5 2	6 2	7 5
	35	6 5	7 7	9 0
	40	7 5	9 0	10 5
	45	8 6	10 4	12 3
	50	9 7	11 8	14 0
	55	10 7	13 0	15 3
	60	12 0	14 2	16 5
	65	13 3	15 5	17 7
	70	15 2	17 1	19 1
	75	17 4	19 0	20 8
	80	20 5	22 0	23 5
	83	23 5	25 5	27 5

Fig. 1 Tuning Voltage Chart

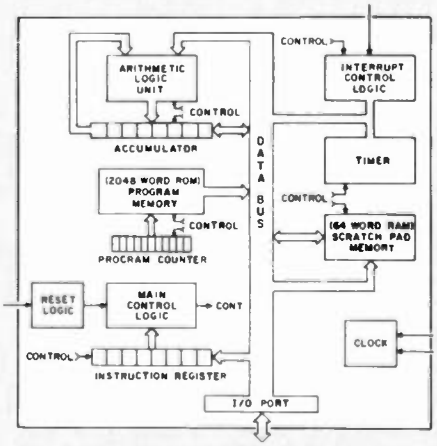


Fig. 2 Microprocessor block diagram

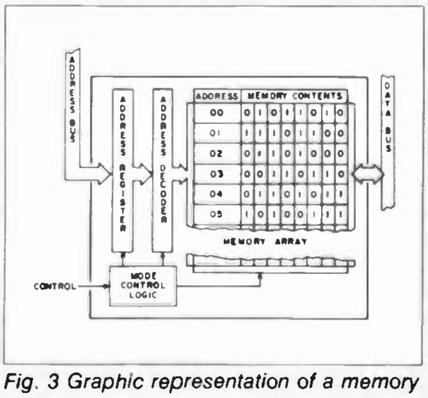


Fig. 3 Graphic representation of a memory bank

unalterable by the user. These instructions sequentially control the steps taken by the microprocessor in accomplishing its task.

Actually the channel memory is more than ROM, it is EAROM which stands for electrically alterable read only memory. What this means insofar as the tuning system is concerned is that it (the memory) retains its data even when power is completely off, thus eliminating the need for batteries such as with the Vidematic systems.

In Figure 3 we see a representation of the program memory capable of storing up to 2048 eight bit words, although only 100 words (1400 bits) are needed to control the Magnavox system. Each memory location contains an address. In the system under study, the tuning information of the last channel used before the set was turned off is always programmed in at address "00" (see Figure 3). The function of the program counter (Figure 2) is to fetch from memory the address of the ROM instruction to be acted on by the microprocessor. Since the program counter is always reset to zero when the set is turned on, the first tuning information it "pulls" from memory when turned on is at address "00", or the last channel actively used. This information in the form of a digital word, is sent to the instruction register, from where it is acted upon by the control logic.

The Arithmetic Logic Unit is self-explanatory as to function (addition, subtraction, etc. occurs here) and is used in conjunction with the 64 word scratch pad memory (where numbers (words) to be acted on by the ALU are stored momentarily until needed).

One key element of any microprocessor is the "interrupt control logic." Because it is so important to the operation of the remote control unit in this tuner system, we will look in detail at its operation. Essentially its function is to "alert" the microprocessor to stop what it is doing at the next logical breaking point, and be prepared to receive instructions to perform a new task.

The need for a clock is also self-explanatory in regard to this discussion. It is enough to say the clock, operated at 14Khz, gates various control signals at that rate to, from and through the microprocessor.

Interrupt logic

Figure 4 is the overall schematic diagram of the Magnavox system. The interrupt logic is developed through the interaction of 60 and 120Hz pulses developed off a 60Hz sine wave taken from the secondary of T201 in the power supply (see Fig. 5).

This 60Hz sine wave performs another important function in connection with the channel display and decoder circuitry. During the positive alternation when the collector of Q2 is low, the "10s" digit of the LED display is illuminated and conversely, when the collector (Q2) is high, the "1s" digit LED lights up.

(Note: The 60Hz sine wave at the

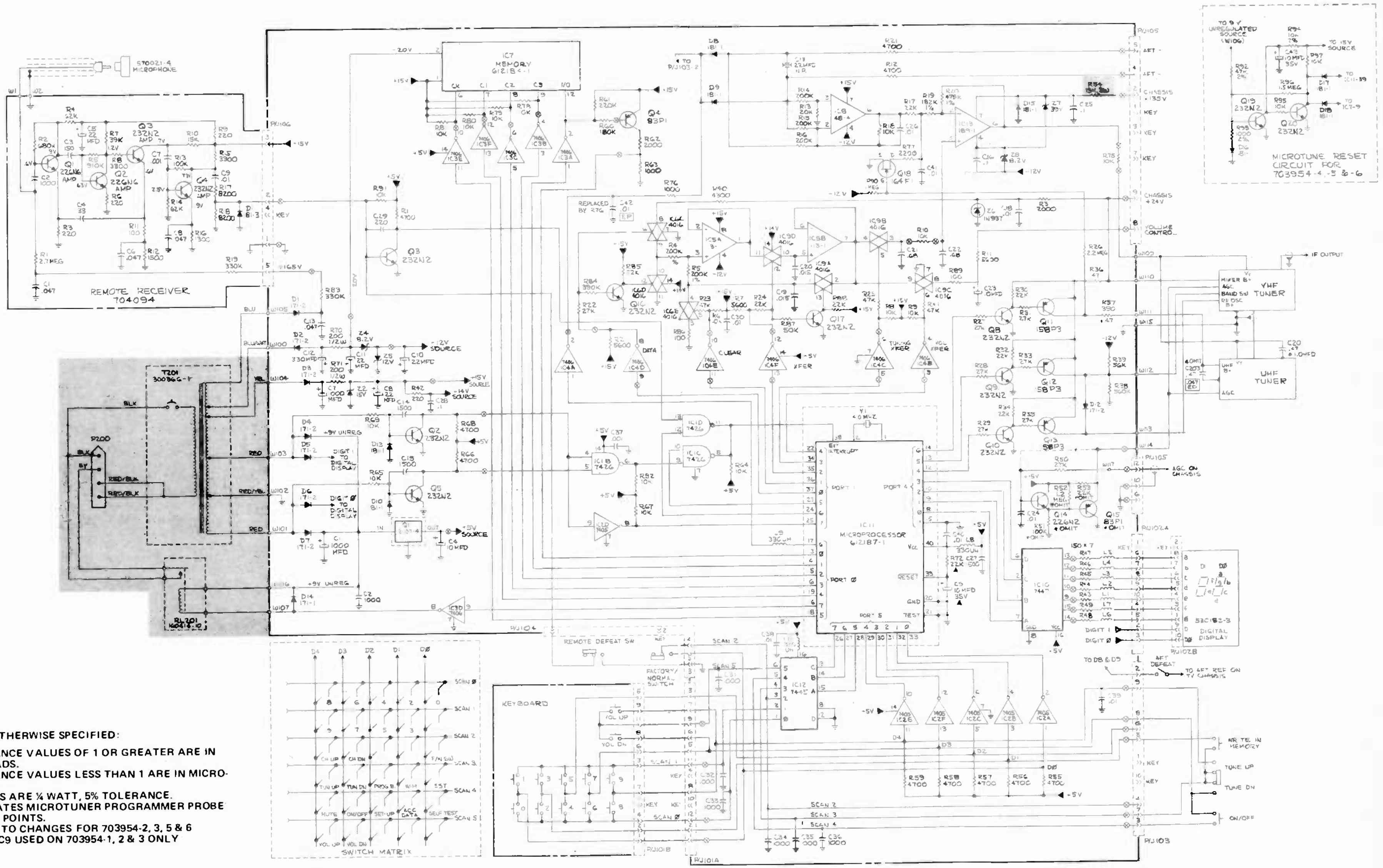


Fig. 4 The overall schematic of the tuning assembly

NOTES:
UNLESS OTHERWISE SPECIFIED:

1. CAPACITANCE VALUES OF 1 OR GREATER ARE IN PICOFARADS.
2. CAPACITANCE VALUES LESS THAN 1 ARE IN MICROFARADS.
3. RESISTORS ARE ¼ WATT, 5% TOLERANCE.
4. ⊗ INDICATES MICROTUNER PROGRAMMER PROBE PROBE POINTS.
5. • REFERS TO CHANGES FOR 703954-2, 3, 5 & 6
6. ▲ R72 & C9 USED ON 703954-1, 2 & 3 ONLY

base of Q2and Q5 develops 60Hz square waves at the collectors of these transistors because the signal at the base drives the units alternately into saturation and then cutoff.) (See Fig. 6.)

Figure 7 shows the timing sequence of the microprocessor functions. The 120Hz pulses that are developed from the out of phase 60Hz pulses at the collectors of Q2 and Q5 (again, see Fig. 6) are used to signal the microprocessor that it is time to begin executing the events illustrated. These events are, during the positive 60Hz pulse, display of the tens digit LED, channel tuning if called for, volume data conversion if required, and sampling and decoding of any remote signals that may be present. During the negative alternation the "ones" digit is displayed, again tuning data is sampled, then the routine varies from the previous alternation in that the front panel keyboard is scanned for any input, and finally any remote signals that may be present are read.

Referring to the schematic diagram, notice that the interrupt circuitry to the microprocessor (IC11) terminates at pins 38 (external interrupt) and pins 23 and 24, the interrupt enable and remote enable pins. Here's how this section works. (See timing diagram Fig. 8).

When interrupt enable (pin 23) is high, positive going 120Hz pulses are gated to pin 38 through a wired OR configuration of IC1D and IC1C. When pin 24 is high, the remote enable, the remote signal switches the output of IC1D between logic one and logic zero at a rate corresponding to the high or low states comprising the digital work being broadcast by the remote transmitter.In essence, the microprocessor identifies the meaning of the remote signal by counting its frequency when pin 24 is high.

Obviously, loss of the 60Hz sine wave at the base of Q2 or Q5 would have catastrophic effects on the operation of this system since it would also wipe out the development of the 120Hz pulse source.

Front panel decoder

Figure 9 helps us see how the microprocessor reacts when front panel controls are activated by the user. IC12, known as the scan converter, accepts a series of six consecutive three line binary numbers from the microprocessor (which continuously scans front panel controls) and converts these signals into six sequential signals appearing at pins zero through 5 of IC12.

When a matrix switch is activated the circuit is closed and the appropriate digital pulse is routed to IC2 (an inverter circuit) and then read (interpreted) by the microprocessor on pins 29 through 33. IC12 is a four line parallel input binary to decimal decoder with pin 12, the most significant digit, grounded because only the three binary signals are needed.

The conversion from digital signals (handled by the microprocessor) to analog signals (needed to generate changes in tuning and volume control voltages) is accomplished through the D/A (digital to analog) conversion circuitry. Transistors Q16 and 17, IC5, IC6 and IC9 comprise the bulk of this circuitry (refer to schematic diagram and Fig. 10A).

This converter circuitry processes both the tuning and the volume data. Tuning voltage data is in 12 bit form and volume data made up of 6 bit words. This permits tuning voltage gradations of 1/4096 ($2^{12}=4096$) and volume level gradations of 1/64 ($2^6=64$).

Since the same A/D circuit handles both conversions identically, it is easier to explain its operation using volume as the example. Notice that pin 8 of IC6C is clamped to a 9.1V zener diode. The DC voltages produced by this converter are proportional to the size of the binary numbers presented to it by the

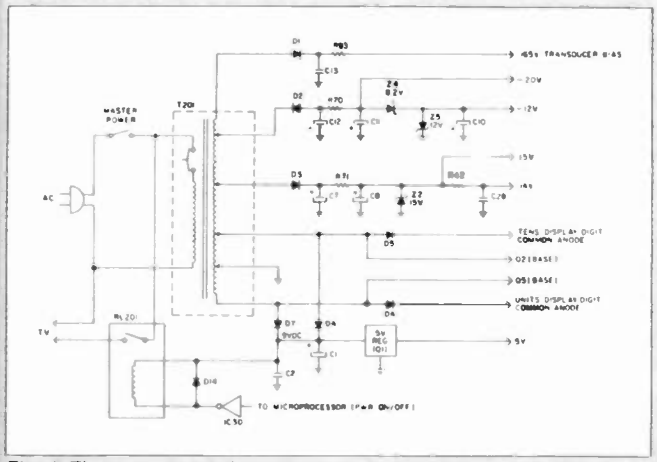


Fig. 5 The power supply

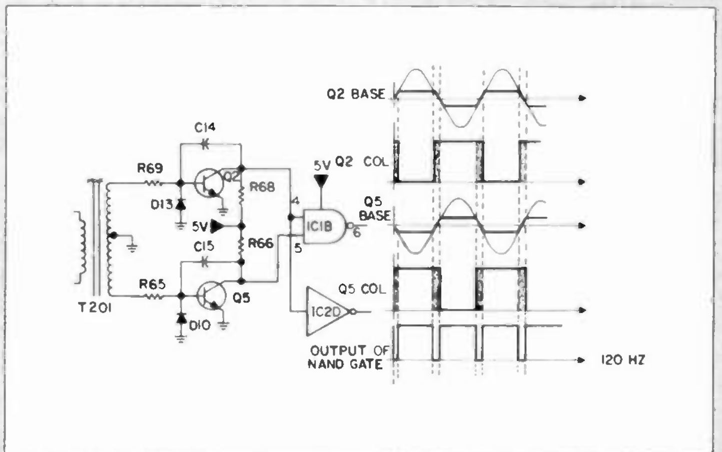


Fig. 6 The 120Hz pulse source

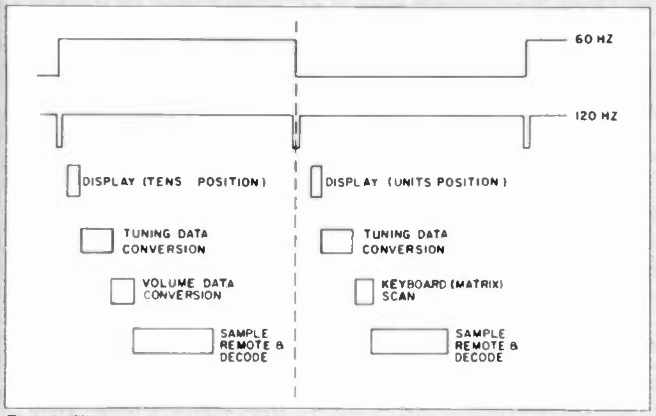


Fig. 7 The program execution sequence

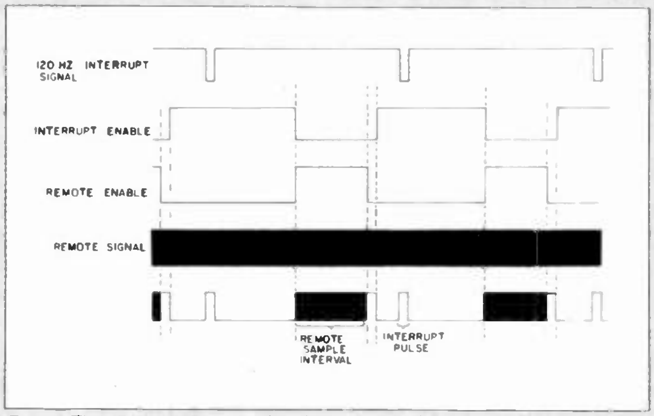


Fig. 8 The timing diagram for the remote signal sample

serial input to the circuit at Q16. Maximum output voltage from this circuit would be 63/64 × 9.1or about 8.9VDC. (Full (9.1VDC) output is unobtainable theoretically since this would require a seven bit data input).

The operation of this circuit follows. Refer to Fig. 10A for reference and note that an expanded version of the volume data signal appears below the overall data signal.

D/A converter

The first data bit applied to this circuit represents the least significant digit in binary form, the last bit the most significant. Let's assume the set is turned on and the user activates the sound volume to a point representing the binary number 011011. This is decimal 27, therefore the volume level at the speaker ultimately will be 27/64 × 9.1 or about 3.8VDC.

The tune and volume store pulses, activate switches IC9B and IC9C respectively. They cause the appropriate voltage to be stored in capacitors C19 and C20 respectively. If tuning data is applied it is applied to the AFT and Tuning Voltage amp before traveling on to the tuners. If volume data is being handled it is ultimately routed to the attenuator in the TV sound IC.

In the following example notice that transfer pulses (Fig. 11) alternate between high and low. When high they cause solid state switch IC9D to close and when low, IC9A to close. The first data bit (of the binary number 27) is a "1" and causes the 9.1VDC reference to connect to the divider network R4 and R5. The opening of IC6D and closing of IC6B effectively short circuits C19 and grounds R5. This places the input and output of IC5A at .5 × 9.1VDC, or 4.55 VDC. The action inside IC9D at this point (which closes) causes C20 to charge to 4.55VDC.

A point to note is that the voltage at C19 (see transfer pulse timing chart) is out of step with the data bits and therefore present to influence the magnitude at IC5A during subsequent bit conversions. This means when the second data bit, also a "1" comes through, the 9.1VDC reference source remains connected to the divider network.

However, the voltage at IC5A is no longer just half this voltage because of the charge still on C19. IC5A will accumulate a voltage equal to half the difference between the reference source and the voltage across C19-plus the voltage across C19. In this case it represents ¾ × 9.1VDC, or 6.8VDC.

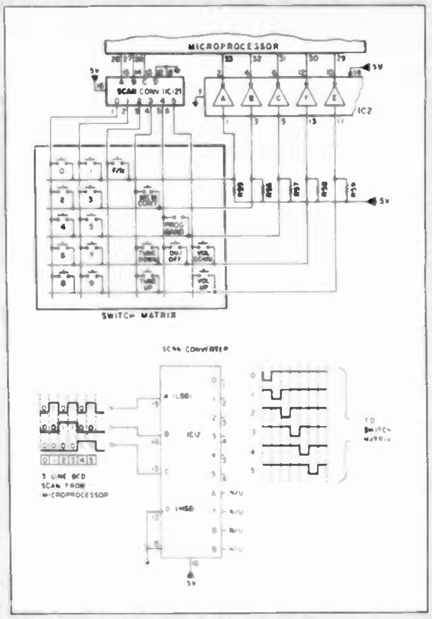


Fig. 9 The scan matrix schematic and converter timing diagram.

As the third data bit, logical "0" enters the stream, IC6D closes, effectively grounding R4. Since this leaves the voltage at C19 the only source for IC5A, the end result is a total voltage of one half its magnitude (.5 × 6.82VDC (¾ ref)or 3.4VDC.

Subsequent data bits are acted on similarly resulting, in our case, in an ending voltage of 27/64 × 9.1VDC, or about 3.83VDC. Illustrations as to how this converter would function in regard to two separate input volume levels are seen from figures 11B and 11C. Figure 10B represents the voltage equivalent of volume level 1/64 (binary 000001) and 11C is the volume level 32/64 (binary 100000).

The display decoder

IC10 serves as this system's display decoder, accepting four bit binary coded decimal inputs (from pins 8 through 11 of the microprocessor) and converting this information in order to "light" segments A, B, C, D, E, F, and G of the channel display.

The channel display is a multiplexed operation with information for the "1s" (right) digit being displayed when the collector of Q2 is high and, for the "10s" (left) digit, when Q2 is low. The corresponding segments of each display LED are in parallel with the common anodes of each digit receiving out of phase 60Hz half wave pulses. In order to light a segment the cathode of the appropriate segment is grounded while the common anode is driven positive.

Pin 3 of IC10 is the test input. Grounding this input will cause all segments of both digits to light. Also,

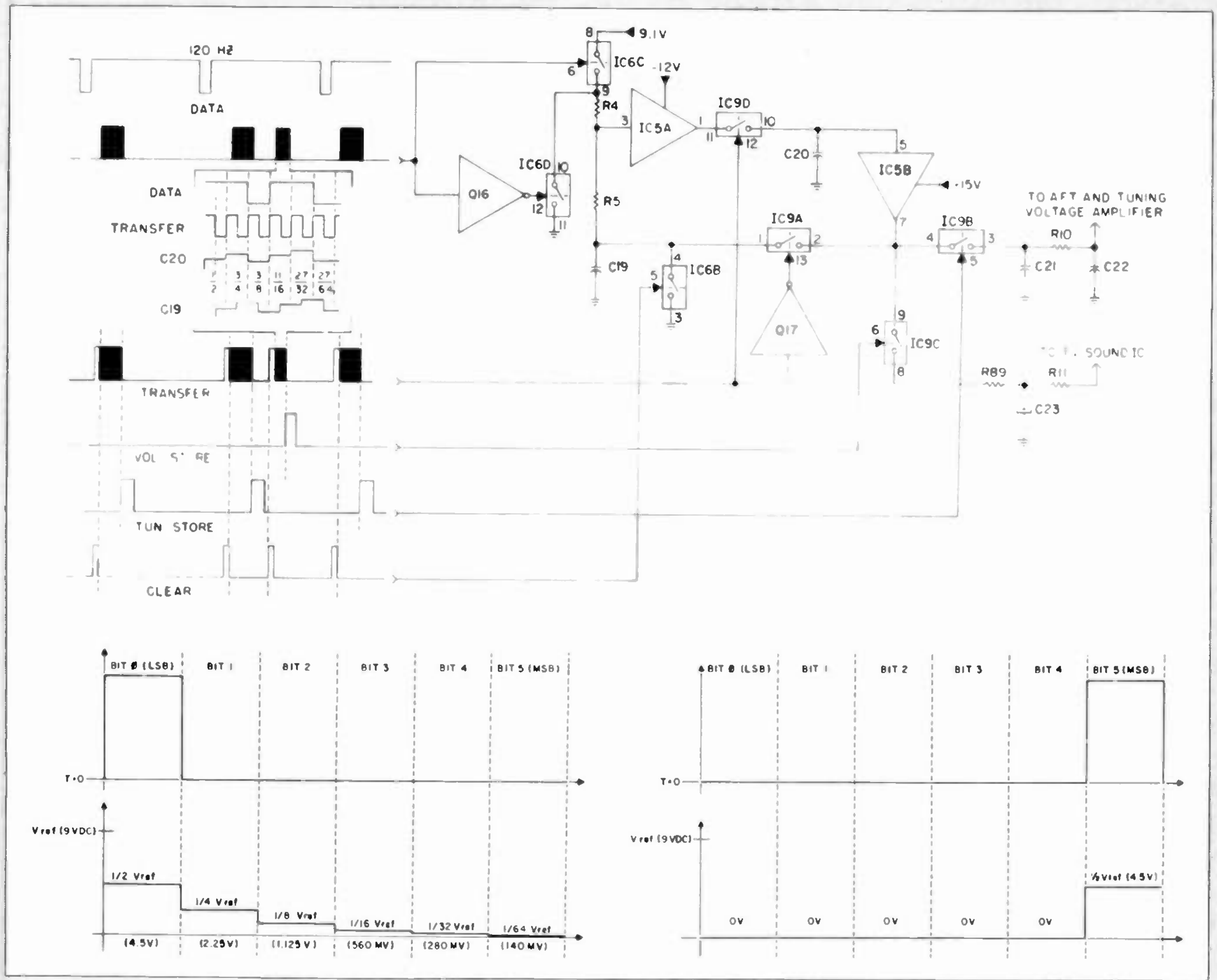


Fig 10 Digital to analog converter circuitry plus the effect of the LSB and MSB on the output.

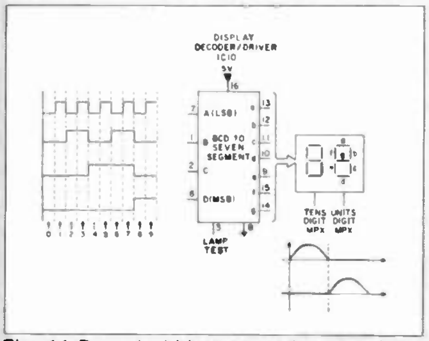


Fig. 11 Decoder/driver operation showing multiplexed operation of the channel display

placing all four input, i.e., pins 7, 1, 2, and 6 of IC10 "high", blanks the display. This condition occurs after the entry of the first digit when changing channels and when channels 2 through 9 are displayed.

The operation of the display decoder is as follows (refer to Figure 11) and let's assume we are tuning to channel 7.

Our entry is "0,7." The first "0" blanks both LEDs. Touching the "7" on the front panel (or by using the remote) causes the microprocessor to generate the binary number 0111 (binary 7) at pins 7, 1, 2, 6 of IC10 respectively. The internal circuitry of the IC decoder is such that outputs at Pins 13, 12, and 11 (corresponding to segments A, B, and C of the LED) are generated. Simultaneously a positive 60Hz pulse drives the anodes positive to cause the "7" to be displayed. The "10s" digit, remains in the blanked condition since all inputs to the IC are high, i.e., at the binary number "15," which has no meaning in regard to a single digit display (the "10s" digit).

One troubleshooting tip noted during a recent Magnovox training clinic is that if something should happen to cause the input to the least significant bit (pin 7 of IC10) to remain high, the system would be unable to display even numbers. The reverse is true in cases where this input (to pin 7) might remain low.

Oh yes, the power supply

Seven of the nine required voltages for Microprocessor Touch Tune are generated right on the tuner chassis; notice the power transformer in the photograph. Plus 24 and +125 volt sources are pulled in from the TV chassis for use by the AFT and tuning voltage amplifier circuitry. The +24 volts is also the source of the all important zener clamped 9.1VDC reference used by the digital to analog converter.

Since the schematic of the power supply is rather self explanatory (Figure 5), I will list here only the functions performed by the various voltage sources. D7 provides 9VDC unregulated for the Power On-Off relay. Q1 is a 5VDC regulator in this line. Diodes D5 and D6 provide the half wave rectified 60Hz pulses used to drive the multiplexed channel display previously discussed.

The center tap winding of T201 drives transistors Q2 and Q5 in a pushpull arrangement to derive the 120Hz signal, the basis of the interrupt logic. Diode D1 rectifies 165VDC to bias the Remote Receiver. Diodes Z4 and Z5, in series, clamp the voltage rectified by D2 into the 20 and 12VDC sources for the varactors and work along with the +24VDC pulled

continued on page 47

Output transformerless amplifiers

Some basic considerations

That simple looking OTL circuit isn't as simple as it first appears. For an inside look at some of the ways to avoid major headaches when troubleshooting many of today's DC coupled audio amplifiers, this article provides you with the necessary ABCs.

By Bernard B. Daien

Output transformerless amplifiers (OTL) have proliferated rapidly in recent years, and are especially popular in high fidelity amplifiers, TV sweep circuits, and control systems.

OTL, which can be recognized by the fact that the output transistors are in series across the power supply source, appears to be so simple that few technicians bother to become familiar with it. This article covers some of the aspects of OTL that are not covered in the general electronics texts. OTL deserves a discussion of its own.

OTL circuitry has some advantages, and some rather severe disadvantages, as outlined in the text, nevertheless the trend is towards more OTL, since OTL permits the elimination of passive components. This is in accordance with the philosophy of current design, as evidenced by active filters, which permit reduction in size, weight, and cost by the elimination of iron cored components.

Some facts

Upon first inspection, OTL seems ideal. It permits the deletion of large, heavy, expensive output transformers, and has a response right down to zero Hertz.

Most technicians simply accept the relatively uncomplicated looking OTL circuit with never a second thought, but it does have some restrictions that did not exist in the older circuits it replaced. Back in the tube days there was no question about it ... a transformer had to be used between the tube plate and the speaker voice coil, since one cannot place 400 volts across a voice coil. But with the advent of solid state, it is quite practical to use direct coupling (with a dual supply arrangement), placing zero DC volts on the voice coil ... or, alternatively, using a large electrolytic coupling capacitor ... and that *seems* to solve the problem. But as we shall see, it simply substitutes new problems for old problems.

Suppose we have an eight ohm voice coil, which is being driven to 20 watts RMS power by an OTL stage. If we now decide to use *two* speakers we run into a first rate problem. With the old matching transformer, all we had to do was change the tap on the transformer, add another identical 8 ohm speaker in parallel using the 4 ohm output tap. Or, we could put the two speakers in series and use the 16 ohm tap. But ... there is no matching transformer in the OTL circuit. If we add another 8 ohm speaker in parallel, the load becomes 4 ohms, which requires twice the previous current from the output transistors. This results in exceeding the current ratings of the transistors under the operating conditions, and also results in overheating the transistors, usually leading to quick failure.

On the other hand if we put two 8 ohm speakers in series, the load becomes 16 ohms, and, since the output voltage swing, which is limited by the supply voltage, hasn't increased, the output power delivered to the speakers is cut in half. The only solution is to scrap your 8 ohm speaker, and go out and buy two 4 ohms speakers which can be put in series to make 8 ohms ... or, buy two 16 ohm speakers which can be put in parallel to make 8 ohms.

What we have just demonstrated is that the power output from an OTL stage depends upon two factors; the supply voltage, and the load impedance. And the good old AC Ohms law still works, since output power equals the RMS voltage squared, divided by the load resistance.

Stated another way ... for a given output power to be achieved, assuming the supply voltage is fixed, the load must be adjusted. Or, if the load is fixed, in order to achieve the desired power output, the supply voltage must be selected. Without the old impedance matching transformer, we have lost flexibility of choice of load impedance, and must make do by adjusting the load to the circuit conditions, or the circuit conditions to the load. And that's the simple fact.

Although the circuit may be more economical, the user may have to buy new speakers, new servos, or new deflection yokes, depending upon the type of amplifier involved. When an audio distribution system is involved, the OTL may wind up being a decided disadvantage.

In most applications it is not required that the DC component be preserved. It is very nice from the standpoint of advertising to say that an amplifier goes right down to zero Hertz. But what's down there? Certainly not program material. With DC coupling, a failure of a small component can cause an offset in the output voltage, shifting it off zero, burning out a voice coil. This is a very common occurence, and with the high cost of hi-fi speakers, a very expensive one. For this reason it is advisable to use a coupling capacitor ... in which case we have lost some of the advantages of OTL, since we have now replaced the transformer with an electrolytic capacitor *of the nonpolar type*, which is larger and costlier than the common polarized type. It is effective speaker protection however.

Basic circuits

Finally, there are several variations of the basic OTL circuit. OTL circuits come in half bridge complementary as in Figure 1A, full bridge complementary as in Figure 1B, half bridge quasi complementary as in Figure 1C, and full bridge quasi complementry as in Figure 1D. Note that true complementary circuits use a PNP and a NPN transistor in the output, and do not need a phase inverter as a result ... while the quasi complementary circuits use two NPN transistors, and require a phase inverter. We will discuss these four basic variations a bit further on. Note that the full bridge circuits require an additional phase inversion since each half bridge must be driven out-of-phase with the other. This is accomplished in Figure 1D by the way the differential amplifier phase inventers are connected. (Look closely!)

Before we consider the differences between the four basic circuits, it might be well to consider some of the similarities. If *dual power supplies are used*, for plus and minus, then the output terminal, *which is the common point between the two output transistors*, will be *approximately* at zero DC potential. Notice we said, "approximately." If we are using an output coupling capacitor, variations in the DC such as turn-on and turn-off transients produce a very annoying thump, but slow drift is not a problem. If we use DC (direct) output coupling, DC excursions can destroy the load with large DC power dissipation.

In order to prevent these effects, some form of DC coupled inverse feedback is taken from the output, and fed back around several stages of gain, in order to maintain the output at, or very close to, zero volts DC. This implies that *any* component failure within the stages encompassed by the feedback loop can cause the output to depart from zero. This dictates that problems in the OTL must be treated the way other "closed loops" are trouble shot ... and so we have a not-so-simple circuit after all! Remember, we now are talking about OTL circuits using *dual power supplies*. Since dual power supplies involve extra rectifiers and filter components, we have lost even more of the apparent advantages of OTL.

There is no good reason why we must use dual supplies. We can run the OTL circuit *from a single supply*, in which case the output terminal will be at, or close to, *one-half* the supply voltage. *This requires the use of an output coupling capacitor in the half bridge circuits*, if the load is to be returned to common ground. The full bridge circuits have close to zero potential difference between the TWO output terminals, and use a multi-stage feedback loop again to maintain that situation ... but ... *there is no common ground return*, which can be a problem. To compensate for this, *theoretically*, no output coupling capacitor is necessary. (Again, that is true only if there are no circuit failures to blow up the load.)

If you think about it, we have just increased our basic combinations to the total of eight, since we can use single or dual supply configurations with our four OTL circuits. Of course the voltages, referenced to ground, must be different depending upon the type of power supply circuitry used.

Linear OTL circuits can be operated Class A, or class B, depending upon the biasing arrangement. In class A operation the operating current, and the quiescent current are the same, and will be read the same on any common average reading D.C. meter, with a sinewave signal input to the amplifier. With *no* signal input there is no output, and all the DC power is *dissipated in the transistors*. Thus dissipation in the output transistors is maximum at zero signal level.

Smoke and fire

In class B operation, the no signal (quiescent) current is very low. When signal is applied, the DC current increases as the signal input is increased. Thus power output, and power dissipation are both affected by the signal level. Dissipation increases to a maximum when the output is about 40% of the maximum unclipped power output level, and then decreases again as the power output is increased towards full output. This fact is not often considered when testing OTL amplifiers. The moral is: If you are going to test an amplifier, use a dummy load and test it at, or near full output if you are using a sine wave signal.

I have tested a number of OTL amplifiers with both sine wave, and "off the air" speech and music programming. The amplifier will loaf along at about ten watts *RMS* power output at the clipping point with "off the air" signal, but a sine wave signal *of the same peak amplitude* will run over 40 watts RMS output! This partly explains why some of the wildly overrated hi-fi amplifiers manage to survive through the warranty period before becoming a

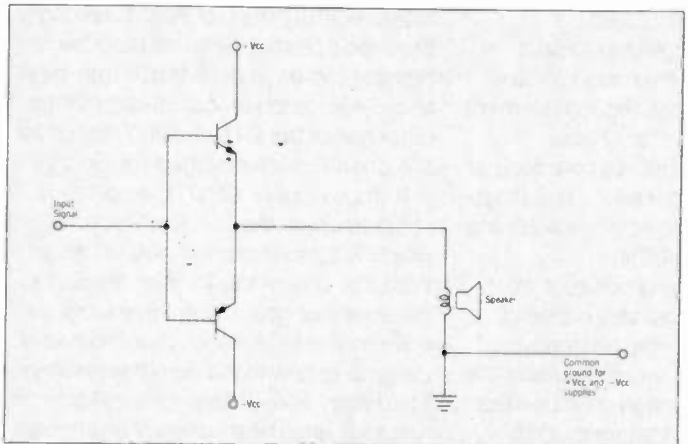


Fig. 1A The basic half bridge complementary OTL configuration.

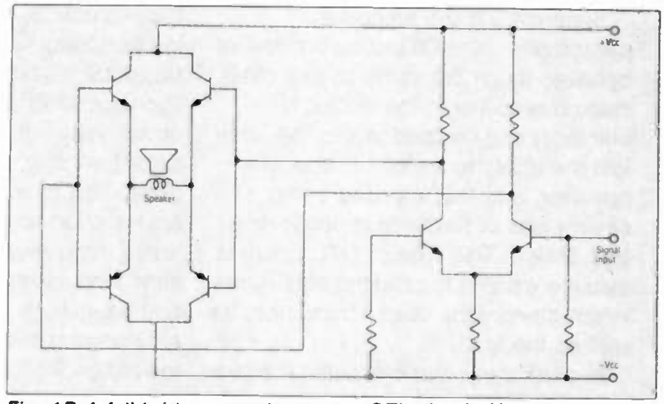


Fig. 1B A full bridge complementary OTL circuit. Note the differential amplifier used as a phase inverter for opposite halves of the bridge.

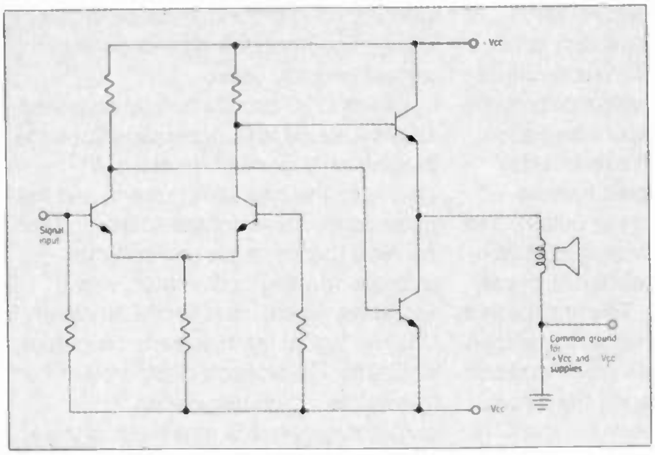


Fig. 1C A representative half bridge quasi-complementary OTL circuit. Here a phase inverter is required since both output transistors are of the same polarity.

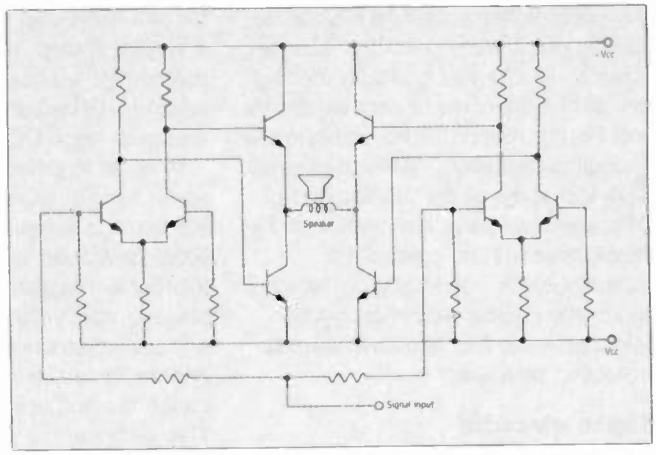


Fig. 1D In this basic full bridge quasi-complementary OTL circuit note that the two differential amplifier phase inverters are also out of phase with each other.

headache to the service technician.

Summarizing the preceding paragraphs ... the OTL class B amplifier behaves much the same as any other class B amplifier in the matter of efficiency and dissipation, etc. We have lost the ability to match impedances however, and that imposes a very severe loss of flexibility in application and design. This type of OTL circuit is also more prone to catastrophic failures which destroy the output transistors as well as the load.

In all of these basic circuits, the two output transistors are in series across the power supply, and this leads us to another problem. If the transistors are run at a high frequency, instead of one turning off, and the other turning on, and vice versa, both may be on at the same time and drawing heavy current. This places a short circuit across the D.C. supply, destroying one, or both, of the transistors. Normally, for example, in hi-fi use, we would choose transistors that can handle 20 KHz. But, if a signal of several hundered KHz was fed into the amplifier, the turn-on and turn-off times of the power transistors might be long enough so that both transistors are heavily on at the same time, as previously described.

Such a signal will appear at times due to parasitic oscillations which often occur with wideband amplifiers and a feedback loop around several stages. This is exactly what we have in OTL circuits. These oscillations are often load dependent ... a long lead to a speaker may have enough capacitance to introduce a phase shift in the output in such direction as to cause high frequency oscillation. Such oscillations tend to show up at certain signal levels, after the amplifier warms up thoroughly, (transistor gain increases with temperature, and the input threshold of base conduction drops with temperature). Changing an output transistor is also a common cause of such oscillations since the replacement device may not have the same capacitance, gain bandwith product, or phase shift characteristics ... and these are not often considered when selecting audio frequency amplifier semiconductors. Manufacturers often add capacitors, or resistor-capacitor networks, to reduce the tendency toward oscillation ... which explains the presence of these apparently "useless" components in low frequency OTL circuits.

Component specifications

Diodes are often used for establishing bias voltage drops, and other D.C. voltage dropping uses. In this application, common rectifier type diodes do very well but, when diodes are used as "signal rectifiers," the fast recovery time demanded for hi-fi audio use (15 KHz) is the same as for the sweep frequency of the horizontal deflection circuits in TV. Such circuits require special fast recovery diodes. The audio waveshapes are also non-sinusodial, with fast rise and fall peaks, making the situation even worse. Some manufacturers have cut costs by using cheap diodes, which do not last very long, in these circuits. When replacing them you might want to consider the above, in order to avoid a recall problem.

In many cases resistors and transistors are *matched* in order to keep the output circuit balanced, but this does not show on the schematic. Authorized factory repair depots usually have bulletins issued by the service department covering matched components. A call to the factory service representative can be very enlightening in this regard. (The fact that 5% resistors are used does not mean that another 5% resistor can be substituted. It may have to closely match its counterpart in the other half of the OTL circuit. Transistors are often factory matched for Beta.)

If the output of an OTL amplifier is shortcircuited, the inverse feedback, which is taken from the output, is lost. With the loss of the inverse feedback, the amplifier gain rises, increasing the drive to the final stage, causing heavy currents to flow in the output transistors. This heavy conduction into a short circuit results in rapid destruction of one or both of the output transistors.

Because of this action, OTL circuitry requires some form of protection. Protection falls into three basic types ... fuses, self protection (inherent), or electronic circuits. Fuses need no discussion here. Inherent protection consists of using parts and circuits capable of withstanding overloads for a reasonable length of time (usually brute force). Electronic overload protection requires additional circuitry to accomplish. (A separate section, later in this article, covers overload protection, and is complete with schematics.)

The differences

The basic half-bridge complementary circuit is the simplest, since it requires no phase inverter at the input. The opposite polarity (NPN, PNP) output transistors provide inherent phase inversion, since they behave oppositely. Unfortunately, it was difficult, in the early days of solid state, to obtain good high power silicon PNP devices, so this circuit fell into disfavor. Even today, although reasonably good complementary pairs of transistors are offered by several major manufacturers, there are some

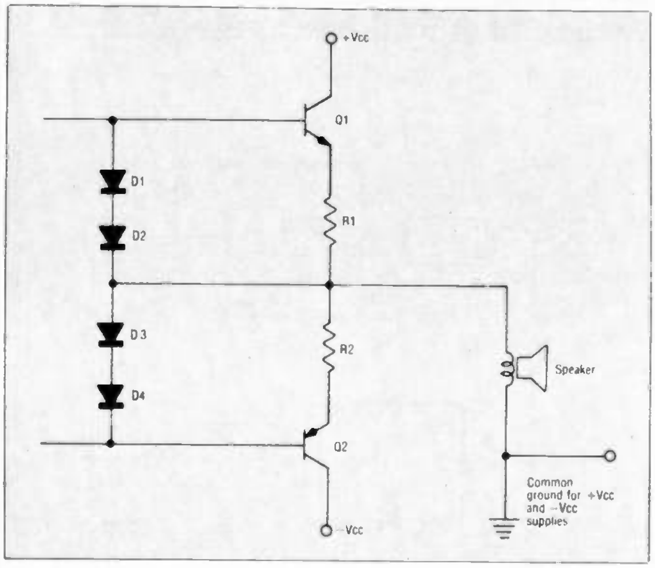


Fig. 2 A basic current limiting protection circuit using diodes.

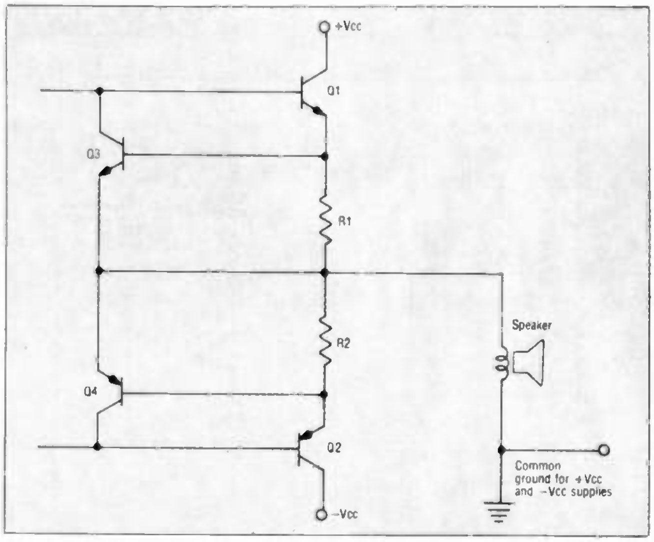


Fig. 3 Transistors Q3 and Q4 serve as current sinking devices in this common protection circuit.

significant differences, notably in turn on and turn off times, between the PNP and the NPN power transistors.

You may think this problem is solved with the use of transistors rated for one megaHertz "F_t" but that is incorrect. F_t is the frequency at which the common emitter current gain, Beta, drops to one (unity current gain). At lower frequencies the current gain increases, rising at the rate of 6 db per octave (the gain doubles every time the frequency is cut in half). Thus the gain would be 2 at 500 KHz, 4 at 250 KHz, 8 at 125 KHz, 16 at 62 KHz, 32 at 31 KHz, and only 62 at 16 KHz. Now you can see that a high gain transistor, (or a Darlington), would be running at only a fraction of its rated Beta, even if it had an F_t of one magaHertz. Remember that some Darlingtons have a low frequency Beta nominally rated in the thousands!

The differences in the factors, such as F_t in a complementary pair of output transistors, could be significant in the OTL circuit which needs matched pairs of output transistors to function properly. It is usually easier to obtain a close match using two NPN devices of the same type (obviously). And, NPN silicon output transistors come in a wider variety, at lower cost, and generally offer somewhat better specifications.

Which brings us to the quasi-complementary half-bridge circuit, which is the most common, and most frequently encountered type in hi-fi and TV. Although there is need for a phase inverter ahead of the output transistors, the cost of a plastic small signal transistor and a few resistors is about 25 cents to the manufacturer, and is recovered in the savings which are effected in the cost of the output devices. The basic problems described regarding the true complementary OTL (above), are thereby economically avoided.

Power supply

As mentioned earlier, the power output is fixed by the power supply voltage, and the load impedance, since there is no impedance matching transformer in an OTL circuit. When higher power output is desired, the supply voltage must be increased, or the load impedance decreased (to draw higher output current from the available supply voltage). Increasing the supply voltage increases the cost very rapidly, since high power transistors are priced in accordance with voltage rating, the high voltage transistors costing a great deal more than the low voltage devices.

There is a limit to how low you can go in speaker impedance without running into problems of loss in speaker cables, and other practical considerations arising from the very high output currents. Four ohms is about the limit of impedance reduction with present day speakers and components.

The full bridge circuits enable us to get four times the power output available from the half-bridge circuits. This is due to the fact that one pair of transistors conduct current in one direction through the load, while the other pair conduct current in the opposite direction through the load, much in the manner of the common bridge rectifier circuit. Thus the power supply appears, to the load, to be an AC source with a peak-to-peak voltage equal to twice the total DC supply voltage.

Of course twice the voltage equals four times the power in accordance with the formula, "Power equals voltage squared divided by the resistance." Some of the high powered automotive audio amplifiers now being sold are using inverters in order to achieve higher voltage from the twelve volt automotive battery, when, in many cases, the bridge OTL would supply adequate power, with greater reliability and freedom from noise radiation. As a matter of fact, the bridge circuit was used quite a few years ago in aircraft solid state amplifiers and is a time proven circuit.

Service aspects of OTL

At this point you might be wondering why OTL is so popular, considering its increased probability of catastrophic failures and the loss of flexibility of application. Aside from the fact that it offers a cost reduction, the reduction in size and weight *permits mounting the OTL on a plug in module*. Vertical sweep amplifiers in some TV sets are now on a small replaceable module. This enables implementation of manufacturers philosophy of replacement modules, which can be traded in on rebuilt modules, available from the manufacturer. This permits the manufacturer continuing profits on parts, where those profits formerly went to the service shop in the form of labor charges.

OTL fits very nicely into the planning which dictates that all service will eventually consist of either replacing, or trading in, portions of the equipment, instead of troubleshooting and repairing it. Thus the OTL amplifier will be part of the scene for many years into the foreseeable future, so you might as well become familiar with it.

I have found that it is worth a *quick* attempt at troubleshooting OTL modules. In some cases, visible inspection reveals poor solder joints, broken parts, burned parts, etc. A quick meter check of the semiconductors completes all the troubleshooting that is worthwhile. If you can't find the problem

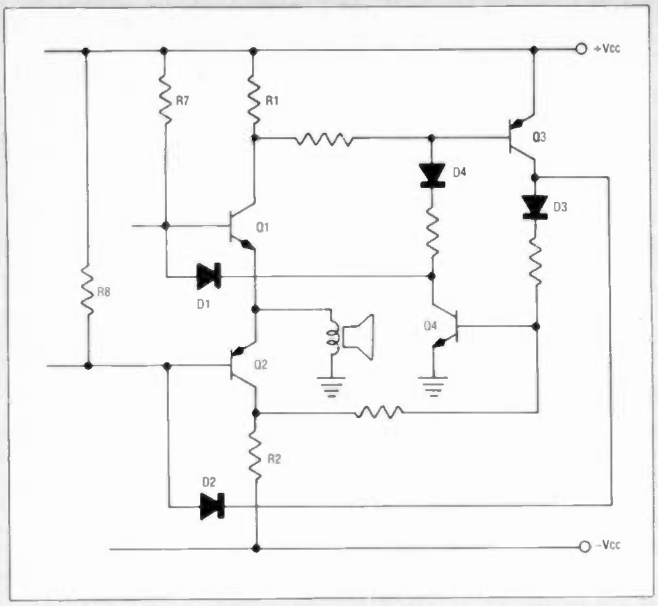


Fig. 4 This "latching" circuit is often used as a protection against short circuits. Essentially it is a bistable flip-flop.

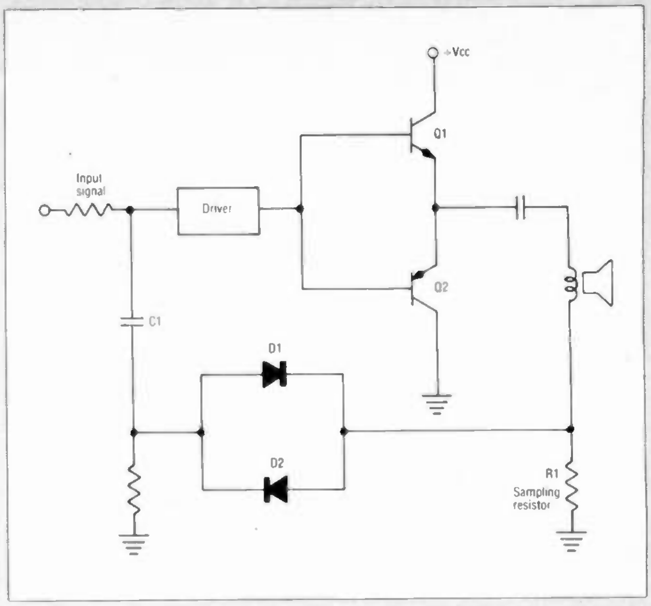


Fig. 5 This "overdrive" circuit serves as a non-linear gain control to hold down signal peaks.

in ten minutes of module troubleshooting, you will probably be ahead by trading in the module, since the rebuilding charge is quite reasonable for most of the popular modular sets.

Don't forget-to clean the module connecting pins! After a period of time, depending upon how clean the environment is, the contacts tend to develop high resistances. Exercising the contacts by pushing the module in and out of the socket usually corrects the problem for quite a while. Use a quality tuner lube—do not use a cleaner that leaves solid residue—all that should remain is a light film of silicone on the contacts!

As with other power semiconductors, the output transistors tend to develop intermittents which appear only after being fully warmed up. This problem is particularly annoying, since the OTL will appear to have been repaired, only to have the same problem recur later, after the equipment has been reassembled. If there is the slightest doubt on a repair, replace *both* of the output transistors, since a failure in one has a direct effect on the other.

A word of advice ... if the mechanical configuration permits, always replace a plastic power transistor with a metal cased device. The metal cased transistors dissipate heat more efficiently, and in consequence are rated for higher operating currents and power. There are commercial kits available for this, and they are worth the cost. Some of the home electronic apparatus with OTL tends to break down at fairly regular intervals ... but the use of metal transistors practically eliminates the problem.

Since there is no output transformer in OTL amplifiers, always check to make sure that the proper load is placed on the amplifier. I have discovered that in many cases of output transistor failure, the user has placed 4 ohm speakers on a unit rated for 8 ohms, or has added extra speakers, reducing the load impedance. This causes the electronic overload protection to trip, and/or the output transistors to blow. It should be noted that some OTL amplifiers have overcurrent protection *built into the power supply*. In such cases the problem will appear to be in the power supply. This type of electronic protection is not covered in the section following on electronic OTL protection, since it is rightfully a part of the power supply.

Protection circuits

Although many OTL amplifiers now incorporate electronic protection circuitry, there is no clear delineation in the schematic as to which components are involved in the protection function. This leads to puzzling over what the various parts are doing in the amplifier. Therefore we will consider the protection circuits in this part of the article.

First, it should be pointed out that fusing is not a very adequate protection method, since most semiconductors employed in OTL amps will fail before a fuse blows. The use of semiconductors heavy enough to accomplish inherent protection, or withstand overloading until a fuse clears, greatly increases the cost of the design.

Electronic circuitry can be very effective for protecting OTL circuits from the TWO main causes of overload failure: Overdriving and shortcircuited (or partially shortcircuited) loads.

Remember, that the transistors in an OTL amplifier are directly connected to the load in many cases. A short circuited load means that the only resistance in the series circuit is the impedance of the power supply, which is usually quite low. On the other hand, due to the transistor's ratings, and the heat dissipation (heat sinking), there is a definite value of current which should not be exceeded for any length of time ... and the current through the load is determined to a large extent by the drive into the bases of the output transistors. Overdriving the transistors with severely clipped (squared) waves, etc., surely will raise the RMS current through the output transistors far above the normal voice and music waveforms for which marginal amplifiers are often designed. Thus electronic circuitry used for protection of OTL amplifiers may, depending upon the design, protect for either one, or both, of these common overload causes.

The schematics that follow illustrate some of the different types of overload protection circuits, how they function, and what they protect against. Once you understand how they work, you will be able to figure out most of the other protective circuits you encounter. (As with anything else, the first time you encounter a protective circuit, it can be very puzzling.)

If you think about it for a bit, a fault in a *preamplifier* which results in clipping (squaring) of the signal at some *low* signal level can result in overdriving the output stages. And, as pointed out early in this article, any fault within the feedback closed loop around the output amplifier and several earlier stages, can also result in overload.

If the protection circuit is performing the protection function it was designed for, you may have to look elsewhere for the reason! Don't assume that the protection circuit has malfunctioned until you ascertain whether the amplifier is in overload, and is being protected by the protection circuit. (A common, and time wasting error.)

Current limiting

Figure 2 illustrates one basic method of limiting the current through the output transistors. The current flows through resistors R1 and R2, producing voltage drops proportional to the current. When the voltage drop through R1 plus the voltage drop between the base and emmitter of Q1 (Vbe) exceeds the turn on voltage of diodes D1 and D2 in series, D1 and D2 conduct, preventing further drive increase into Q1. The same thing happens with Q2, R2, D3, and D4. Thus, if the voltage drop across R1 or R2 exceeds one diode's forward voltage drop, limiting occurs, since there is already one forward diode voltage drop in the Vbe of each transistor. By selecting the proper resistance of R1 and R2, limiting can occur at any desired current.

The circuit of Figure 2 can also be used to limit the *dissipation* in Q1 or Q2 by merely positioning the diodes on the same heat sink with the associated transistor, and using silicon, germanium, or a combination of both, plus resistors or thermistors, as required in place of D1 and D2. The combination is chosen to change its forward condiction, and the amount of conduction, in accordance with temperature rise. Properly selected, the drive will be reduced to effect limiting of the output current if the temperature rises to the point of excessive heating of the heatsink, and therefore also keeps the transistor temperature within safe limits.

Figure 3 is a popular current limiting circuit, using transistors instead of diodes to obtain a more pronounced action. R1 is selected so that the voltage drop across it will forward bias transistor Q3 when excessive current flows. When Q3 turns on, the drive into Q1 is shunted to ground, reducing the current through Q1. The same action occures with Q2, R2 and Q4.

Short circuit protection

Figure 4 is a circuit often used to prevent destruction of the output transistors when the load is short circuited. Resistors R1 and R2 sample the current flowing through the transistors. If the current through R1 is excessive, the drop is sufficient to turn on Q3, which drives Q4 on, which in turn holds Q3 on. This is the old "latching circuit," or a "bistable flip flop." It should be noted that the same action occurs if the current through R2 is excessive. In this case Q4 is turned on by the drop across R2, and Q3 is latched on by Q4. Thus if either Q1 or Q2 draw heavy current, the latching circuit will latch up.

Once the latch up occurs, the drive and bias into Q1 is shorted to ground through D1 and Q4, while the drive and bias into Q2 is shorted to + Vc through D2 and Q3. Each of the output transistors is thus reverse biased off. This off state continues until the latch up action is broken, which can be done by adding a push button ... But the simplest way is to merely turn off the power supply for a moment, thus avoiding adding another control to the amplifier. R7 and R8 are bias resistors, part of the usual biasing network and driver circuitry. Diodes D3 and D4 prevent "sneak paths" for the current flows in the latching circuit.

Figure 5 is a circuit which prevents overdrive into the output transistors. R1 is placed in series with the load. Excessive drive through the load results in sufficient voltage drop across R1 to cause diodes D1 and D2 to conduct. The signal through D1 and D2 is applied to the input of the driver circuitry, via C1, in such phase as to be "negative feedback," i.e., 180 degrees out of phase with the input signal. This negative feedback knocks down the gain on high level peaks which exceed the limit determined by the value of R1. It should be noted that this circuit does not operate on the bias to the output transistors, but merely acts as a non-linear gain control to hold down signal peaks. It is a "compressor."

These four circuits illustrate a good cross section of the various types of protective circuits commonly in use. Of course you will find that manufacturers use combinations of the different protection systems ... but you should be able to "think through" them now that you understand what they do, and how they do it. Each circuit offers advantages, and disadvantages, when compared with the others, for a given amplifier design. Eventually you will encounter all of them, plus a few others. There can be no argument that some form of protective circuitry is required

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Tools and equipment

Video (Tape and disc)

Article title index

ETD

BULLETIN BOARD

Practical electronic theory and background makes the *Handbook of Electronics Calculations for Engineers and Technicians* even more useful than its name might imply. This handbook covers basic applied mathematics, for nearly every aspect of electronics design and strips away superfluous material to present typical, practical, fully worked out problem examples. Its 24 sections cover ac and dc circuit analysis, amplifiers, feedback, oscillators, power supplies, digital logic, communications, microwaves and many other areas of electronics. Edited by Milton Kaufman and Arthur H. Seidman, 668 pages, hardbound, $24.50, McGraw-Hill.

A booklet that explains High Fidelity at the consumer level has recently been published by *Yamaha*. This sixteen page booklet is intended for dealer distribution to consumers. Titled "An Introduction to Stereo" it should teach the consumer how to understand manufacturers technical specifications and make intelligent comparisons between competing products. The function of each component of a system is explained along with means to understand manufacturers performance claims. Copies are available from Yamaha reps or by writing to: Audio Sales Department, Yamaha International Corp., P.O. Box 6600, Buena Park, CA 90629.

A Security System Merchandising Portfolio is now available from *Chamberlain Manufacturing Corporation*. It includes information on selling, to the home security market, Chamberlain's radio-controlled Dual Alarm Home Security System. It also includes a collection of sales literature, brochures, envelope stuffers, direct mail pieces, ad mats, sample radio commercials and other material. Contact Michael Schatz, Chamberlain Manufacturing Corp., 845 Larch Ave., Elmhurst, IL 60126.

Texas Instruments latest addition to their **"Understanding Series,"** is a new soft cover, entitled *"Understanding Microprocessors."* It begins in a non-technical manner to explain what a microprocessor is and how it fits into a micro computer system. *"Understanding Microprocessors"* is a self teaching textbook complete with quizzes and includes an introduction to digital electronics and microprocessor applications with exercises and solutions. Well worth the $4.95 price. Texas Instruments Incorporated, P.O. Box 3640, MS 84, Dallas, TX 75285.

A new **Module Cross Reference Guide** and a new brochure covering PTS and Castle Test Instruments have recently been published by *PTS Electronics*. The module guide offers cross reference information for Admiral, GE, Magnavox, Philco, Quasar, RCA, Sylvania, Wells-Gardner and Zenith modules. The test instruments featured in the brochure are PTS and Castle tuner/signal analysts and PTS's new digital voltmeter/power supply combinations. Free from PTS service centers or PTS Electronics, 5233 S. Hwy 37, P.O. Box 272, Bloomington, IN 47401.

Stan Prentiss has written another book on **TV Troubleshooting** and it has just been published. Written from the viewpoint of a technician rather than an engineer or an instructor, it is a discussion of recent (and current) television receivers, circuit theory, problems and troubleshooting. Stan works step by step through the various sections of TV sets, combining theory with practical troubleshooting procedures and hints, and emphasizes the dual trace oscilloscope as a troubleshooting tool. A good book. *Color Television Theory and Troubleshooting*, by Stan Prentiss, hardbound, 370 pages, Reston Publishing Co., $16.95.

A new **MRO Semiconductor Replacement Guide** has just been announced by *RCA*. This guide lists the SK series transistors and other solid state devices for industrial/commercial equipment repair. Available from RCA SK distributors or SK Series Merchandising, RCA Distributor and Special Products, P.O. Box 100, Depford, NJ, 08096 for $1.00 per copy.

Business band and ham antennas are the subject of a new twenty-two page mini-catalog from *Hustler*. It covers commercial antennas for 30-50, 148-174 and 450-512MHz and amateur antennas from 80 meters through 435MHz. Copies are available free from Hustler distributors or write: Hustler, Inc., 3275 N. 8 Ave., Kissimmee, FL 32741.

A 16 page **catalog of directional wattmeters, dummy loads** amd accessories is now available from *Bird Electronics Corporation*. Mob Cat-79 describes various models of directional wattmeters, most of which use interchangeable plug-in elements, absorption wattmeters, coaxial load resistors with ratings from 5 to 1500 watts continuous duty, and a new series of low pass filters for mobile communications transmitters. A copy is available from Bird Electronic Corp. 30303 Aurora Rd., Cleveland (Solon), OH 44139.

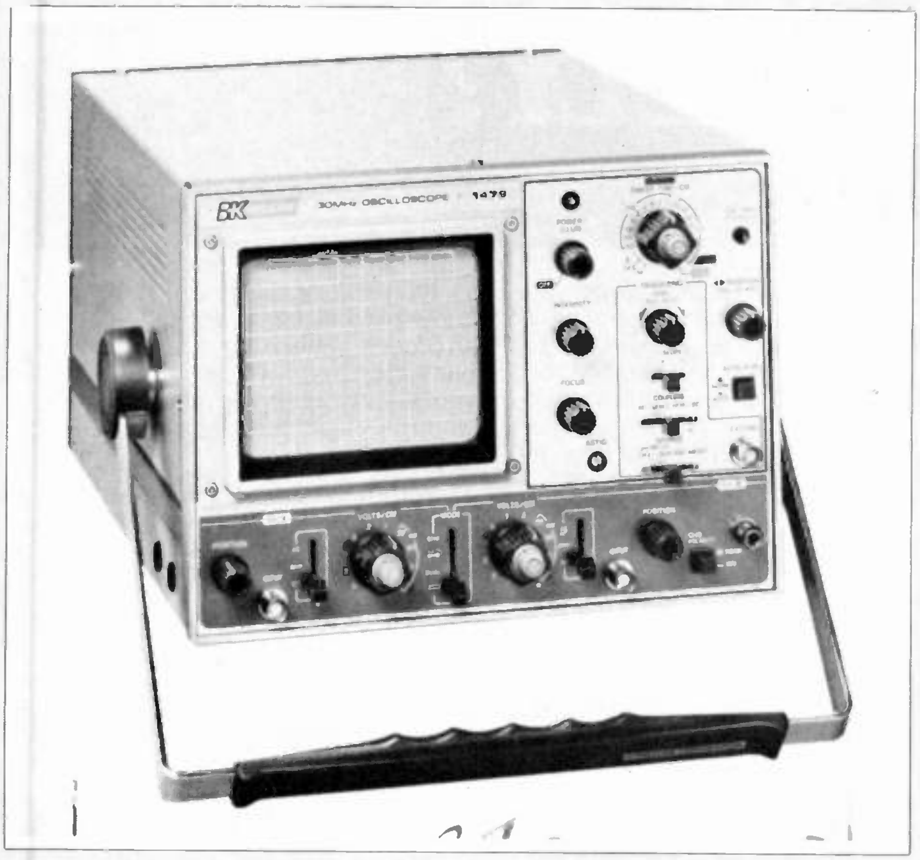
A new fall **catalog of tools, tool cases and tool kits** has just been issued by *Jensen Tools, Inc.* Its 128 pages include more than 2,000 tools for field engineers, technicians, locksmiths, watchmakers, and electronics hobbyists. Jensen's specialty, complete tool kits for the traveling field engineer are featured prominently. For a free copy write: Jensen Tools Inc., 1230 S. Priest Drive, Tempe, AZ 85281.

Semiconductors, IC's and components, with quantity prices are featured in the latest catalog from *Digi-Key*. The catalog offers a wide variety of TTL, CMOS, Linear IC's and discrete semiconductors as well as resistors, capacitors, hardware, pc board supplies, tools and books. Write for a free copy: Digi-Key Corp., P.O. Box 677, Thief River Falls, MN 56701. ET/D

TEST INSTRUMENT REPORT

Hopefully, all our readers by now realize the increasing importance of a good wideband, triggered scope in troubleshooting consumer or industrial electronics and all the digital applications that are becoming more and more common. But that's enough of a lecture.

B&K-Precision's new 1474 is a 30MHz, dual trace, oscilloscope which



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

The B&K-Precision Model 1479 Oscilloscope

30MHz and signal delay

By Walter H. Schwartz

additionally includes a delay line in the vertical amplifier. For those who perhaps are not familiar with this feature, which is still not common in oscilloscopes intended for consumer electronics trouble-shooting, the delay line delays the input signal in the vertical amplifier allowing it to trigger the sweep so that it—the sweep—begins before the signal reaches the CRT deflection plates. The significance of this is that you can see the entire leading edge of a pulse or square wave, which can be important in digital and other pulse circuits.

Some of the features of the 1479 are: 20 sweep speeds from 0.2μsec/cm to 0.5sec/cm and a X5 magnifier, dual vertical amplifiers with sensitivities of 5mV/cm with several modes of operation: Channel A, Channel B, Dual Trace, Add (A+B), and by using Channel B invert, (A-B). The 1479's sweep can be triggered on either the positive or negative going slope of a waveform and the trigger coupling switch offers four options: AC—AC coupled from 20Hz to 30MHz (or better), LF REJ—triggering below 10kHz is attenuated, HF REJ—Triggering above 30kHz is attentuated, and DC—DC coupling of the trigger signal.

Operation of the 1479 is a pleasure. Triggering is easy and if you think you have lost the trace, automatic triggering is available. The vertical amplifier calibration is accurate and the bandwidth is even better than specified. We measured it up to 50MHz using a B&K-Precision E200D signal generator and found the gain to be down only about 5% at 30MHz, and the 3dB point to be a bit beyond 40MHz. The gain was down about 6dB at about 55MHz. In our strong signal area, I was able to signal-trace with a low capacitance probe throughout the IF of an old RCA CTC24 chassis very easily. Which brings up my pet peeve: Maximum input voltage ratings. The 1479 is rated at 300V (dc + peak ac) or 600V P-P ac. While you certainly won't get into trouble with digital circuits, I still like to be able to look at, for example, horizontal output transistor collector waveforms which are typically 150vdc, plus 800v peak pulse. Apparently though, this input rating is adequate for most technicians; the 1479 is no better or worse on this count than most of its competition. The PR-36 probes supplied with the 1439 are rated at 500V and since they can be used as 10:1 low capacitance probes, presumably when used as such help this situation to some extent. They are convenient, slim and are changed from direct to 10:1 by pulling out the tip, rotating it 180 degrees and reinserting it. The probe ratio is displayed in a window in the probe body. No higher voltage, higher attenuation probes appear to be available at this time.

X-Y operation is possible with the horizontal (X) input at Channel B. The horizontal amplifier's frequency response is specified to be down 3dB at 2MHz. Again we found the 1479's specifications to be conservative. When measured the 3dB point was found to be a bit beyond 3MHz. We did find however a measurable phase shift between X and Y inputs beginning about 150KHz and by the time we reached 2MHz the difference was apparently more than 90°.

If your 1479 ever requires repair it may not be easy (simply because of the approximately 75 discrete transistors and eight integrated circuits it contains), but it will be greatly simplified by one of the neatest layouts we've seen lately. All components are parallel to or at right

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CUT YOUR AD BUDGET LATELY?

Honesty compels us to admit that you're not alone.

Whenever the cost/price squeeze gets really tough, it's a temptation to regard advertising as a cost...and to cut.

Not at every company, however.

In recent years, a significant change has taken place in the thinking of many management men about advertising budgets. No longer are appropriations cut automatically when the pressure is on.

Why?

For a number of reasons. Among them are:

1. *With the growth of the marketing concept,* advertising is no longer looked upon merely as an expense, but as an integral part of the company's marketing mix.

2. *Firms that maintain advertising during recession years do better in sales—and profits—in those and later years.* That was proved conclusively in studies of five separate recessions made by ABP and Meldrum and Fewsmith.

3. *The cost of a salesman's call today makes it imperative to make maximum use of advertising.* The average cost of an industrial sales call soared to a record $96.79 according to the latest report by McGraw-Hill's Research Laboratory of Advertising Performance. Yet studies show that a *completed* advertising sales call—that is, one ad read thoroughly by one buying influence—literally costs only pennies. Why deny yourself such efficiency?

4. *In some cases, there is no way to reach customers except by advertising.* The "Paper Mill Study" shows (1) the number of buying influences in the average plant is far greater than marketers are aware of, (2) the vast majority of these influences are unknown to salesmen, (3) no salesman has the time to contact all influences even if he knows them.

5. *Selling costs are lower in companies that assign advertising a larger role in marketing products.* So advertising is an investment in profit, just like a machine that cuts production costs.

6. *Memories are short.* There is an estimated 30% turnover every year among buyers. It isn't surprising, then, that lack of advertising contact can quickly result in loss of share of market.

7. *Most down periods turn out to be shorter than expected.* The history of every postwar recession is that it didn't last as long as predicted. Why gamble your market position for short-term gain?

8. *Consider lead time.* Very few products sold to business and industry are bought on impulse. The advertising you are doing—or missing—right now will have its effect years from now.

9. *Advertising works cumulatively.* It would be nice to think that every reader reads all of your ad. We know it doesn't work that way. To be most effective, advertising must have continuity.

10. *Did your competitor cancel his budget, too?* If not, you may be taking a big risk.

11. *Will you lose salesmen?* They know that their chance of getting an order is better if they are backed up by advertising. Can you be sure of keeping them when they learn that that support has gone?

12. *You know better.* Survey after survey of executives shows that they expect a *drop* in sales if advertising stops.

But there is need for efficiency...

whenever advertising budgets are being assembled—never more than in these inflationary times. Significantly, a recent survey shows that nearly 40% of the average budget for advertising to business and industry is invested in business publication space and preparation. That's *more than double* the next largest item.

Why? Because specialized business publications remain the most effective and efficient method of reaching target audiences in business, industry and the professions.

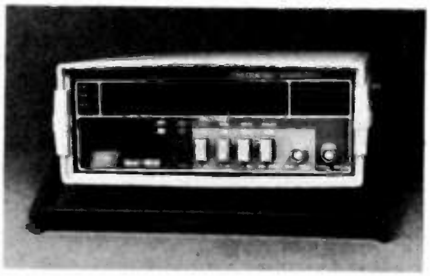
And we can prove it.

Write for your copy of "The ABP Library of Publishing, Advertising & Marketing" to American Business Press.

ABP

American Business Press, Inc:
205 East 42nd Street
New York, N.Y. 10017
212 661-6360

new PRODUCTS

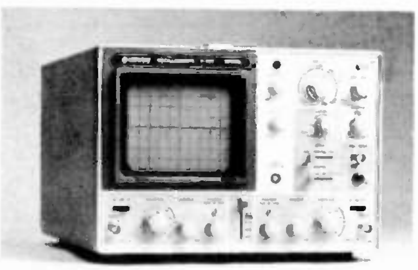


High accuracy, low cost, counter
Circle No. 124 on Reader Inquiry Card

A 50Hz to 550MHz 9 digit frequency counter with a 10MHz proportional oven crystal controlled time base of a stated accuracy of 0.2 PPM from 10 to 40°C is now available from *DSI Instruments*. Features include push button selection of resolution from 0.1Hz to 1kHz, "Standby," "Oven-Ready" and "Gate Time" lights and an internal battery compartment. Options include a 10 hour rechargeable battery pack, an audio multiplier that permits up to 0.001Hz resolution, and 25dB preamplifier. The 5600A is available for $149.95 as a kit and $179.95 fully assembled.

Oscilloscopes Introduced
Circle No. 125 on Reader Inquiry Card

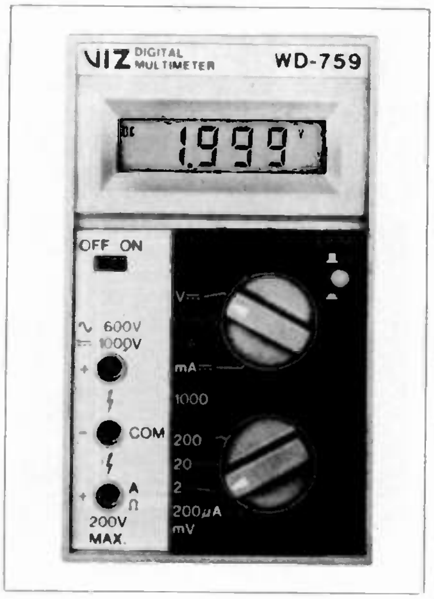
Hitachi has introduced to the U.S. market four new 5-inch oscilloscope models, V-151, V-152, V-301 and V-302. Similar in characteristics, the 151 and 301 are



single trace while the 152 and 302 provide dual trace capability. Other features include bandwidth rated at 15MHz for the 151 and 152 and 30MHz for the 301 and 302, and 1mV sensitivity with a times 5 vertical amplifier expander. Both models offer automatic, normal and TV triggering and time base sweep speeds of from .2µS to .2S/DIV in 19 calibrated steps. The models also feature TV sync separator circuit, a times 10 sweep magnifier, trace rotation, front panel X-Y operation, Z-axis modulation and the 301 and 302 have an internal signal delay line. The model 151 is priced at $545 and the 152 at $695. The 301 is $745 and the 302 is $945.

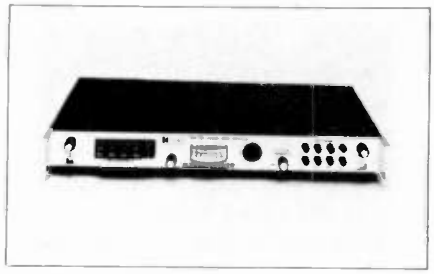
High Accuracy DMM
Circle No. 126 on Reader Inquiry Card

With a choice of either LCD or LED displays, these two 3½ digit DMMs provide an accuracy of 0.1% (dcV) with an input impedance of 10 megohms, according to *VIZ Mfg. Co.* The LCD model, WD-759, offers the advantage of a visual indication of function (DC or AC volts, ohms or amperes) in the display window as well as the measurement value. The suggested price is $159. Measurement ranges are from 100 microvolts to 1000Vdc and up to 600Vac; from 0.1 ohm to 20 megohms and from 0.1 microamp to 1A, DC and AC. The units also provide for measurement of either high or low power ohms in all ranges—switch selectable. This assures accurate readings when making measurements either in or out of circuits. The instruments are



housed in tough, impact resistant cases with a raised guard edge on the front to protect the selector switches from impact if the unit is dropped face down. For easy service in the field, there is a 1A fuse plus spare conveniently located in the rear battery compartment. An AC adaptor is available for bench operation. A carrying case is available that permits use of the instrument while in the case. Another accessory is a high-voltage probe (50KV DC). The LED model, WD-758, is identical in electrical performance except that it doesn't provide function indication in the display. Price is $149.

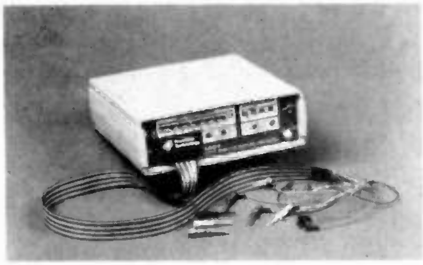
Time/Frequency Receiver
Circle No. 127 on Reader Inquiry Card



Tired of not knowing the correct time to set your watch? The *True Time Division of Kinemetrics* has recently introduced a WWV time and frequency receiver, Model WVTR, Mark V. This receiver scans and locks onto the best signal from either 2.5, 5, 10 or 15MHz. It also includes a time code stripper which converts the 100Hz subcarrier to a dc level shift. Guaranteed for two years the Mark V receiver is priced below $1,000.

Logic Analyzer
Circle No. 128 on Reader Inquiry Card

A logic analyzer for production and maintenance troubleshooting is available from Practical Technology. The Logic Analysis Display formatter, abbreviated to LADY, captures, stores and



formats eight input lines into a sixteen interval state timing diagram for viewing on an ordinary oscilloscope. LADY enhances each display line with sample markers, a trigger marker, and a low level reference signal and simultaneously records eight digital signals either synchronously with an external clock (10MHz maximum) or asynchoronously using the unit's internal 10MHz clock.

MATV/CATA Instrumentation

Circle No. 129 on Reader Inquiry Card

Two instruments for checking MATV and CATV systems have recently been introduced by *Leader Instruments Corp.*

Model LCF-944B is a TV field strength meter capable of measuring signals of -40 to +60 dBmV on VHF and -30 to +70 dBmV on UHF. Up to 80dB of attenuation is available in steps of 10 dB.

Model LCG-138 is a VHF signal generator intended for injection of a known level of signal into a MATV or CATV system.

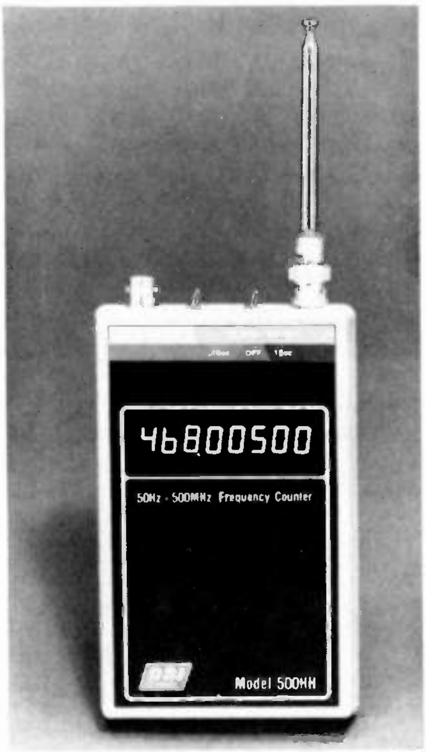
Output is available on two high and two low VHF channels at a level of +40 dBmV and can be attenuated up to 40 dB in 10 dB steps.

The price of the LCF 944B is $512 and the LCG-138 is priced at $244.

Minature Frequency Counter

Circle No. 130 on Reader Inquiry Card

DSI's 50Hz to 500MHz Model 500HH and 50Hz to 100MHz Model 100HH counters are reportedly accurate to 1.0 PPM (using a TXCO time base) over a +17 to +40° temperature range. Their 8 digit LED array with 0.4 inch characters has automatic decimal point shift and zero blanking. Input impedance is 1 megohm direct, 50 ohms pre-scaled. The counters operate from a built-in rechargeable battery pack and measure 3.5 inches wide by 1.25 inches deep by 5.75 inches high. The price of the 100HH starts at $119.95 and the 500HH is $169.95.



Power Monitors

Circle No. 131 on Reader Inquiry Card

A new series of digital ac power meters has recently been introduced by *Diego Systems*. Each model measures ac volts, current, peak current and true power. Isolated BNC outputs allow monitoring of load current and voltage by an oscilloscope. Model 230 with a 200 watt range is priced at $319. Other models measure up to 1KW, are auto ranging, and cost from $399 to $445. Accuracy is 0.25%.

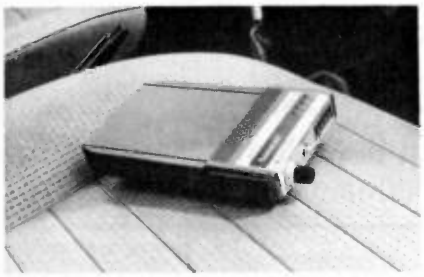
Portable DMM

Circle No. 132 on Reader Inquiry Card

Simpson has recently introduced a new compact portable, 3½ digit, LCD, digital multimeter, model 463. The 26 range instrument is stated to offer up to 200 hours of continuous operation on a 9V

alkaline transistor battery. The 463 is said to be highly transient and overload resistant and features push button range selection, and automatic zeroing and polarity indication. Complete with battery, test leads and manual, the price is $175. Accessories include RF and 40kV HV probes, an ac amp-clamp adapter and a carrying case. ET/D

DEALER'S SHOWCASE



8-Track Player/Plug-in Scanner Cartridge

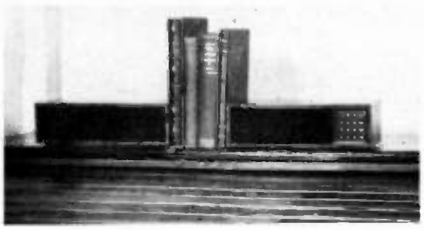
Circle No. 135 on Reader Inquiry Card

Electra Company has announced the development of a scanner radio cartridge for use with any 8-track player. The new "Bearcat 8-Track Scanner" plugs into the 8-track player in place of a conventional tape cartridge. Up to four VHF high/low band communications channels, including police, fire and other public safety services are then automatically scanned for calls. Volume and tone controls can be used normally, while a special squelch control on the plug-in scanner cartridge silences noise when no calls are being received. Red LED's indicate the channel being received. Lockout switches are provided for by-passing any channel when desired. The suggested retail price of the new Bearcat 8-Track Scanner is $99.95, less crystals.

Microcomputer-Based Ultrasonic Intrusion Detector

Circle No. 136 on Reader Inquiry Card

A microcomputer-based ultrasonic intrusion detection system that reportedly eliminates false alarms is being introduced by Massa Products Corp. The MassaSonic Ultrasonic Intrusion Alarm is a patented microcomputer based system that discriminates between moving air and actual moving targets. A touch keyboard provides control and more than 1700 possible 3-digit key codes for disarming. If tripped, the alarm sounds a built-in siren (rated at 105dB at 1 foot) for 4 minutes, then rearms itself automatically. Modular design permits system expansion. Providing a 120° angle of coverage in any room up to 1000 sq ft, the alarm plugs into any 115 Vac wall outlet and needs no adjustment. A walk test feature helps users position the unit for maximum coverage. An optional anti-tamper battery siren unit with a distinctive alarm tone provides up to 48 hours of continuous emergency power.



The price is $269.95; the battery/siren unit, is $99.95.

3-Way Home Stereo Speaker

Circle No. 137 on Reader Inquiry Card

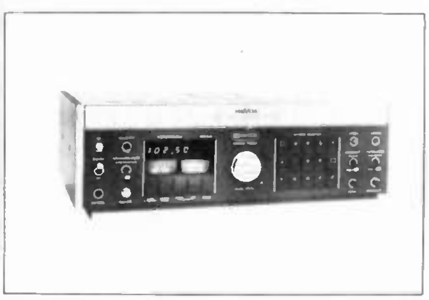
A new 3-way home stereo loudspeaker is being introduced by *Burhoe Acoustics* of Melrose, Massachusetts. The Burhoe Royal Blue Speaker features four drivers that offer a wide, reportedly 27Hz to 26KHz, frequency response for quality sound reproduction in home stereo systems. For greater ambience, two 1 inch biradial tweeters are located on the top and front of the cabinet, and can be individually controlled. For use with amplifiers providing 20 to 150 Watts per channel, the Speaker incorporates a newly designed 2 inch inverted dome mid-

range that improves power handling and reduces distortion, and a 10 inch woofer, in addition to the biradial tweeters. Each walnut veneer, 18 inch × 30 inch × 11½ inch cabinet is internally reinforced. It is priced at $800 per pair (retail).

Quartz-Controlled FM Tuner

Circle No. 138 on Reader Inquiry Card

In their new B760 FM tuner, *Studer Revox* has combined quartz-controlled synthesizer tuning, a 15-station programmable memory and digital readout. The CMOS electronic memory is programmed from the front panel, without the need for screwdriver adjustments or internal alignment. Once programmed, stations are selected by pressing one of fifteen pushbuttons. Stations may also be manually tuned using the tuning knob, in increments of 25 or 50kHz. Both tuning systems have frequency accuracy to within 0.005%. An optional Dolby FM circuit card may be user installed to permit reception of Dolby broadcasts. Additional control features include variable-threshold interstation muting, variable output level, a headphone amplifier with volume control, dual tuning meters, and a high-blend switch that reduces channel separation at high frequencies to make fringe-area stations more listenable. An internal standby battery power supply prevents loss of memory in the event of a power outage. Rear panel oscilloscope outputs are included for visual evaluation of signal strength, deviation and multipath interference. Specifications of the tuner include an IHF sensitivity of 2.5μV (13.2dBf), sensitivity for 50dB quieting, in stereo 30μV (34.8dBf), alternate channel selectivity of 78dB, and an exceptionally low stereo harmonic distortion figure of 0.25%. ultimate signal-to-noise ratio is 78dB, capture ratio is 2dB, and AM suppression is 70dB. The B760 measures 17.8 inches (w) × 6 inches (h) × 13.7 inches (d), and weighs 26 lbs. It can be used with European, Asian and American station spacings and deemphasis curves, and with all standard world line voltages and frequencies. Suggested retail price of the B760 is $1,649.00; the optional type 34610 Dolby plug-in is $130.00



Record Care Kit

Circle No. 139 on Reader Inquiry Card

A record care kit designed to keep both styli and records clean has been introduced by *Empire Scientific*. The "Dry System" reportedly performs its cleaning job without applying any potentially harmful chemicals to the record. The system includes a static eliminator to neutralize dust attracting static electricity, a dust eliminator brush to clean the record grooves, and stylus cleaner fluid and brush. Suggested retail price is $79.95. ET/D

TEST INSTR. REPORT

continued from page 41

angles to each other and are labeled with schematic designations. Circuit paths are marked on the top side of the boards; transistors have E-B-C designations; IC's have pin one indicated. All boards are accessible; the manual and schematic are very readable and complete.

High performance as it is, the 1479 is a compact instrument. It measures 14.5 inches wide, 9.8 inches high and 17.8 inches deep and weighs only 19 lbs. It is supplied complete with two probes for $1,099. ET/D

MAGNAVOX

continued from page 29

from the TV chassis to handle band switching chores.

Voltage rectified by D3 is clamped at 15VDC by zener Z2 and R42 drops this to 14VDC to power IC's 6 and 9 in the D/A converter circuitry.

D14 is a current shunting diode used to protect EC3D when switch RL201 is de-energized.

Admittedly, this is a quick run through of the operation of a microprocessor controlled device; space simply does not permit discussion of this complicated circuitry in detail. I have tried to touch on some of the highlights, but other features (the tuner and bandswitch circuits, the AFT and tuning voltage amp, and others) were not even touched on.

For complete details you should contact your Magnavox distributor and training center. ET/D

AMPLIFIERS

continued from page 35

with OTL, especially if no output coupling capacitor is used. Thus you will be seeing a lot of protective circuits, even though they may not be so identified on the schematic, or in the literature. A failure in the protective circuitry may cause severe problems in the amplifier's performance and the only way you can put things right without a great deal of "hit and miss" work, is to understand the function of the protective circuit.

Next time you see one of those simple looking OTL amplifiers, look again. They can be first rate headaches for the service technician which is why so many of the OTL TV modules are being traded in for rebuilding. ET/D

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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

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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
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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
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2SB 523	.70	.80	.90
2SB 526C	.70	.80	.90
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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
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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
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2SB 557	2.10	2.50	2.80
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2SB 596	1.10	1.40	1.50
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2SC 184	.40	.53	.59
2SC 281	.30	.35	.40
2SC 283	.40	.53	.59
2SC 284	.80	.90	1.00
2SC 317	.40	.53	.59
2SC 352A	2.00	2.20	2.50
2SC 353A	1.40	1.60	1.80
2SC 367	.60	.70	.80
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2SC 370	.20	.27	.30
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2SC 377	.30	.35	.40
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2SC 381	.35	.40	.45
2SC 382	.35	.40	.45
2SC 383	.35	.40	.45
2SC 387A	.35	.40	.45
2SC 388A	.40	.53	.59
2SC 394	.20	.27	.30
2SC 403	.30	.35	.40
2SC 430	.50	.64	.70
2SC 454	.30	.35	.40
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2SC 460	.35	.40	.45
2SC 461	.35	.40	.45
2SC 478	.60	.70	.80
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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
2SC 517	2.50	2.70	3.00
2SC 535	.30	.35	.40
2SC 536	.30	.35	.40
2SC 537	.30	.35	.40
2SC 627	1.30	1.45	1.60
2SC 631	.35	.40	.45
2SC 632A	.35	.40	.45
2SC 634A	.35	.40	.45
2SC 680	1.90	2.10	2.40
2SC 681A	3.00	3.25	3.50
2SC 684	.80	.90	1.00

TYPE	25-UP	10-24	1-9
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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
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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
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2SC 774	1.00	1.20	1.30
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2SC 799	2.00	2.20	2.50
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2SC 871	.35	.40	.45
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2SC 897	2.00	2.20	2.50
2SC 898	2.50	2.70	3.00
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2SC 923	.20	.27	.30
2SC 929	.20	.27	.30
2SC 930	.20	.27	.30
2SC 941	.20	.27	.30
2SC 943	.35	.40	.45
2SC 945	.20	.27	.30
2SC 959	1.00	1.20	1.30
2SC 971	.70	.80	.90
2SC 982	.70	.80	.90
2SC 983	.50	.64	.70
2SC 1000	.35	.40	.45
2SC 1012	1.20	1.40	1.50
2SC 1013	.50	.64	.70
2SC 1014	.50	.64	.70
2SC 1017	.80	.90	1.00
2SC 1018	.60	.70	.80
2SC 1030	1.80	2.10	2.40
2SC 1047	.35	.40	.45
2SC 1051	3.40	3.55	3.90
2SC 1060	.70	.80	.90
2SC 1061	.70	.80	.90
2SC 1076	30.00	35.00	39.00
2SC 1079	3.40	3.55	3.90
2SC 1080	3.40	3.55	3.90
2SC 1096	.45	.55	.60
2SC 1098	.50	.64	.70
2SC 1111	2.10	2.50	2.80
2SC 1114	4.20	4.40	4.90
2SC 1115	2.50	2.70	3.00
2SC 1116	3.20	3.40	3.70
2SC 1116A	3.40	3.55	3.90
2SC 1124	.80	.90	1.00
2SC 1127	.80	.90	1.00
2SC 1161	1.30	1.45	1.60
2SC 1162	.70	.80	.90
2SC 1166	.20	.27	.30
2SC 1167	3.80	4.00	4.40
2SC 1170B	3.80	4.00	4.40
2SC 1172B	3.20	3.60	3.95
2SC 1173	.50	.55	.60
2SC 1175	.35	.40	.45
2SC 1177	11.00	12.60	14.00
2SC 1189	1.00	1.10	1.20
2SC 1209	.30	.35	.40
2SC 1211D	.30	.35	.40
2SC 1212A	.80	.90	1.00
2SC 1213	.30	.35	.40
2SC 1215	.35	.40	.45
2SC 1222	.20	.27	.30
2SC 1226	.50	.55	.60

TYPE	25-UP	10-24	1-9
2SC 1226A	.50	.55	.60
2SC 1237	1.80	2.00	2.25
2SC 1239	2.20	2.70	2.90
2SC 1279	.50	.55	.60
2SC 1306	1.30	1.45	1.60
2SC 1307	1.90	2.10	2.40
2SC 1310	.20	.27	.30
2SC 1312	.20	.27	.30
2SC 1313G	.20	.27	.30
2SC 1316	4.20	4.40	4.90
2SC 1317	.20	.27	.30
2SC 1318	.35	.40	.45
2SC 1325A	6.50	6.90	7.60
2SC 1327	.20	.27	.30
2SC 1330	.50	.55	.60
2SC 1335	.50	.55	.60
2SC 1342	.45	.53	.59
2SC 1344	.45	.53	.59
2SC 1358	4.20	4.40	4.90
2SC 1359	.30	.35	.40
2SC 1360	.50	.55	.60
2SC 1362	.35	.40	.45
2SC 1364	.35	.40	.45
2SC 1377	3.20	3.40	3.70
2SC 1383	.30	.35	.40
2SC 1384	.35	.40	.45
2SC 1396	.45	.53	.59
2SC 1398	.70	.80	.90
2SC 1400	.35	.40	.45
2SC 1402	3.00	3.20	3.40
2SC 1403	3.20	3.40	3.70
2SC 1407	.50	.55	.60
2SC 1419	.60	.70	.80
2SC 1444	1.60	1.80	2.00
2SC 1445	2.50	2.70	2.90
2SC 1447	.60	.70	.80
2SC 1448	.70	.80	.90
2SC 1449	.60	.70	.80
2SC 1451	1.00	1.10	1.20
2SC 1454	3.20	3.40	3.70
2SC 1475	.80	.90	1.00
2SC 1478	.50	.55	.60
2SC 1509	.50	.55	.60
2SC 1567	.60	.70	.80
2SC 1567A	.60	.70	.80
2SC 1584	6.00	6.30	7.00
2SC 1586	6.50	6.90	7.60
2SC 1624	.60	.70	.80
2SC 1626	.60	.70	.80
2SC 1628	.60	.70	.80
2SC 1647	.70	.80	.90
2SC 1667	3.00	3.20	3.40
2SC 1669	.90	1.00	1.10
2SC 1674	.30	.35	.40
2SC 1675	.20	.27	.30
2SC 1678	1.10	1.25	1.40
2SC 1679	3.00	3.20	3.40
2SC 1681	.30	.35	.40
2SC 1682	.30	.35	.40
2SC 1684	.30	.35	.40
2SC 1687	.40	.45	.50
2SC 1688	.35	.40	.45
2SC 1708	.30	.35	.40
2SC 1728	.70	.80	.90
2SC 1730	.45	.53	.59
2SC 4756	.50	.55	.60
2SC 1760	.70	.80	.90
2SC 1816	1.50	1.75	1.95
2SC 1856	.45	.53	.59
2SC 1885	.45	.53	.59
2SC 1908	.30	.35	.40
2SC 1909	1.80	2.00	2.25
2SC 1945	4.50	5.00	5.60
2SC 1957	.60	.70	.80
2SC 1969	3.60	4.00	4.40
2SC 1973	.70	.80	.90
2SC 1975	1.30	1.70	1.90
2SC 1978	5.40	6.00	6.60
2SC 2028	.50	.64	.70
2SC 2029	1.50	1.80	2.00
2SC 2074	.80	.90	1.00
2SC 2076	.50	.64	.70
2SC 2091	.90	1.10	1.20
2SC 2092	1.80	2.00	2.25
2SC 2098	3.20	3.40	3.70
2SC 2166	1.40	1.60	1.80
2SD 72	.50	.64	.70
2SD 77	.35	.40	.45
2SD 90	1.30	1.45	1.60
2SD 91	1.30	1.45	1.60
2SD 92	1.30	1.45	1.60
2SD 93	1.60	1.80	2.00
2SD 118	2.90	3.20	3.40
2SD 130	1.10	1.25	1.40
2SD 187	.35	.40	.45
2SD 201	2.30	2.40	2.65
2SD 202	3.40	3.55	3.90
2SD 218	2.50	2.70	3.00

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

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