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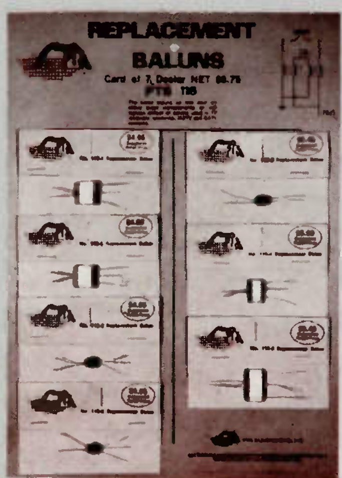

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INDUSTRY REPORT

Moch Named Head of Warranty Watchdog Committee

The Consumer Electronic Council, a group comprised of large warranty servicers and three national associations—NARDA, NATESA, and NESDA—has named Frank J. Moch head of its warranty watchdog committee.

Moch, the executive director of NATESA, was elected at a reorganization meeting of the council held recently in Chicago. The purpose of the special council is to acquaint manufacturers with specific implementation problems designated by the council as "contrary to the interests of the set purchasers and all elements of the home electronics industry."

According to a statement from the council, 17 specific warranty problems have already been identified, "six of which are particularly onerous." Moch said each alleged violator will be privately contacted in an effort to gain warranty problem modifications.

The council has already sent large warranty service organizations across the United States a questionnaire on the specific warranty practices of 10 television receiver manufacturers. The manufacturers on which data is being collected are Admiral, GE, Panasonic, Quasar, RCA, Sony, Sylvania, Zenith, MGA, and Sharp.

JVC Unveils Capacitive Pickup Video Disc System

A grooveless, capacitive pickup video disc system, capable of playing one-hour of color television programming per side, has been announced by Victor Company of Japan (JVC).

According to JVC, the player is connectable to any "ordinary" color television receiver. It plays a 12-inch plastic disc that may be recorded with color television programming or pulse code modulated stereo.

The basic features of the JVC system are:

Picture and sound information—including PCM stereo—are recorded as pits on the disc surface via laser beam. For playback, information and tracking signals are simultaneously picked up electronically as capacitance variations between the disc surface and an electrode on the tracking stylus.

The tracking stylus, JVC says, is located in a cantilever arm which is servo controlled to track the imaginary grooves and to correct for the time base

error of the rotating disc via an electrotracking system.

According to JVC spokesman engineering studies indicated a system for both home and industrial use would be the most advantageous. "In other words, we wanted a system which our industrial and domestic consumers would welcome."

FCC Seeks More Data on AM Stereo

/The FCC says it wants more data plus some persuasion of the "need" for AM stereo before it makes any hard and fast dicisions concerning competing systems and authorization.

Citing "great interest" for AM stereo on the part of some manufacturers and broadcasters, the commission noted a similar lack of interest on the part of the general public.

Going so far as to question the need for AM stereo, the FCC requested more data on the price impact on the public plus, it said, many technical standards remain unresolved. Among the deficiencies noted were the impact of the reduction in AM bandwidth and channel spacing under international law, the effects on listeners who depend solely on skywaves, and receiver compatibility.

The FCC's chief engineer, Raymond Spence, asked the question who wants AM stereo except perhaps manufacturers and broadcasters?

IHF Speeds Work on Technical Standards

The Institute of High Fidelity, an organization consisting of manufacturers of stereo components, says it is taking steps to speed the development of its technical standards program.

IHF President Jerry Kalov, president of Jensen Sound Laboratories, says, because of the growing need "for more such industry standards" the IHF Board of Directors has activated standards committees for turntables, cassette recorders, and speakers. This, he said, is considered one of the most valuable programs for the development of comprehensive high fidelity standards.

One of the committees has already met, according to Kalov, and has set initial goals for the development of standards for turntables. A first order of busi-

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DECEMBER 1978, VOL. 100, NO. 12

On the cover: With the colors of the approaching holiday season on our cover, the staff of ET/D extends to one and all best wishes for the coming year.

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2SA 102	.20	.27	.30
2SA 234	.45	.53	.59
2SA 473	.45	.53	.59
2SA 484	1.50	1.75	1.95
2SA 495	.30	35	40
2SA 497	1.00	1 20	1 30
2SA 509	.30	35	40
2SA 561	.30	35	40
2SA 562	30	35	40
2SA 564A	20	27	30
2SA 634	40	45	50
2SA 643	30	40	45
2SA 673	35	40	45
2SA 678	35	40	45
2SA 682	.80	90	1 00
2SA 683	30	35	40
2SA 684	.35	40	45
2SA 695	.40	53	59
2SA 699A	.50	64	70
2SA 706	.85	1 00	1 10
2SA 719	30	35	40
2SA 720	30	35	40
2SA 733	.20	27	30
2SA 747	4.20	4 40	4 90
2SA 818	.70	80	90
2SA 841	20	27	30

2SB

TYPE	25-UP	10-24	1-9
2SB 22	30	35	40
2SB 54	20	27	.30
2SB 75	35	40	45
2SB 175	20	27	.30
2SB 186	20	.27	.30
2SB 324	30	.35	.40
2SB 337	.70	.80	.90
2SB 405	30	.35	.40
2SB 407	.80	90	1.00
2SB 434	.80	.90	1.00
2SB 435	90	1 10	1.20
2SB 463	.90	1 10	1.20
2SB 473	80	90	1.00
2SB 474	.70	80	.90
2SB 492	.60	70	.80
2SB 507	.80	90	1.00
2SB 528D	.70	80	.90
2SB 595	1.10	1 40	1.50
2SB 596	1 10	1.40	1.50

2SC

TYPE	25-UP	10-24	1-9
2SC 281	.30	.35	.40
2SC 372	.20	27	.30
2SC 373	20	27	30
2SC 380	20	.27	30
2SC 394	20	.27	.30
2SC 458	20	27	.30
2SC 495	45	55	60
2SC 509	35	40	.45
2SC 515A	80	90	1.00
2SC 517	2 50	2 70	3.00
2SC 535	30	35	.40
2SC 634A	35	40	.45

TYPE	25-UP	10-24	1-9
2SC 696	1.00	1.20	1.30
2SC 710	.20	.27	.30
2SC 711	.20	.27	.30
2SC 730	3.00	3.20	3.40
2SC 732	.20	.27	.30
2SC 735	.20	.27	.30
2SC 756	1.50	1.80	2.00
2SC 756A	1.50	1.80	2.00
2SC 781	1.90	2.10	2.40
2SC 784	.30	.35	.40
2SC 799	2.00	2.20	2.50
2SC 828	.20	.27	.30
2SC 839	.30	.35	.40
2SC 867	3.20	3.40	3.70
2SC 867A	3.20	3.40	3.70
2SC 897	2.00	2.20	2.50
2SC 930	.20	.27	.30
2SC 945	.20	.27	.30
2SC 983	.50	.64	70
2SC 959	1 10	1.20	1 30
2SC 1000BL	.35	.40	.45
2SC 1014	.50	.64	.70
2SC 1018	.60	.70	.80
2SC 1030C	1.80	2.10	2 40
2SC 1061	70	.80	.90
2SC 1079	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 1124	.80	90	1.00
2SC 1172B	3.20	3 60	3.95
2SC 1173	50	55	60
2SC 1226	.50	55	.60
2SC 1226A	.50	55	60
2SC 1239	2.20	2.70	2.90
2SC 1306	1.30	1.45	1.60
2SC 1307	1.90	2.10	2.40
2SC 1318	35	.40	.45
2SC 1383	30	.35	.40
2SC 1384	35	.40	.45
2SC 1419	60	.70	.80
2SC 1675	20	27	.30
2SC 1678	1.10	1.25	1.40
2SC 1728	70	.80	.90
2SC 1730	.45	.53	.59
2SC 1760	.70	.80	.90
2SC 1816	1.50	1.75	1.95
2SC 1856	.50	.64	.70
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 1970	2.10	2.50	2.80
2SC 1978	5.40	6.00	6.60
2SC 2028	.50	.64	.70
2SC 2029	1.50	1.80	2.00
2SC 2076	.50	.64	.70
2SC 2091	.90	1.10	1.20
2SC 2092	1.80	2.00	2.25
2SC 2166	1.40	1.60	1.80

2SD

TYPE	25-UP	10-24	1-9
2SD 72	.50	64	70
2SD 234	.60	.70	.80
2SD 235	.60	.70	.80
2SD 261	.35	.40	.45
2SD 287	2.50	2.70	2.90
2SD 313	.60	.70	.80
2SD 315	.60	.70	.80
2SD 325	.60	.70	.80
2SD 427	1.80	2.00	2.25
2SD 525	.90	1.10	1.20
2SD 526	.60	.70	.80

FET

TYPE	25-UP	10-24	1-9
2SK 19BL	.45	.55	.60
2SK 23	70	.80	90
2SK 30	40	45	.50
2SK 33	.60	.70	.80
2SK 55	.60	.70	.80
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
3SK 48	3.40	3.55	3.90
3SK 49	1.30	1.45	1.60

IC

TYPE	25-UP	10-24	1-9
AN 214Q	1.30	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 1156	1.60	1.80	2.00
HA 1306W	2.00	2.20	2.50
HA 1322	2.50	2 70	3.00
HA 1339	2.50	2 70	3.00
HA 1339A	2 50	2.70	3.00
HA 1366	2.50	2 70	2.90
HA 1366W	2.50	2.70	2.90
HA 1366WR	2.50	2.70	2.90
LA 4031P	1.80	2.00	2.25
LA 4032P	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
M51513L	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
TA 7045M	2.00	2.20	2.50
TA 7060P	70	.80	.90
TA 7061P	.90	1 10	1.20
TA 7062P	1 10	1.25	1.40
TA 7089P	2.00	2.20	2.50
TA 7202P	2.50	2 70	2.90
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 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 002	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 592HZ	.70	.80	.90
UPC 1001	1.90	2.10	2.40
UPC 1008C	4.20	4.40	4.90
UPC 1020H	1.90	2.10	2.40
UPC 1025H	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
UPC 14305	3.00	3.20	3.40
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	5.30	5.90
PLL 03A	7.60	8.00	8.80

DIODES

TYPE	25-UP	10-24	1-9
1S 84	.45	.55	60
1S 332	35	.40	.45
1S 953	16	.18	.20
1S 1007	.35	.40	.45
1S 1209	35	.40	.45
1S 1211	35	.40	.45
1S 1555	.20	.22	.25
1S 1588	.20	.22	.25
1S 1885	16	.18	.20
1S 2076	.20	.22	.25
1S 2093	.35	.40	.45
1S 2473	16	.18	.20
1N 34	12	.13	15
1N 60	.12	.13	15
10D 1	.30	.35	.40
10D 10	.45	.55	.60
V06B	.30	.35	.40

ZENERS

TYPE	25-UP	10-24	1-9
WZ 071	20	22	25
WZ 075	20	22	25
WZ 090	20	22	25
WZ 120	20	22	25
WZ 192	20	22	25

MISC.

TYPE	25-UP	10-24	1-9
SG 613	5 20	5 40	5 95
78LO5	90	1 00	1 10
MPS U31	1 50	1 70	1 90

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ness will be development of a glossary of terms, the separation of such terms into groups, the development of standard test conditions, and development of a set of measurement standards for the various groups.

Zenith Reports Improved Financial Results

Zenith Radio Corporation has reported improved third quarter financial results for the period ending Sept. 30.

According to Zenith's consolidated statements of income, net sales were up 12.2 per cent to $276.6 million during the three months period while net income showed a profit of $6.4 million—or 34 cents per share, compared with a 69 cents per share loss for the corresponding period a year earlier.

For the nine months period, sales were up slightly to $703.4 million while earnings showed a per share increase of 46 cents, to 70 cents per share, on 18.8 million shares outstanding.

Winter CES to Feature Audio Merchandising

Next month's Winter Consumer Electronics Show, Jan. 6-9 in Las Vegas, will feature expanded emphasis on retail merchandising programs of consumer electronics products...especially in the highly competitive audio field.

According to Jack Wayman, Senior Vice President of CES, about half of the 31-scheduled hours of showtime will be devoted to "consumer electronics product knowledge, retail store management and sales development."

Each of the four mornings of the show—starting Saturday Jan., 6—will be devoted to two separate retail and merchandising conferences. Starting off on the 6th will be Personal Communications at 8:30 a.m., followed by the Telephone Devices conference at 10:30.

The following days' conferences will be audio systems and auto sound; television, projection TV and video systems; and personal computers, TV games, calculators and watches.

CES also reports that for the benefit of attendees a special "retail idea center" will be on the convention floor and will feature 100 of the most outstanding retail merchandising techniques. This includes theme promotions, retail advertising campaigns, direct mail, community relations, store design and product display.

Also, according to sopkesmen for the show, a CES retail resource center will offer attendees an opportunity to consult with 15 exhibitors who provide nationwide retail store services such as financing, store design and lighting, freight bill auditing service, retail management services, merchandising aids, and retail sales training. ET/D

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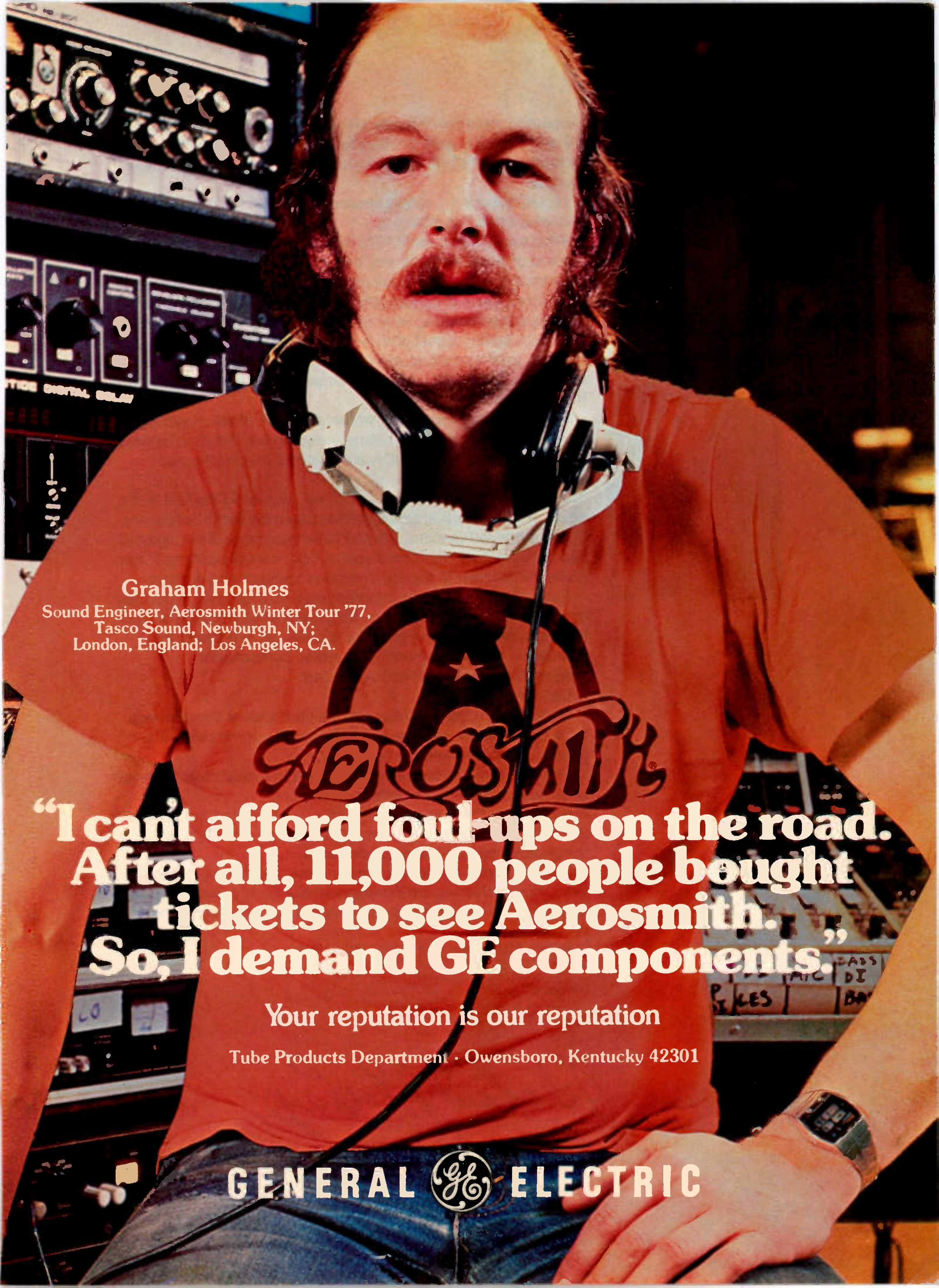
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GENERAL ELECTRIC

FROM THE EDITOR'S DESK

I suppose I could start this editorial with the traditional saying that as the end of another year approaches, it seems a good time for all of us to pause and reflect on our accomplishments during the past 12 months.

I could, but won't ... simply because none of us in this industry has very much time for reflecting.

What we will recall about 1978 though, as the years go by, is that if it is at all possible to pin any kind of a label on it, insofar as the consumer and home entertainment electronics service industry is concerned, it should rightfully be known as the year of the digital IC.

Already completed as we entered 1978 was the transformation of the major analog signal processing circuitry—sound, video, chroma, from transistors to integrated circuits. In most cases on-board voltage regulators were already in place to help confuse the uninitiated.

The new year brought the wholesale influx of electronic digital tuning into America's living rooms, including late this year, digitally synthesized tuning from RCA and Zenith's on-circuit-board electronic tuning system.

Just a very few years ago (1973) we witnessed the last of the electron tube television sets roll off the assembly line to be followed by transistorized versions. We now see the advance of the digital IC into the frequency (horizontal and vertical) control sections of the home TV receiver in the form of more counters and dividers.

Even a new commercially viable system for processing video and color information in the receiver (Magnavox's comb filter) is with us. And, already the micro-processor is upon us. Programmable microwave ovens; programmable stereo components; programmable home blenders, etc., etc.

Get the picture?

Over the last year ET/D has had the priviledge of trying to keep track of the accelerating pace of change in our industry—and passing what we have learned on to you.

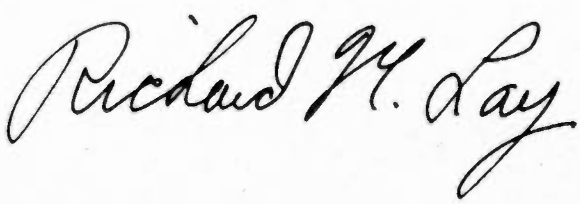
Really—what it all boils down to is an educational crisis for most of us associated with consumer electronics.

Where can the modern serviceshop of today and the proficient technician, get the kind and quality education he needs to continually upgrade his electronic skills.

This is an area that is now clearly emerging as one of the very most important facing the independent electronic serviceshop. We at ET/D will be looking for the answers to these questions in the new year.

Merry Christmas and Happy New Year.

Sincerely,



LETTERS

HELP WANTED

I'd appreciate any help you or your readers can provide in getting service info for a Sears Model 562.40291400 Color TV. It was not listed in Sam's current index, and the local Sears store could not get it for me.
Thanks,
Marc W. Scharf
Audio Video Service
5109 Algonquin Trail
Kukomo, IN 46901

I am in need of a schematic for a MIKADO Model 1224 AM-FM-Stereo and have had no success in obtaining one. I wrote to an address in San Francisco buy my letter was returned marked "out of business."
Very truly,
Frank Neal
3647 Viaorilla
Lompoc, CA 93436

I have been a subscriber to your magazine for years. I need a little help now! My own AM-FM-SW radio has a broken FM-AM-MB-SW switch. I cannot get a part for it. The radio is a YORK Model-B/E-124 Can anyone help me?
Thank you,
Leslie Vargas
8921 Roosevelt Blvd.
Philadelphia, PA 19152

I need the address of Lavoie Laboratories that used to be in Morganville, New Jersey and also the operating and service manual on a Lavoie Oscolloscope Model LA-545 which is not exactly like a Tektronix 545.
Thanks,
Rejean Mathieu
660 13th Ave.
P.O. Box 1601
Sennetere, Quebec, Canada J0Y-2M0

I need a schematic for an AM/FM/8 track stereo system. I cannot get any information through the store where it was purchased. It is an Electra made by Electra Radio Corp., Model No. 8TR-400 Series A. Any help would be appreciated.
Stanley E. Johnson
4201 Winegar Rd.
Bancroft, MI 48414

In your next edition of ET/D magazine would you please print the following message to your readers. I need service literature and a schematic for a B&K Model 1050 video and audio generator and for a New London Instruments Co. Model 901A Transconductance Analyzer. Both need repair. Any help would be appreciated.
Ris Electronics Co.
1542 Averitt Road
Greenwood, IN 46142

I have a color TV made by Division of Sparten's Industries Inc., N.Y., N.Y. 10001, distributed by KORVETT'S, Model #1869. The number of the chassis 1013AH. I have tried several ways to obtain information. Your column has been helpful before. I hope someone can put me on the track of a schematic.
Fred Berberich
131 Washington Ave.
Tappan, NY 10983

Circle No. 125 on Reader Inquiry Card

Circle No. 120 on Reader Inquiry Card

NEWSLINE

SEARS SLAPPED WITH TV DUMPING FINES. Sears, Roebuck & Company has been fined $5.5 million by the U.S. Treasury Department for allegedly selling imported Japanese-made TVs in this country for less than they sold for in Japan. Sears, however, is paying the fines under protest and will seek recovery. The levy is part of a $43 million total assessed against a number of U.S. and Japanese companies for alleged dumping activities between 1971 and 1973. The case is the outgrowth of Zenith Radio Corporation protests against unfair market practices.

"HIS MASTER'S VOICE." The world's most famous 94-year-old dog--Nipper--is back. The focal point of a new RCA $8-million marketing program, Nipper will again be used in conjunction with RCA advertising programs for its consumer electronics, service company, commercial communications, solid state, and distributor products divisions. The famous fox terrier was originally painted in 1890 listening to a gramophone by British artist Francis Barraud.

REVISED NESDA CONVENTION DATES. Revised dates for the 1979 convention of the National Electronics Service Dealers Association (NESDA) convention have been announced by President Bob Villont. According to Villont, industry conflicts necessitated a change for the convention in Tucson, Az. to August 13-19. Originally the meeting had been scheduled for August 20-26. The headquarters hotel for the event will be Tucson's Mariott Hotel.

ISCET BACK WITH NESDA. In another statement, NESDA Executive Vice President Charles Porter revealed that "effective immediately" the operational headquarters for the International Society of Certified Electronic Technicians (ISCET) is once again back in NESDA headquarters in Indianapolis. ISCET affairs had been directed from Ames, Ia., since August of last year after moving out of the NESDA headquarters. "The move is in accord with the expressions of concern we have received from the majority of the members of both organizations," Porter said.

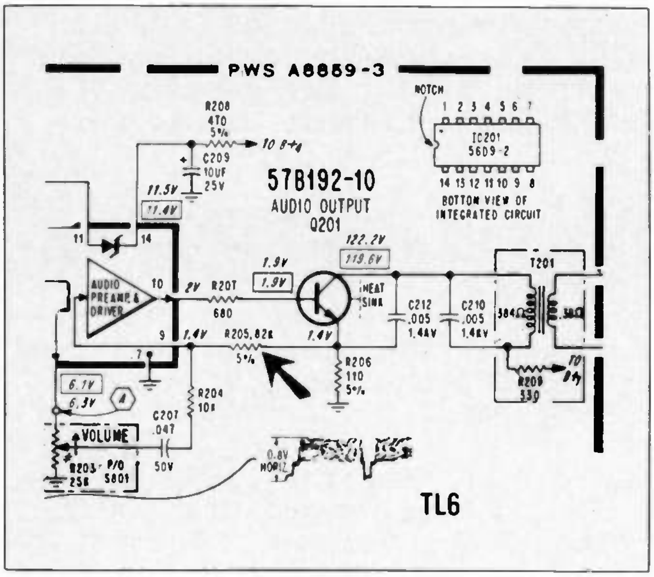
CONSUMER ELECTRONICS IMPORTS UP. The Electronic Industries Association reports increases in United States imports for most categories of consumer electronics products during the third quarter of 1978. Here's a brief rundown: Color TV, up 14.2% to 787,187; Mono TV, up 28.4% to 1,727,245; phonos and phono combinations up 12.6% to 1.2-million; record players up 34.4% to 2.8-million; audio tape/player combos up 27.2% to 3.9-million; and Video tapes up 153.6% to 137,295 units. The EIA also states that the total exports of television, radios and tape equipment increased during the third quarter but activity was low. For instance color television exports in the third quarter were only 118,365.

COLOR TV HITS QUARTER, NINE MONTH HIGHS. Imports pushed total new set supply to a record high for any quarter, according to Television Digest. The share produced by domestic factories increased, aided substantially by Japanese owned plants, while the U.S. factory share of b & w fell to 5.6%, down from 12.5% a year earlier, TV Digest said.

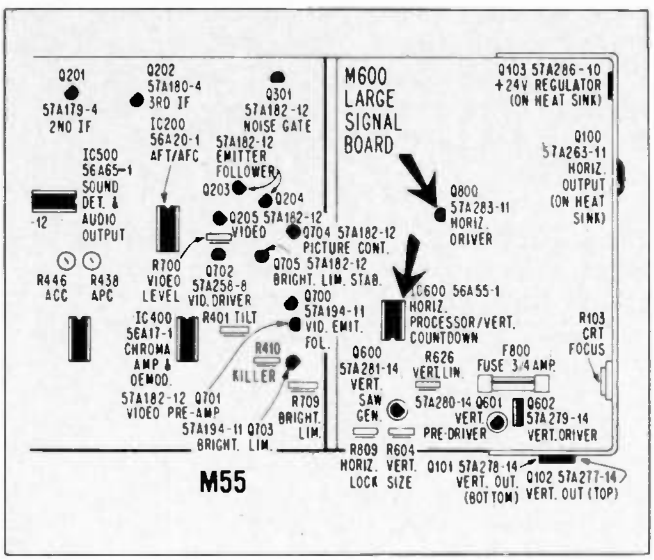
SERVICE SEMINAR

ADMIRAL

Chassis TL6—No sound.
Could be wrong value of R205 (should be 82k ohm) which could take out Q201, cause R207 to change value (should be 6.8k ohms) and possibly damage IC201.

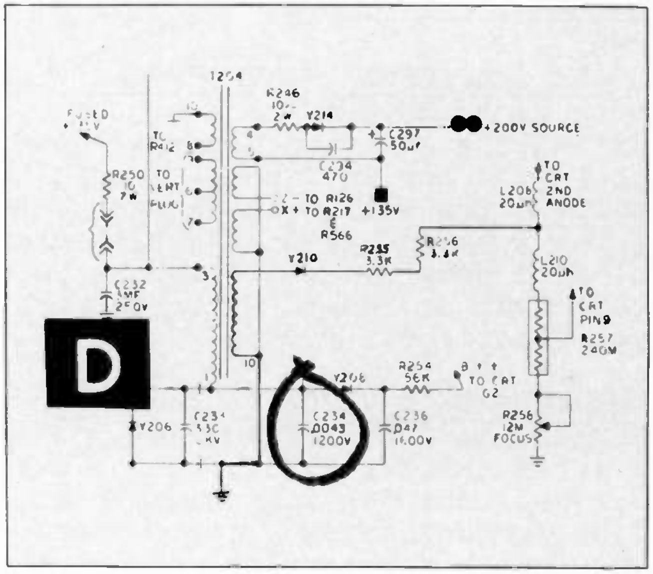


Chassis M55—IC600.
When replacing IC600 (56A55-1) horizontal processor/vertical countdown chip, be sure the keyway is facing the *rear* of the chassis. Reversal of this chip can cause a second failure. Prior to turning power on, check Q800 (horizontal driver). If Q800 is shorted, it could be the cause of IC600 failing.



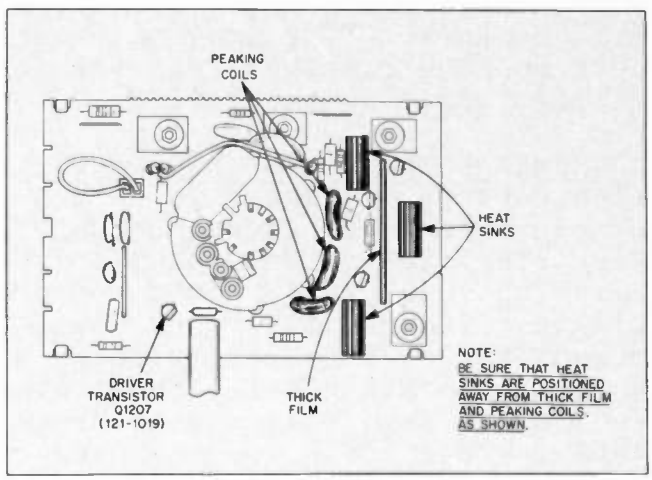
GENERAL ELECTRIC

Chassis 19QB—Drive lines in raster—then horizontal output transistor shorts.
Replacement does not correct—shorts again. Check C234 :0047mfd 1200v probably open—replace.



ZENITH

Module 9-121-01C—Heat sinks require proper positioning for continued reliability.
Whenever you service or replace a 9-121-01B, C, D video output module, be sure that the heat sinks of the 3 output transistors are positioned away from the thick film device and peaking coils as shown in the illustration below. If the heat sinks come in close proximity with the peaking coils, an arc-over may occur which could cause failure of driver transistor Q1207 (121-1019). Therefore, always check and reposition if necessary, (1) the thick film device which should be perpendicular to the printed circuit panel, (2) the transistor heat sinks which should be midway between the thick film and peaking coils.



Neck-mounted video output modules.
Whenever replacing the CRT for whatever reason on any chassis utilizing the neck-mounted 9-121-01 or 9-155 series video output module, always first make an ohmmeter check of the video driver transistor (121-1019). (Refer to the previous illustration.) If the collector to emitter is shorted or has very low resistance, replace it or the entire module *first*, before proceeding with the CRT replacement. ET/D

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DC VOLTS (5 RANGES): 0.1mV to 1000V; Accuracy ±0.5% rdg ±0.5% f.s.; Input imped: 10MΩ; Max. input 1kV except 500V on 200mV range.
AC VOLTS (40Hz to 5kHz): 0.1V to 600V; Accuracy: ±1.0% rdg ±0.5% f.s. (−2dB max. at 5kHz); Max. input: 600V.
RESISTANCE (6 LOW POWER RANGES): 0.1Ω to 20MΩ; Accuracy: ±0.5% rdg ±0.5% f.s. (±1.5% rdg on 20MΩ range); input protected to 120VAC all ranges.
DC CURRENT (6 RANGES): 0.1nA to 100mA; Accuracy: ±1.0% rdg ±0.5% f.s.
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Phase locked loops revisited

Where frequencies abound

Working around in these circuits can be a joy or a nightmare, depending on your own level of understanding.

By Bernard B. Daien

The phrase "phase locked loop" has been popping up in recent electronic literature. These articles convey the impression that phase locked loops are something new, different, and require new methods of troubleshooting.

Nothing could be further from the truth, since phase locked loops were used prior to World War II, later in the horizontal AFC of black and white TVs, and more recently in the color AFPC circuitry which synchronizes the color oscillator to the color burst signal in color TV sets. They have been in constant use for forty years!

The phase locked loop consists of three circuits: A phase detector, low pass filter, and voltage (or current) controlled oscillator. The phase detector compares the frequency and phase of the incoming signal to that of the controlled oscillator. If the two frequencies, or phases, differ, the phase detector generates an output signal which is applied to the controlled oscillator, correcting its frequency so that lock-in occurs. The low pass filter is used to clean out the unwanted frequencies which appear in the output of the phase detector. That's it. From this starting point we can make the phase locked loop "stand up and do tricks" ... if you want to know just how we use the phase locked loop in more sophisticated ways, read on.

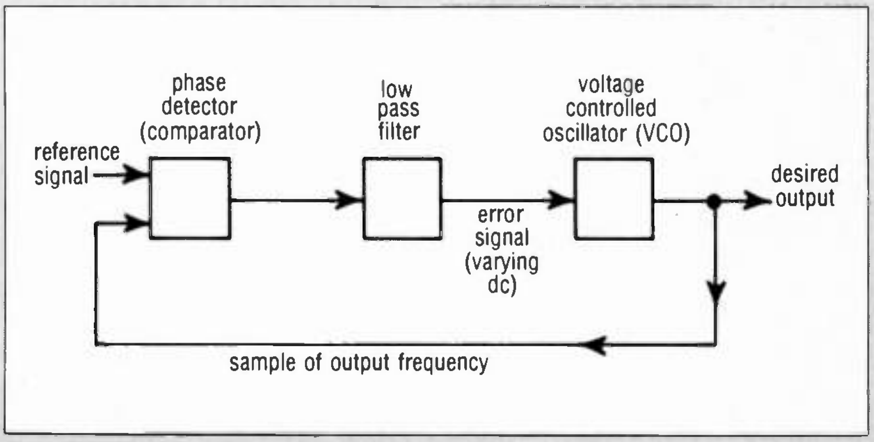

Fig 1–Basic Phase Locked Loop Block Diagram

The buzz words

Let's start by defining the words used to describe phase locked loops, and the abbreviations for those words. Phase Detector, (PD). This compares the two signals and produces an error voltage which is dependent upon their relative frequencies and phase differences (providing there is sufficient signal input amplitude so that output is not dependent upon input level). This is sometimes called a "Phase Comparator." There are many different circuits which can perform this function.

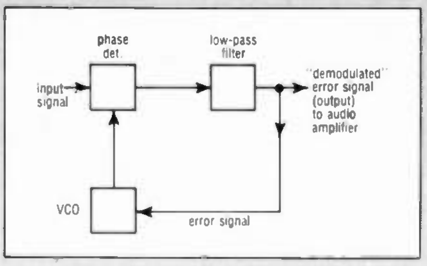

Fig 2–PLL used as FM/PM Detector

Voltage Controlled Oscillator, (VCO). This is an oscillator the frequency of which is determined by the applied control voltage. Most of these oscillators are variations of the astable (free running) multivibrator, and their output is not sinusoidal. (*NOTE:* although the term "voltage controlled" is generally employed, the fact is that many integrated circuit VCOs are actually *Current Controlled Oscillators* (CCO). Since Integrated circuits are frequently solid state devices using *bipolar transistors,* a current is used to control circuit characteristics since bipolar transistors are current operated devices.)

Low Pass Filter, (LPF). This filter removes any of the two input frequencies that appear in the output of the phase detector, along with much of the noise, and the intermodulation and harmonic distortion products generated in the phase detector. The object is to permit only the DC and low frequency components to pass on to the phase locked loop circuitry.

Free Running Frequency, (f_o). This is the frequency at which the VCO runs when not locked ... sometimes called the "Center Frequency."

Capture Range. This is the range of frequencies over which the phase locked loop can "pull in" and lock onto a signal. This refers to both plus and minus frequencies, as in bandwidth of a circuit. The term "Lock-In Range" is sometimes used, but it is different because it refers to the frequency plus *or* minus, and thus is one half of the

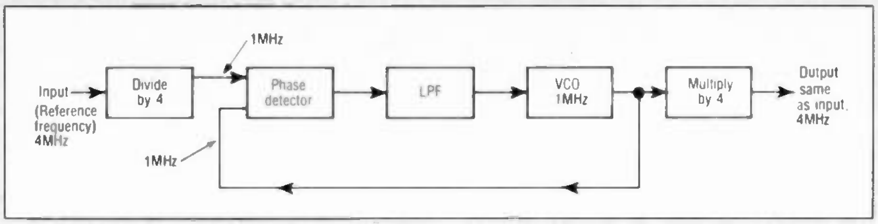

Fig 3A–Phase locked loop running at lower frequency than input or output frequencies.

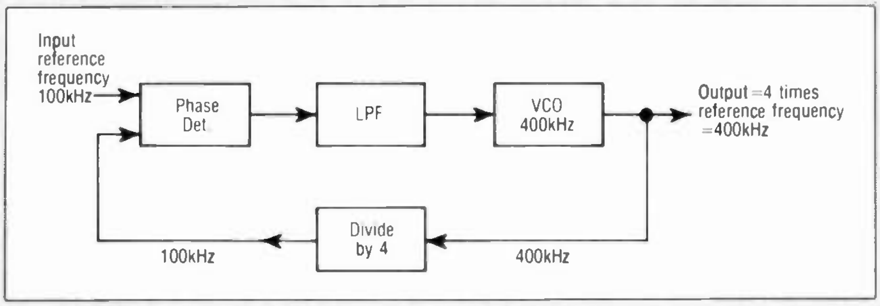

Fig 3B–Phase Locked Loop with output frequency higher than input frequency.

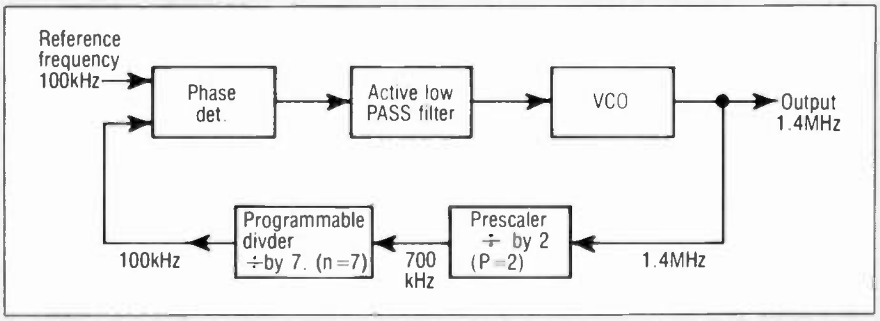

Fig 4–Use of PLL with programmable divider (counter), and prescaler, to generate several frequencies from one crystal oscillator.

Capture Range. It's like double side-band versus single side-band. One is one half of the bandwidth of the other.

Lock Range. (*NOTE* "Lock-In" Range, Above). This is the range of frequencies over which the loop will *remain locked* once lock-in has been achieved. It is also called the "Hold-In Range" and "Tracking Range."

... and last, but not least, Phase Locked Loop, hereafter referred to as PLL ... and by now you have a good idea of what it is, but not all the nice little tricks it can do.

The basic PLL

Refer to Figure 1. The input signal is called the "reference signal," because it really is. Think about the color burst in a color TV, which is the reference onto which we lock the color oscillator, in exact phase, in the color AFPC.

The output of the VCO is also fed into the phase detector. Whether the signals are out-of-phase ... or in-phase, determines the polarity of the error output signal from the phase detector, exactly the same as in the phase detector of a horizontal AFC phase detector in a TV set. Since the two frequencies may be different to start with, there will be several frequencies in the output of the phase detector ... the two input frequencies, and the various sum and difference frequencies.

Active filters

We solve this problem just the way we do in the output of any "detector" ... with a low pass filter. Ideally this filter would remove all the spurious (unwanted) frequencies in the output, but leave the desired error output signal, which is a slowly varying DC voltage. Unfortunately this filter has several side effects in the system which must be considered. For one, if the filter has too long a time constant, the PLL will not be able to respond quickly enough to enable lock-in over a wide range of frequencies. If the time constant is too short, unwanted frequencies will upset the system. One method is to use two RC filters, with different time constants, just as in the horizontal AFC in TV, where the time constant must be right in order to prevent the classic "pie crust" effect shown in TV service texts. Unfortunately, as we add RC filter sections we get into rapidly increasing phase shift, which is undesirable. Today we have active filters available to us (refer to any good Operational Amplifier Handbook for reference), and active filters are able to give us the desired frequency bandpass characteristic with acceptable phase shift. Thus the low pass filter may be on the printed circuit board in the form of an integrated circuit operational amplifier, or even be part of one of the PLL ICs internally, and thus not be readily apparent, but it is there, it is essential, and it is critical!

Some applications

So far we haven't discussed anything you really didn't know already, except the buzz words are different. As we proceed you will note that the entire PPL follows this same pattern. Let's get along then. Figure 1 shows the output of the low pass filter directly feeding the VCO, but of course you realize that it may be desirable in some cases to put a DC amplifier between the phase detector and VCO in order to boost the voltage level. Again, an active filter is preferred because it can give us the desired bandpass, with gain, while a passive filter always has a loss. The varying DC error signal from the low pass filter causes the oscillator frequency to vary, exactly the same way as the output of the color phase detector causes the reactance tube to vary the frequency of the color oscillator in a color TV. When the reference frequency is higher than the oscillator frequency, we get one polarity or error signal output from the phase detector, when the reference frequency is lower than the oscillator's we get the opposite polarity of error signal. Thus the output of the phase detector can be used as an FM detector, or a PM detector! Refer to Figure 2 now ... the only difference is in where we take off the output, and what we use it for. Figure 2 is a basic FM/PM detector.

I can just hear you saying, "So what? We have plenty of FM detectors now ... Foster Seeley, Ratio, Quadrature, etc. Why more?" All of the above use tuned circuits, which employ coils, which often need shielding ... to prevent stray coupling. Coils cost money, shielding costs money, and both take up room. The PLL is small, cheap, light, and needs no shielding. And the trend today is toward more ICs and fewer discreet components. Enough said!

Derived frequencies

Which brings us to the last of the three blocks in Figure 1 ... the VCO. Since the VCO is really a specialized multivibrator, it has some limitations. For example, it does not run at very high frequencies. Therefore, we need to devise ways to obtain the desired frequencies. Several alternate solutions are available, each with certain advantages and disadvantages. Figure 3A shows a PLL configuration which can handle a reference frequency four times higher than either the VCO or the Phase Detector.

All we did was divide the input frequency by four, the PLL then easily handled the lower frequency, and the output is multiplied back to the desired frequency with a multiply-by-four circuit. The frequency dividers and multipliers are standard digital ICs. Remember, the PLL is a non-sinusoidal circuit, so digital IC output waveforms are perfectly acceptable. Any cleanup of the waveform can be accomplished with very simple filtering at the output of the PLL. (Harmonic distortion only requires that a filter be capable of eliminating the *second, and higher* harmonics, thus the filter need not be particularly selective, with the nearest undesired frequency being *twice* the desired frequency.)

All we did in Figure 3A was introduce frequency dividers, and multipliers, which are nothing new to you. But we also made the point that by using frequency dividers and multipliers we are able to extend the useful range of frequencies of the PLL so that we can use the PLL for almost any frequency from ultra low frequencies in instrumentation, to audio in electronic musical instruments, right on up to UHF. Of course, we do not need to multiply and divide in the same ratio, we can use any multiplier on the input or output, or any divider, or even use multipliers and dividers *inside* the PLL's "closed loop," as we will now demonstrate with the aid of Figure 3B.

Frequency synthesis

We have added a frequency divider in the feedback loop between the output of the VCO and the phase detector. As a result, the VCO can run, for example, at 400 kHz. The 400 kHz, divided by 4, is presented to the phase detector as 100 kHz, and compared to the 100 kHz reference frequency. If the reference frequency is stable, (a crystal oscillator), the output will have the stability of the stable reference input, since it is phased locked to it. By now you are seeing the basis of a frequency synthesizer, which enables us to generate many frequencies from just one stable crystal. In order to *change* the output frequency, while preserving the stability of the reference, all we need do is change the dividers (or multipliers) in the loop, or ahead of the loop, or following the loop.

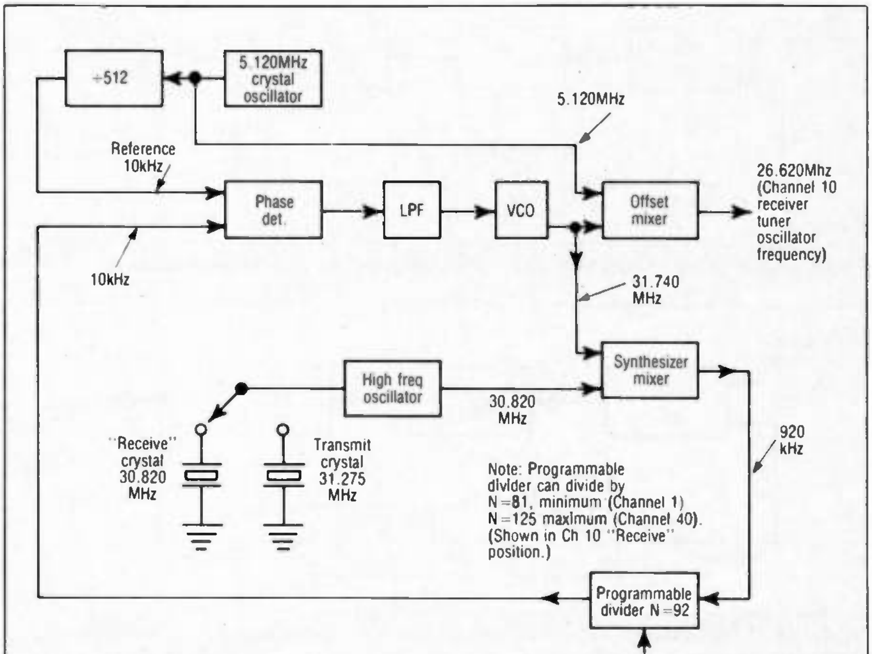

Fig 5–Citizens band transceiver frequency synthesizer.

There are available ICs which incorporate four flip-flops, each flip-flop dividing by two ... (thus the IC is capable of dividing by 15) ... and such ICs are also "programmable" ... which means that we can choose what number they will divide by, up to a maximum of 15. The reason the count is limited to 15 is that we actually use sixteen different states, starting with "zero" as the first state ... thus 0 through 15 equals 16 different output states. Some of these ICs have a built-in limit of ten counts ... 0 through 9.

The IC programmable counters that go up to 9 are called "Programmable Decade Counters." The ones that go up through 15 are "Programmable Hexadecimal Counters." In either case we can select any count (division) up to the maximum of the IC. Now we need to add a few more buzz words: N. This is the number we divide by. Thus to say "divide by 5," we write "N=5," (when talking about dividers). Modulus. The same as N. If we divide by 5, then N=5, and the modulus is 5.

Inserting prescalers

Sometimes we also use a fixed divider, or multiplier ahead of a programmable divider, as, for example, in Figure 4. Notice that the programmable divider has a modulus of 7, and the fixed divider a modulus of 2, for a total division of 14, which provides an output frequency of 1.4 mHz, with the same accuracy as that of the reference. Now if you think about it, it's a little hard to achieve "odd" multiplications and divisions using the frequency doublers and triplers that are used in transmitters, for example.

Specifically, how would *you* go about generating a 1.4 mHz signal from a 100 kHz frequency standard type crystal, without the convenience of the phase locked loop? Notice that the fixed divider is labled "Prescaler" ... another buzz word, for a fixed modulus circuit that "precedes" a programmable (variable) divider. Generally we can tell if the circuit is a "Prescaler" because the modulus of a prescaler is often shown as "P=2" instead of "N=2." Some prescalers give you a choice of prescaling modulus, such as P=2 or P=6 ... sort of semi-programmable, like the difference between a variable resistor, and an adjustable resistor. The programmable divider can be set for any value of N between, say 1 and 9, for a decade counter, while a two modulus prescaler would permit the choice of only two divider ratios. The programming is accomplished with electrical signals, not by mechanical switching, although electromechanical switches can be used to provide the electrical signals if desired (toggle switches, relays, push buttons, etc.)

Prescalers are used for a variety of reasons ... they do not have to be programmable, hence can trade off that feature for speed, permitting very high frequency inputs and, since the output is a much lower frequency, the rest of the

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Practical applications

We are now going to examine the frequency synthesizer used in a 40 channel Citizens Band transceiver, but first, to better understand the system, let's look at Figure 3B again. What would happen if we changed the ratio, N=4, in the divider? Let's make a chart:

N=1, output frequency = 100 kHz.
N=2, output frequency = 200 kHz.
N=3, output frequency = 300 kHz.

As you can see, the output changes in 100 KHz jumps, as the divider ratio is changed. Notice that the reference frequency is also 100 KHz. Is it coincidence? To check, we'll now look at what would happen if we substitute a reference frequency of 10 KHz. The output becomes a 40 KHz for N=4. Again we'll make a chart for various values of N:

N=1, output frequency = 10 kHz.
N=2, output frequency = 20 kHz.
N=3, output frequency = 30 kHz.

... as you can see, the divider ratio, N *causes the output to be multiples of the reference frequency*. (There are some circuits that use special prescalers to enable changing the output in steps less than the reference frequency, and these can be spotted by the fact that the prescaler has two ratios, called a "Two Modulus Prescaler," one modulus being P, and the other P + 1, (one more than P). We will confine ourselves to the more common circuitry which does not use the Two Modulus Prescaler.)

A basic synthesizer

In the light of the above, we will proceed to the frequency synthesizer, not only for conceptual purposes ... but also with the aim of doing some analysis ... (see, you're not only using the buzz words, you're even going to do some sharp circuit analyzing). On to Figure 5, the basic synthesizer circuit right out of a commercial CB transceiver.

We can pick up the reference signal at the input to the phase detector, and notice that it's 10 kHz, which probably indicates that our output is going to change in 10 KHz steps ... and we're right, since CB channels are in multiples of 10 kHz. So far, so good. The reference frequency is derived from a 5.120 MHz crystal, divided by N=512, which gives us 10 KHz. (Ten KHz would be a very low frequency for a low temperature coefficient crystal, and it would be a very thick, heavy, expensive crystal, so 5 MHz is a good choice for a crystal with reference to stability and cost.)

The phase detector error signal passes through a low pass filter, and on to a 31.740 MHz VCO. The output of the VCO goes to a mixer, along with the 5.120 MHz from the crystal, yielding a difference frequency of 26.620 MHz, just the right frequency for the *receiver* tuner mixer oscillator frequency for CB channel 10. Since CH 10 has a transmitter frequency of 27.075 mHz, and our receiver has an IF frequency of 455 KHz, then 26.620 + .455 = 27.075. Knowing this we are in a good position to start trouble shooting our PLL frequency synthesizer!

Checking frequencies

Let's see, we know the crystal oscillator should be 5.120 ... and we will need a frequency counter to check it. Assuming you are able to get hold of one (and you'll need it to service PLLs which are nothing but a bunch of frequencies), it's a snap. Of course you should check to see if the output of the "divide by 512" is really 10 kHz. Then set the switch to "Receive" and the Channel Selector to Channel 10, and look for 31.740 input into the "Offset Mixer" and 26.620 out of the Offset Mixer. If you lose the signal, or get an incorrect frequency, you have a well localized fault. By now you have the idea, and it's no more difficult than signal tracing through all the conversions in a color TV set, what with the video IF, sound IF, local oscillator, and color oscillator, etc.

Back to the synthesizer. The VCO output also goes to the "Synthesizer Mixer" where it is mixed with the "High Frequency Oscillator." This oscillator has two crystals, and depending upon which one is used, the output is either 30.820, or 31.275 MHz. Since the crystals are marked "Receive" and "Transmit" and are 455 KHz apart, we can assume that this oscillator is used to shift the frequency of the receiver mixer oscillator 455 KHz away from the transmitter frequency, thus generating the 455 KHz receiver IF frequency. The Synthesizer Mixer output is the difference between the 30.820 and 31.740 inputs, or 920 KHz.

This 920 KHz is the input to a programmable divider, with N=92 for CB channel 10, thus the onput of the divider is ... you guess it ... 10 KHz. The 10 KHz so derived is fed into the phase detector, which compares it to the 10 kHz from the "divide by 512" circuitry. The PLL adjusts the VCO frequency until the two are locked in phase, which means the VCO output has to be 31.740 kHz.

Transmit mode

If we throw the switch to "Transmit," the 31.275 crystal is switched into the circuit and feeds the Synthesizer Mixer. Since we still have the Channel Selector set for Channel 10, the programmable divider is still at N=92 ... therefore if the input to the phase detector is to remain at 10 kHz (as it must to be phase locked), the input to the programmable divider must remain at 920 KHz. The only way this can happen is if the VCO output shifts from 31.740 to 32.195. Let's check that out. If the VCO shifts to 32.195, it will mix with the 31.275 in the Synthesizer mixer, and the difference will be 920 KHz ... correct! But there is another requirement ... the output of the Offset Mixer must now be a 27.075, the *transmit* frequency for channel 10. Let's see if it is. The inputs to the Offset Mixer are now 32.195 and 5.120. The difference frequency is 27.075 ... again, correct!

Of course, by now, you know that if we change channels by changing the programmable divider to N=91, instead of N=92, the output will change exactly 10 KHz, because that's our reference frequency. It was obviously chosen because the CB channels are spaced multiples of 10 kHz ... but for purposes of exercise, the table below lists some of the channels, their transmit frequencies, the required modulus (N) in the programmable divider, and the feedback frequency into the programmable divider. You should try checking them ... grab a pencil and a piece of paper and prove to yourself that you now understand how a PLL frequency synthesizer works! You do!

Channel	Transmit Frequency	N =	Feedback Frequency
1	26.965	81	810 kHz
10	27.075	92	920
20	27.205	105	1050
30	27.305	115	1150
40	27.405	125	1250

Note: If the above do not seem in uniform order, it is because not all adjacent channel assignments are separated by 10 kHz. Some are spaced 20 kHz, some 30 kHz, and in the case of Channel 23, is actually higher in frequency than channels 24 and 25 (put in reverse order!).

Troubleshooting hints

To check the VCO, use a substitute bias box for the phase detector error output signal. Varying the bias should vary the

VCO's frequency if it is operating properly. A quick check of the presence or absence of signals is in order early in the troubleshooting process. And, of course, so is a check for the proper supply voltages.

Oscillation, due to defective grounds or bypass capacitors will really throw you ... so be sure to check for spurious oscillations with a scope.

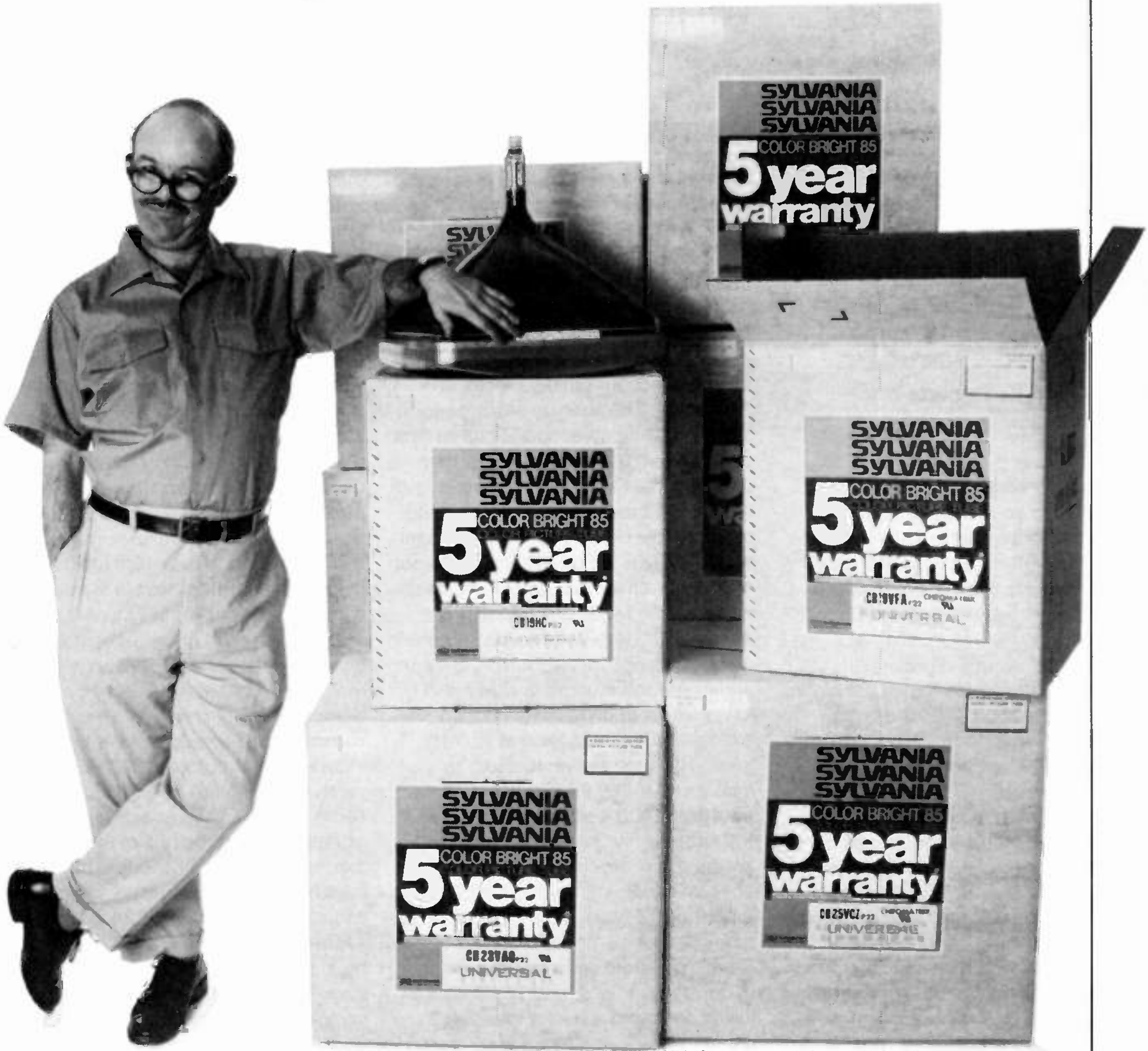
To check the phase detector, vary the VCO frequency with a subsitute bias source. The error voltage out of the phase detector should vary as the VCO frequency varies.

A defective capacitor or resistor can cause the VCO center frequency to shift, (remember the VCO is a multivibrator, and the center frequency is determined by rc time constants).

A signal that is too weak can cause the PLL to lose lock, or fail to track. Usually a defective IC, or transistor is at fault. Be especially wary of replacement parts. For example, a crystal oscillator may run out of frequency limits if the oscillator transistor is changed, even using a replacement with the same "2Nxxx" number. The reason is that there is a 3 to 1 spread on beta (current gain) specifications. Changing the gain causes a shift in the transistor's effective capacitances, which causes the circuit to run out of frequency specs. The remedy is to get a replacement part from the distributor, or else to vary the bias on the transistor until the frequency is within limits. Of course if the transistor itself has the wrong junction capacitances to begin with, no amount of fiddling will fix it. Many manufacturers use specially selected parts in critical circuits, and in such cases the transistor substitution books are worse than useless!

Finally, with the cost of frequency counters down to the level of other service instruments, get one before you try to guess at the frequency. You just can't do it! Reminds me of the fellow who says he doesn't need a color bar generator to converge sets. He does OK if you don't mind color fringes on peoples' teeth. ET/D

Only eight TV tubes can make a warehouse out of your backroom.



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Microprocessor technology

What goes on inside

Come with us as we take you on a journey through the maze of pathways and channels to be found inside of those—up to now—mysterious 40-pin chips.

By Steven K. Roberts

That conventional-looking blender brought into your shop yesterday for repair (ah, gravy money, this!) rests on the bench with its innards exposed. Hello? What is this PC board with two 40-pin Large Scale Integrated Circuits?

Good morning. You have just come face-to-face with third-generation microcomputer technology. Last night, while you were probably sleeping peacefully, it popped into your business environment. You are reading the continuation of ET/D's ongoing attempt to give it a proper introduction.

In the first article of our series on microprocessors ("Micros on Your Bench?" August, 1978, p. 26), we discussed some of the rationale behind the use of "intelligent hardware" in consumer electronics equipment, and briefly related the principle of instruction execution as the basis of the micro's decision making capability. We highlighted the fact that these devices, along with the rest of the new technology, are making inroads into the marketplace with such rapidity that the service technician interested in survival would do well to pay close attention. We are now ready to present some of the meat of the subject: by creating a hypothetical piece of stereo equipment that could be belly-up on your bench next month, we will methodically strip the microprocessor of its mystery and, ideally, give you a firm basis from which to begin the interesting task of catching up with current developments.

Why a micro?

In addition to the design and production economics discussed in our first article, there are some other compelling justifications for the use of a microprocessor in many pieces of equipment. The ability to easily perform logical and arithmetic operations on data derived from the outside world, then control certain aspects of that world as a function of those operations, suggests the use of the device in any environment where the tasks to be performed are not so trivial that they can be cost-effectively accomplished with simple hardware. The easy availability of micro's in a variety of configurations at very low cost is pushing the tradeoff to lower and lower levels of complexity (indeed, the example of the blender was not a joke—Hamilton Beach has just introduced a $69.95 blender controlled by a TMS1000 4-bit chip from Texas Instruments, Inc.). It is precisely this lowering of price, coupled with the innate ability to handle information flexibly, that is causing the processors to appear in so many seemingly unlikely places.

Let's generate a stereo cassette deck in our imaginations, and see if we can justify *not* using a microprocessor to control it.

The ET/D Compusette 80

The basic objective of a stereo cassette deck is the faithful reproduction of two channels of sound, with appropriate audio response characteristics for the intended application. In order to fulfill this objective, we need a method of handling the tape, some means for controlling its movement, signal processing electronics, a means of controlling *that*, and a method of interconnection with the remainder of the stereo system. In addition, we can add optional features such as the ability to index and search a tape, automatic recording of radio programs, frequency response optimization for the type of tape in use, and so on. Let's take a closer look at some of these types of operations.

At the "gut level" of the deck, we need to worry about the physical handling of the tape. Proper tension must be maintained on the active surface, it must be free of vibration, and the speed must be tightly controlled. These interacting types of functions involve some rather complex relationships which are beyond the scope of this article, but the system concept is as shown in Figure 1. The mechanical reality of reels, capstan, and tape is both sensed and driven by three motors (servos), each with some associated electronics. In order to correlate the operation of the three independent circuits, a CONTROL UNIT receives the signals X, Y, and Z from the servo drivers, as well as a group of mode signals (M) from the rest of the system, expressing desired speeds. The interrelationships necessary to produce accurate speed (or tension) control information from the various inputs can be implemented with traditional analog circuitry (if we don't mind drift, high cost, complex design, and thermal sensitivity) or with a digital system.

Closed loop control

The key point here, whatever the means of solution, is *closed-loop control*. If we simply tell the motors to go in some direction at some speed, and then assume that it happens, we are performing open-loop control. If external factors (reel friction, temperature, humidity, physical orientation of the machine, etc.) happen to affect the speed and thus the system performance, we would have no way of

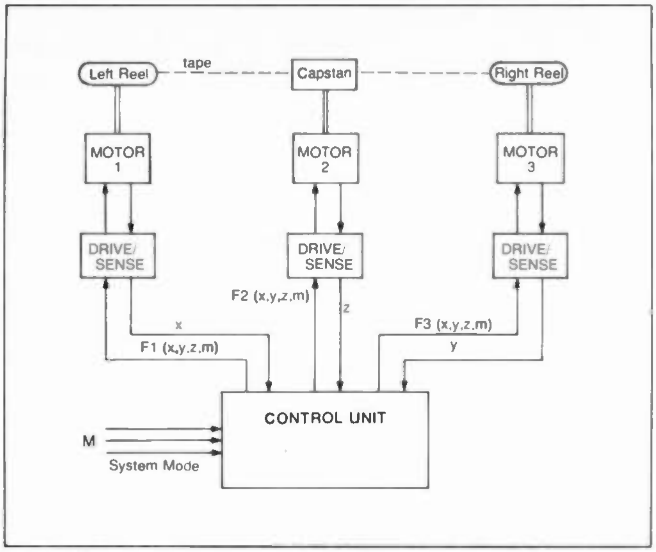

Fig. 1 Motor control system, showing a control unit which generates drive signals as functions of sense signals x, y, z, and the mode controls m. This is an example of closed loop control.

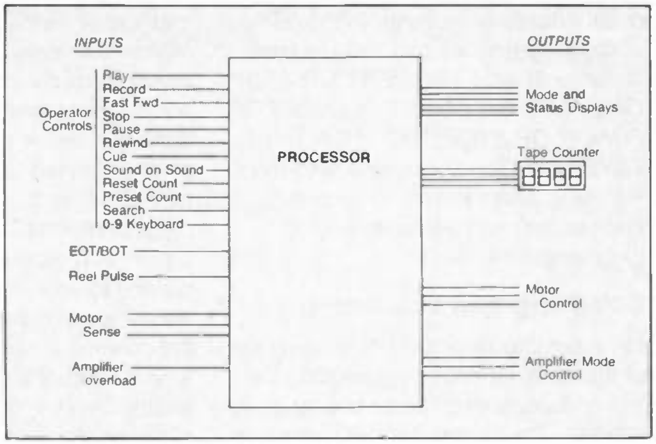

Fig. 2 The ET/D COMPUSETTE 80 from the microprocessor's viewpoint.

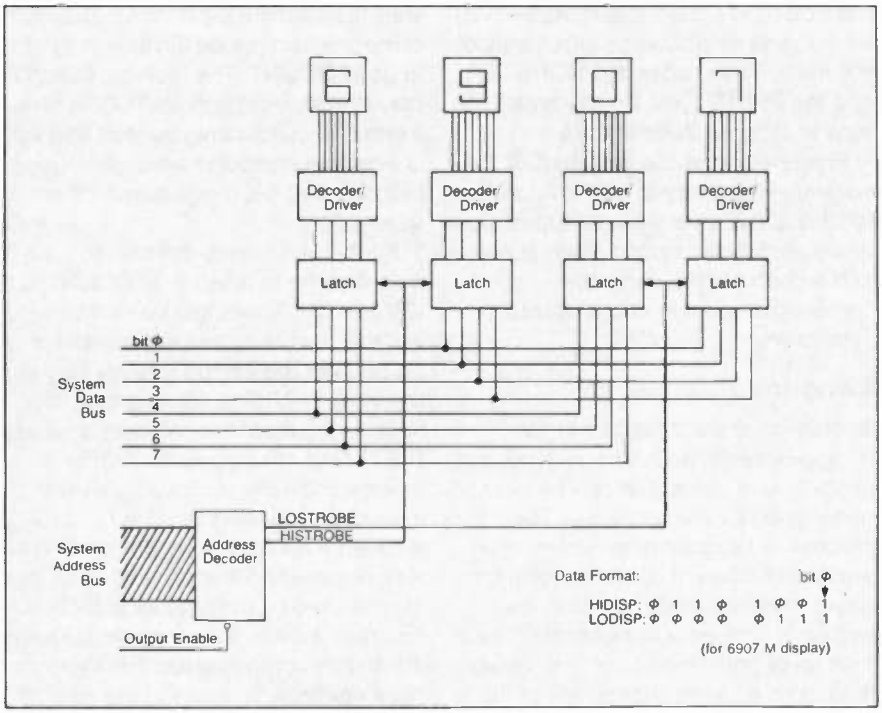

Fig. 3 Display logic for the tape counter, shown as separate functional units for clarity. Most of this is available in a single IC.

knowing it. However, if we design circuitry to monitor the operation of the motors (by factors such as current consumption and phase lag—or with built-in tachometers) and then use that information to constantly trim the control signals that we give them, then we have a closed-loop system. In any kind of critical application, such as industrial control, that is the *only* way it is done, for without some built-in monitoring, catastrophic failure could result from relatively minor changes.

This level of closed-loop control raises some new problems. In order to produce a stable, accurate system, the means of deriving drive signals from the sense signals must be very carefully defined. If we simply say, "if it slows down, increase the current," and vice versa, we may well find upon turning it on that the speed will oscillate wildly around the desired speed. This is called underdamping. The means of attaining "critical damping" in the transfer functions of the control system is one of the most interesting applications of the field of calculus.

Fortunately, we don't have to design it right now, just understand enough of the underlying concepts to render it repairable. Attention to a few aspects of system theory can divest the microprocessor in our cassette deck of its "mysterious black box" status.

Inputs and outputs

Even if tape motion control were the only task to be performed in the ET/D COMPUSETTE 80, we might well find that the kind of quality we want could justify a microprocessor. In fact, the sampling rates necessary to achieve critical damping might even call for a little analog help as it stands. But there's much more.

Take a look at Figure 2. Here we have all the inputs and outputs of the system, from the processor's standpoint. The group called "Operator Controls" consists mostly of switch closures, including a small numeric keyboard to allow entry of cueing points on the tape or the stop/start times for automatic recording. Amplifier gain, mixing levels, and the like are conventionally controlled with pots (next year's model will use digital signal processing throughout, but let's keep this one simple). Groups of signals are shown which interact with the motors and amplifiers; these are for the various internal control functions described above. A digital display (4 digits) is provided to show the tape count, and miscellaneous other displays exist to advise the operator of mode, status, and error conditions (Edison would roll over in his grave!). Additionally, there is a line coming in from an optical sensor which is activated by the beginning or the end of the tape (BOT or EOT) as represented by clear leader, and another from a tape motion sensor which we will use to trigger the tape counter.

Now we start to see where a single hardware unit called a microprocessor can simplify a design. Instead of a maze of specialized control functions made out of levers, cams, switches, and other dedicated pieces of hardware, we have one general purpose controller which does virtually everything. In the design of the program, we can include such statements as: IF *BOT/EOT* OR *STOP* OR *PAUSE* OR *COUNT-PRESENT* OR *ERROR* OR *STOPTIME* THEN *HALT TAPE MOTION*. This single statement (actually, about ten machine code instructions) can eliminate a lot of mechanical hardware.

Counting and searching

Let's dive into the actual implementation of a control function by designing the logic necessary to handle the tape counter. The display itself is something like that shown in Figure 3, although in a production unit it would be further integrated into one or two chips. Each digit of the display has associated with it a latch (to hold the 4-bit Binary Coded Decimal—BCD—value we wish to display), a decoder (to convert the four bits into seven segment signals), and a driver (to provide current to the light-emitting diodes—LED's—in the display as the decoder dictates). The data for the latches comes directly from the data bus of the microprocessor, and it is stored for the use of the display whenever the device address decoder issues the commands LOSTROBE or HISTROBE. This is a standard type of bus structure, and we will go much deeper into its ramifications in a future article. It is basically a universal method of passing data to and from an assortment of logical devices in a system, under control of the computer.

The data for the display is formatted as shown in the lower part of Figure 3. Two data *bytes* (eight-bit chunks) each contain two 4-bit binary coded decimal values. When these are strobed into the latches, the 4 digits are immediately decoded and displayed. From the standpoint of the microprocessor, this is accomplished by an instruction such as "OUT LODISP,A"—assuming that the data for the LO two digits started out in the A register. The instruction causes the processor to place the data in *A* on the data bus, then create the signal LOSTROBE via the address decoder.

Identifying functions

Now, what functions do we want our counter to perform? It is a simple matter to simply keep track of the tape's position—all that is involved there is the increment of the counter whenever a pulse is received from the tape motion detector (on one of the reels) if the tape is moving forward, or the decrement of the counter if the tape is moving in reverse. But why stop there? Since we have the counter's value in system memory at all times and control of tape motion is so easy (and, after all, this *is* a computerized deck and should have some fancy features!) we might as well allow the use to enter a PRESET stop point which will allow searching of the tape to a specific spot. Finding a certain piece of information has classically been a pain with cassettes, and here is our chance to solve the problem. All that is necessary is the storage of the value of the counter at which the user wants the tape to stop. If the SEARCH function is enabled, every time the counter is changed, the program will check to see if it is within 5 counts of the PRESET value. If not, the tape continues at Fast-Forward or Rewind speed, but if so, it is slowed to a lower rate (CREEPING) so its inertia will not cause it to overshoot the mark. Then, when the COUNTER and the PRESET are exactly equal, the tape is stopped. Nice feature.

Figure 4 shows the flowchart of the software necessary to perform these functions. It is a semi-formal expression of the verbal description given above, and represents the complete "procedural" design of the counter sybsystem.

Language

In order to make it happen in the microprocessor, we need to express the procedure in terms that can be directly understood by the hardware. The process of programming occurs at a number of different levels, ranging from direct "machine-code" commands written in a mnemonic fashion to a very high level "interpreting" or "compiling" language, allowing expression of the program in something approaching English. The high level languages require a very complex translation program (the necessary end result, after all, is still machine code), and usually a large development system, but the simplicity of their use generally justifies these expensive investments. We're here, however, to learn about the microprocessor, and expression of a program in a few English sentences gives few clues about what goes on inside.

Take a moment to examine the listing in Figure 5. This is a program written in assembly language, which is merely a means of allowing expression of a machine code program in a fashion less cumbersome than thousands of 1's and 0's. Each line of the program (such as COUNT: CALL INCR in line #7) will, after processing by another program called an *Assembler*, result in a single machine instruction, consisting of 1, 2, 3, or 4 bytes (in the case of line 7, the actual machine instruction which will be "seen" by the microprocessor is "CD3F00"). The assembler allows not only the convenience of naming instructions with abbreviations that are easy to remember (ADD, SUB, CALL, etc.) but also enables the use of named locations within the program. Without this, the programmer would be required to remember the physical location in memory of each piece of data he might be interested in referencing and each location he might want to jump to. For example, in the first line of the program (line #7), the word COUNT is the *label*; it represents the starting point of all the code immediately following. When we want the machine to perform that section of the program, we tell it in some fashion to go to COUNT. The fact that COUNT may actually be at address 0000 is of no interest to us humans, but that address is what the computer sees after the program has been digested by the assembler.

Further examining the first line, we note that the instruction at COUNT is CALL INCR. The actual instruction here is *CALL*, and it directs the computer to go perform the instructions starting at the label *INCR*(line 40), but to *come right back* when it encounters a *return* (RET) (line 49) instruction. When it returns, it simply continues with the instruction following the CALL. "INCR" is called a *subroutine*, and it is a handy way of providing a section of code that can be used by many other parts of the program. A CALL is distinguished from a JUMP (JP) only by the fact that the latter does not imply a return to the next instruction. A JUMP is a straightforward transfer of execution.

We have seen that the computer will begin executing this program when it is somehow directed to go to COUNT. Where might that direction have come from?

The executive

The microprocessor is always in one of two major modes: it is executing instructions as fast as it can, or it is in a HALT state, doing absolutely nothing. Normally, in a machine such as the ET/D COMPUSETTE 80, the processor will be spending most of its time in a section of the program called a *wait loop*, in which it is continually testing various external conditions for something which justifies further action. Thousands of

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times a second, it will be asking such questions as:

Has anybody depressed a pushbutton? It is the end of the tape? Is there any kind of error? Do the motors need help? Is there a pulse from the reel sensor? Has anybody depressed a pushbutton? Is it the end of the tape? Is there. . . . .

This "loop" continues forever, or until any of the questions receives a "yes" answer. The one that interests us now is the motion pulse from the reel sensor.

In order to give the machine some reference for the control of the tape counter, we associate a slotted disc with the supply reel hub, and monitor it with an optical sensor. The output of this sensor (an LED—Phototransistor pair) is connected to one of the input ports of the microprocessor. Thus, once each revolution of the hub, the processor will be able to detect the passage of some amount of tape (which varies as a function of the tape's depth on the reel, but is repeatable). Whenever this occurs, the processor is directed, by means of the "yes" response to the question in the loop, to perform the subroutine called COUNT. The instruction would be a CALL, since after the completion of COUNT, we want the machine to return to the wait loop, often referred to as the executive.

Counting......

Most introductory texts on the subject of microprocessors start with binary arithmetic, spend many pages on the rudiments of logic, then laboriously spell out the "instruction set" of the computer. That approach, frankly, is boring. How can you learn if you don't have a framework in mind into which you can fit new information? As long as the stuff being taught is distant and abstract, it stands little chance of being absorbed with any degree of efficiency.

Ah, but we have a cassette deck. It is pretty clear that we want to replace the mechanical counter of traditional designs with an electronic one, and that we are interested in stopping the tape when it reaches some user-defined value. It so happens that we are using a small computer to do this.

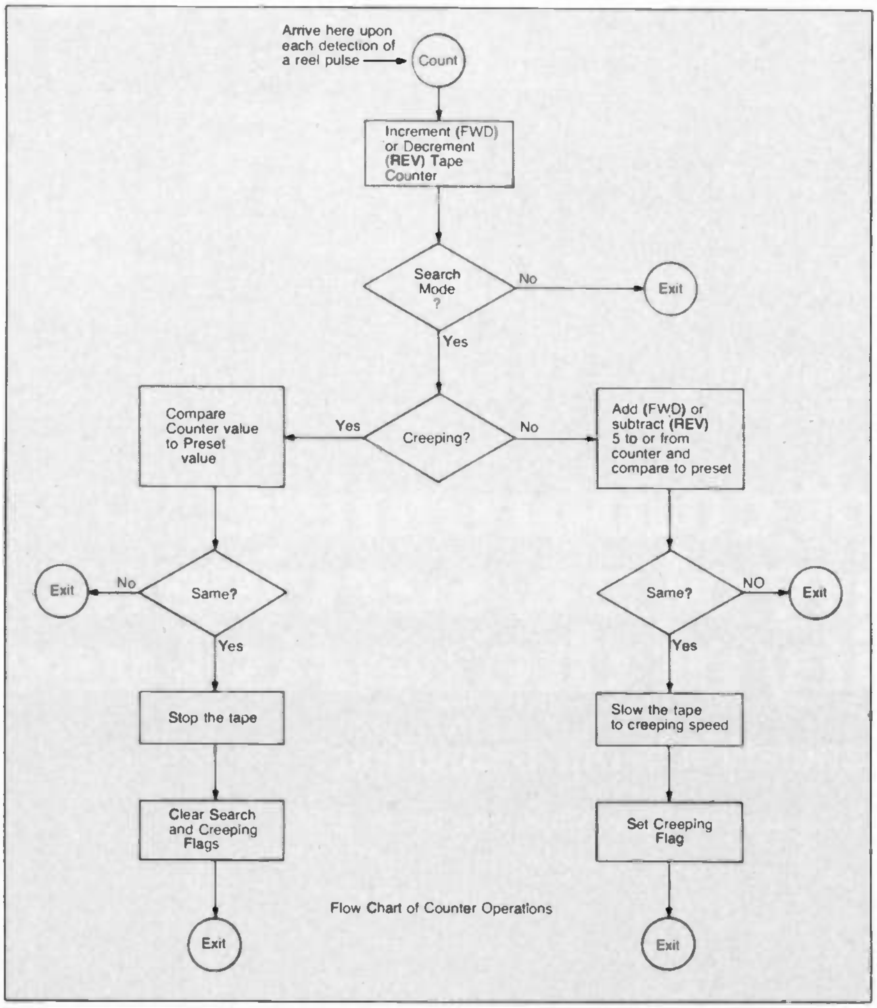

Fig. 4 Flowchart of tape counter operations. The processor arrives here on each detection of a reel pulse, and follows the arrows to take care of display and search functions.

And so, the reels turn forward, and a pulse is detected by the executive: the microprocessor suddenly finds itself at COUNT, being told by the first instruction to CALL INCR. Dutifully, it performs the CALL, and finds itself at INCR.

Once there (find the label INCR at line 40 of Figure 5), the processor is immediately directed to "LD A,(LOBITS)". As before, the instruction itself is in the second column (the first being for the labels), and in this case it is a LD, or LOAD. The LOAD instruction is simple—merely a copy of a piece of data from one place to another. The *destination* and *source* are given, in that order, in the third column, and are known as the *operands* of the instruction. Thus, the machine is being directed to move the data in (LOBITS) to A.

Well, if it's not one thing, it's another—we just have to take this a step at a time. "A" is a *register*—and the most important one of all, since it is the *accumulator*. Most of the machine's logical and arithmetic operations focus on A. In addition to A, there are registers called B, C, D, E, H, & L. Each of them is a byte, or an eight bit quantity, and they are physically located on the microprocessor chip. A large group of LOAD instructions is devoted to all possible combinations of data transfers between them, such as LD B,E.

Memory

But (LOBITS) is not a register, it is a memory location—one which is arbitrarily defined and named by the program. Like COUNT and INCR, it can be found referenced by a label (line 73), but it consists only of one statement: LOBITS: DEFB 0. DEFB stands for "Define Byte", and the purpose of that line of code (which is never executed, since it is *data*, not part of the program) is to set aside one eight bit location in memory for the purpose of counting tape; there is a second, called HIBITS (line 74), and together they represent the present value of the tape counter.

Thus, execution of LD A,(LOBITS) will result in the value of LOBITS being placed in register A, the Accumulator. The moment this occurs, the processor moves on to the next instruction, which tells it to LOAD register pair HL with the address of INCVAL.

Registers H and L, as well as B & C and D & E, can be treated as a 16-bit pair. Unlike the others, however, the HL pair is used for a very wide variety of addressing purposes. If the programmer wishes to load the contents of some random location in memory (and one of

65,536 locations), he needs to specify a full 16 bit address. This is generally done by loading the register pair HL with that address, then performing the instruction LD A,(HL). The parentheses here, as in the instruction at line 40, instruct the processor to fetch the data located at the address specified by the named contents of the operand. In the first LOAD instruction we talked about, the specified address was defined by the name "LOBITS", and in the case of the instruction at line 42, the address is "INCVAL" since that is what the register pair HL was loaded with in line 41.

Subroutines

The existence of INCVAL (and of TSTVAL, SETVAL, and SLOVAL) is the result of the fact that cassette drives can rewind as well as fast-forward. The function being performed here is merely the increment of the counter, but if the deck were in reverse instead, we would have to decrement it. This could be accomplished by an entirely separate subroutine, called when the executive perceives a pulse during rewind, but that would have been wasteful. Instead, whenever a motion command is given in the motor control part of the program, the variables mentioned above are set to the appropriate values for the code in the COUNT program (see lines 76-79). Obviously, since we are assuming forward motion at this point, INCVAL is equal to 1. the ADD instruction at line 42 merely adds this 1 in memory to the value of A, which still contains the value from LOBITS.

Now, since this is a 4 digit counter (as far as the human user is concerned), and the microprocessor uses 8 bit data quantities, we have a slight tactical problem. Each digit for the display is expressed as a 4 bit value (in BCD), so it takes two of the processor's bytes (LOBITS and HIBITS) to represent them. The only problem is that people like decimal and machines like binary; this results in the need to do some conversion. The good news is that it's easy. We simply split the counter in half and use LOBITS for the right two digits and HIBITS for the left LOBITS for the right two digits and HIBITS for the left two. An eight bit value can be used to express any number in the range 0-255, but we will not allow it to go over 100.

Making decisions

So, after one is added to the value of the counter's low two digits, we first need to make sure that they are still under 100. The next instruction sets us up to do just that: INC HL increments the present 16-bit address in HL by one, causing it to point at TSTVAL. Then, the CP A,(HL) instruction in line 44 directs the machine to COMPARE the value of A with the value of TSTVAL, which was set to 100 at the same time that INCVAL was set to one. And here, at last, we have our first real example of a conditional test.

A computer would be quite useless if it could not make decisions, and a moment's thought about the manner in which decisions could be made reveals that it is pretty well limited to conditional JUMPs, CALLs, and RETURNs. Let's look at the next instruction (line 45).

JP Z,CARRY . . . . JUMP if ZERO to CARRY. ZERO is one of four special bits called conditional flags, which are manipulated by the internal logic of the microprocessor as certain instructions are performed. Some instructions, like the LOAD group, have no effect on the flags, but others, like the COMPARE, exist largely because of them. The COMPARE instruction affects them very strongly; in fact, their conditions after its execution can be used to detect all possible relationships between A and whatever it was that was compared with it. The most commonly used flag after a

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ROMEMCO CDOS Z80 ASSEMBLER version 02.12                    PAGE 0001

                    0001 :        <<< ET/D COMPUSETTE 80 - COUNTER CONTROL LOGIC >>>
                    0002 ;
                    0003 ;                  by Steven K. Roberts
                    0004 ;                  CYBERTRONICS, INC.
                    0005 :                  25 August, 1978
                    0006 ;
0000' CD3F00'       0007 COUNT:   CALL    INCR            ;Arrive here when reel pulse - go bump counter
0003' 3A7D00'       0008          LD      A,(SEARCH)      ;Check for SEARCH operation in progress
0006' 1F            0009          RRA                     ; (Rotate A right - bit 0 goes to Carry flag)
0007' D0            0010          RET     NC              ; (If no Carry flag, return to executive)
0008' 1F            0011          RRA                     ;Check next bit for CREEP mode
0009' DA2500'       0012          JP      C,CREEP         ;If set, then tape is already within 5 counts
000C' 2A7E00'       0013          LD      HL,(LOBITS)     ;Place complete counter value in H and L
000F' 118500'       0014          LD      DE,SLOVAL       ;Load D and E with either +5 or -5
0012' 19            0015          ADD     HL,DE           ;Add the 16-bit quantities
0013' ED5B8000'     0016          LD      DE,(PRESET)     ;Get the preset stop point in DE
0017' CD3900'       0017          CALL    COMPAR          ;Compare PRESET value with counter +/- 5
001A' C0            0018          RET     NZ              ;If not that close yet, return to executive
001B' 3E01          0019          LD      A,SLOW          ;Otherwise, load A with the CREEP command
001D' D304          0020          OUT     SPEED,A         ;And physically command the tape to slow down
001F' 3E03          0021          LD      A,3             ;Now set the CREEP flag
0021' 327D00'       0022          LD      (SEARCH),A
0024' C9            0023          RET                     ;and return to executive
0025' 2A7E00'       0024 CREEP:   LD      HL,(LOBITS)     ;Arrive here if CREEP in progress -
0028' ED5B8000'     0025          LD      DE,(PRESET)     ;Have we reached setpoint yet?
002C' CD3900'       0026          CALL    COMPAR          ;(Use the 16 bit COMPARE utility)
002F' C0            0027          RET     NZ              ;If not, return to the executive
0030' 3E02          0028          LD      A,STOP          ;Otherwise, load A with the STOP command
0032' D304          0029          OUT     SPEED,A         ; and issue it.
0034' AF            0030          XOR     A               ;Clear A (Exclusive OR A with itself)
0035' 327D00'       0031          LD      (SEARCH),A      ;Use it to reset the SEARCH mode
0038' C9            0032          RET                     ;Exit to executive
0039' 7D            0033 COMPAR:  LD      A,L             ;Comparison utility...
003A' BB            0034          CP      A,E             ; if D & E equal H & L,
003B' C0            0035          RET     NZ              ; then return with ZERO flag set
003C' 7C            0036          LD      A,H
003D' BA            0037          CP      A,D             ; (otherwise, ZERO is reset)
003E' C9            0038          RET
                    0039 ;
003F' 3A7E00'       0040 INCR:    LD      A,(LOBITS)      ;Get low-order counter value into A
0042' 218200'       0041          LD      HL,INCVAL       ;Point to Increment value
0045' 86            0042          ADD     A,(HL)          ;Add +1 or -1, depending on tape direction
0046' 23            0043          INC     HL              ;Point to Test value (next location in mem)
0047' BE            0044          CP      A,(HL)          ;Has it reached 100 (or -1)?
0048' CA5200'       0045          JP      Z,CARRY         ;If so, go carry into the next digits
004B' 327E00'       0046          LD      (LOBITS),A      ;Otherwise, store new value
004E' 27            0047          DAA                     ;Decimally Adjust Accumulator for display
004F' D308          0048          OUT     LODISP,A        ;Display it
0051' C9            0049          RET                     ;Return to calling program
0052' 3A8400'       0050 CARRY:   LD      A,(SETVAL)      ;Place 0 (or 99) in counter value,
0055' 327E00'       0051          LD      (LOBITS),A      ; depending on tape direction
0058' 27            0052          DAA                     ;Adjust for display
0059' D308          0053          OUT     LODISP,A        ;Display it
005B' 3A7F00'       0054          LD      A,(HIBITS)      ;Now the same with high bits -
005E' 218200'       0055          LD      HL,INCVAL       ;Point to Increment value
0061' 86            0056          ADD     A,(HL)          ;Add +1 or -1 as before
0062' 23            0057          INC     HL              ;Point to Test value


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0063' BE            0058          CP      A,(HL)          ;Test for over- or under-flow
0064' CA6E00'       0059          JP      Z,WRAP          ;If so, go "wrap around" the counter
0067' 327F00'       0060          LD      (HIBITS),A      ;Store new value, otherwise
006A' 27            0061          DAA                     ;Adjust
006B' D309          0062          OUT     HIDISP,A        ;Display new value
006D' C9            0063          RET                     ;Exit
006E' 3A8400'       0064 WRAP:    LD      A,(SETVAL)      ;Get the wrap value (either 0000 or 9999)
0071' 327E00'       0065          LD      (LOBITS),A      ;Store 2 digits low
0074' 327F00'       0066          LD      (HIBITS),A      ; and 2 digits high....
0077' 27            0067          DAA                     ;Convert to decimal
0078' D308          0068          OUT     LODISP,A        ;and display both on the seven segment
007A' D309          0069          OUT     HIDISP,A        ; LED's
007C' C9            0070          RET
                    0071 ;
007D' 00            0072 SEARCH:  DEFB    0               ;Search mode and creep flags
007E' 00            0073 LOBITS:  DEFB    0               ;Low-order counter value
007F' 00            0074 HIBITS:  DEFB    0               ;High-order counter value
0080' 0000          0075 PRESET:  DEFW    0               ;Preset stop point
0082' 00            0076 INCVAL:  DEFB    0               ;Increment value: FWD -> 1     REV -> -1
0083' 00            0077 TSTVAL:  DEFB    0               ;Ovfl test value: FWD -> 100   REV -> -1
0084' 00            0078 SETVAL:  DEFB    0               ;Count set value: FWD -> 0     REV -> 99
0085' 00            0079 SLOVAL:  DEFB    0               ;Slow test value: FWD -> 5     REV -> -5
                    0080 ;
      (0001)        0081 SLOW:    EQU     1               ;Slow tape command
      (0002)        0082 STOP:    EQU     2               ;Stop tape command
      (0004)        0083 SPEED:   EQU     4               ;Speed control port
      (0008)        0084 LODISP:  EQU     8               ;Low display port
      (0009)        0085 HIDISP:  EQU     9               ;High display port
                    0086 ;
0086' (0000')       0087          END     COUNT           ;End Statement (for Assembler use only)

Errors          0

Program Length  0086 (134)

end of assembly
```

Fig. 5 Program listing for counter control functions, using Z-80 Assembly language. Location COUNT at the top corresponds to the top of the flowchart in Figure 4.

COMPARE is Z (ZERO), and it means, if set, that the two values compared were equal.

Well! If the counter's low digits equal 100 after one was added, go to a routine called CARRY!

Let's assume for now that they have not made it to 100 yet. The next instruction (line 46), which is where the processor goes if they are NOT equal, is another LOAD. The new value of LOBITS is returned to memory.

After the LOAD, the internal counter has been properly updated with the position of the tape, but so far it has not shown up on the display. The next instruction, DAA, is a special function provided for the specific purpose of converting 8-bit binary to "packed BCD" (DAA stands for "Decimal Adjust Accumulator), and its execution magically produces a pair of 4 bit digits ready to be output to the display...........

OUT LODISP,A—OUTPUT to the port called LODISP the contents of A. LODISP is defined near the end of the code (find the label at line 84) with an EQU, or EQUATE statement. That merely means that wherever the assembler encounters the word LODISP, it should substitute an 8 (note the "D308" at the beginning of line 48—D3 means OUTPUT and 08 is the port number). Thus, the two 4-bit digits from A suddenly appear on the data bus of Figure 3, and the signal LOSTROBE is produced by the decoder. The data in the display changes.

The next instruction is RET, or RETURN. Since we arrived in INCR as a result of a CALL instruction, the RETURN signifies the end of the procedure. The processor immediately returns to the second instruction of COUNT, and proceeds as directed. The total elapsed time since arrival at INCR is 48.5 microseconds.

The comment field

That should give you a pretty good idea of how instruction execution progresses through a program. The code in Figure 5 is a complete procedure for the function we have been talking about, shown in the flowchart. (It isn't 100% guaranteed—it was written for this article and not debugged on a system. But what could possibly go wrong? Designs always work the first time. Who was Murphy, anyway?)

We recommend that you continue to study Figure 5, pretending that you are the processor. (It's not a bad life—just dull). When you encounter instruction types that we haven't talked about, look at the comment field to the right of the listing. Try letting the value of LOBITS reach 100. Try letting the value of HIBITS reach 100. Notice the use of the low two bits of SEARCH to govern what happens after INCR is performed. Try writing a program to let the user scan the tape by loading a value called INTERVAL, which is used to switch from fast-forward to Play for a few seconds every time it expires.

The ET/D COMPUSETTE 80 is a fictitious piece of equipment, but the techniques used therein are very real (no pun intended). Using a fraction of the normal amount of hardware and some fairly straightforward software, we can outperform most of the competition at a lower price. Considering the incentives of consumer marketing economics, I think that can be treated as a prediction of things to come.

Future subjects

Next in this series we will demonstrate methods of interface between a microprocessor and the rest of the world. Later issues will treat hardware, software, new developments and suggestions for getting hands on experience with a system. This is the only real way to get familiar with a new technology—get hands as well as head into it—suddenly it all clicks, and you're a wizard. ET/D

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Zenith for '79

A no chassis television set.

Here's a most innovative method of assembling a television set.

By Walter H. Schwartz

The new series of Zenith TV sets introduced late in 1978's "J" line, the System III Series, makes up approximately 60% of the 1979 line. The System III "Triple Plus" sets number 43 of some 70 "K" line models. The remainder of the line uses a modular vertical chassis very similar to that of the past several years.

The "Triple Plus" all modular sets do not have a conventional chassis and have no assigned chassis number. The modules are self-contained circuit blocks, identified by M-numbers and part numbers, and are connected together by a cabling harness. Everything plugs in—the modules, the power transformer, the filter capacitors, the yoke, the filter choke—*everything*. The only components that are part of the wiring harness are the volume and picture controls. (See Fig. 1 for typical module interconnect.) The "Triple Plus" set, I keep wanting to say chassis, is made up of six to nine modules, the M1 module or IF section; the M2 module, luminance and chroma; the M3 module, horizontal sweep system; the M4 module, power supply; the M5 module, video output; a 9-157 module, secondary controls; and in some sets, an M9 module, Zoom and a remote receiver and its power supply.

The M1 module

The M1 module contains the tuners, VHF and UHF, the sync-AGC, audio, and master scan oscillator circuits. This module has several interesting circuit features. Having the turners on the same module board as the IF, eliminates the interconnecting cable and combined with the SWIF (Surface Wave Integrated Filter), also eliminates any service problems on a tuner-IF matching network. The SWIF sets the basic IF bandpass; the only other IF tuning is a "Maximum Gain Coil" at the output of the IF gain block, tuned to the picture carrier. A "De-Q-ing" transistor circuit driven by the AGC allows maximum video carrier gain at low signal levels for more contrast and less snow. Stronger signals "walk" the bandpass for a more conventional IF response. (Fig. 2)

The synchronous video detector IC includes AFC circuitry and also has noise processing circuitry formerly included in the sync-AGC IC. The new sync-AGC IC incorporates the master scan and horizontal APC circuits on its chip. (Fig. 3). The horizontal APC output is applied to the master scan oscillator, so-called because it does not operate at either the horizontal or vertical rate, but at 503.5 khz and is divided by 32 to produce the horizontal rate and an additional 262.5 times to produce the vertical rate.

The M2 module

The M2 module contains the luminance, chroma, and the vertical sweep system. The luminance and chroma systems are quite similar to previous systems, except that they operate on a 12 volt supply. The biggest difference here, from a service standpoint, is lower amplitude color difference outputs. The luminance channel has a lumped constant delay line, made up of discrete coils and capacitors instead of the distributed constant line previously used, to reduce susceptibility to magnetic fields. Also, this module uses thick film circuits for a number of the resistances, as do several other modules.

The vertical section accepts the 503khz signal from the M1 module and with appropriate supply voltages provides vertical deflection and horizontal drive to the pre-driver, and blanking to the luminance circuits. (Fig. 4) The vertical countdown IC divides by 16 and then by 2 to produce the horizontal signal via a buffer, for the pre-driver to supply horizontal drive. The divide by 16 stage also drives logic circuitry which provides a pulse to trigger a ramp generator, which in turn drives a differential amplifier, then an output stage and, finally, the vertical windings of the yoke. The logic circuitry also decides if the signal has the standard 525 lines. If not, the ramp generator is not triggered by the countdown circuitry and some of the noise immunity and interlace advantages can be lost. This can happen on some cable or closed circuit systems. The countdown system, of course, eliminates the vertical hold control.

Horizontal sweep

The M3 module contains the pre-driver, the driver, the horizontal output stage, the sweep transformer, and high voltage and focus voltage supplies. The same module is used for all models, the 2kv difference in high voltage (30kv in 25 V models, 28 kv in 19V models) is produced by different yoke inductances.

The horizontal sweep transformer is completely new. The "Triumph" sweep transformer incorporates voltage multiplication and all voltage dividers within it; no tripler is used. (Fig. 5)

Power supply

The heavy power supply components are mounted on a small sub chassis, the nearest thing to a chassis in these sets. The components mounted here include the Voltage Regulating Transformer, its tuning capacitor, the filter choke and filter capacitors. The small components,

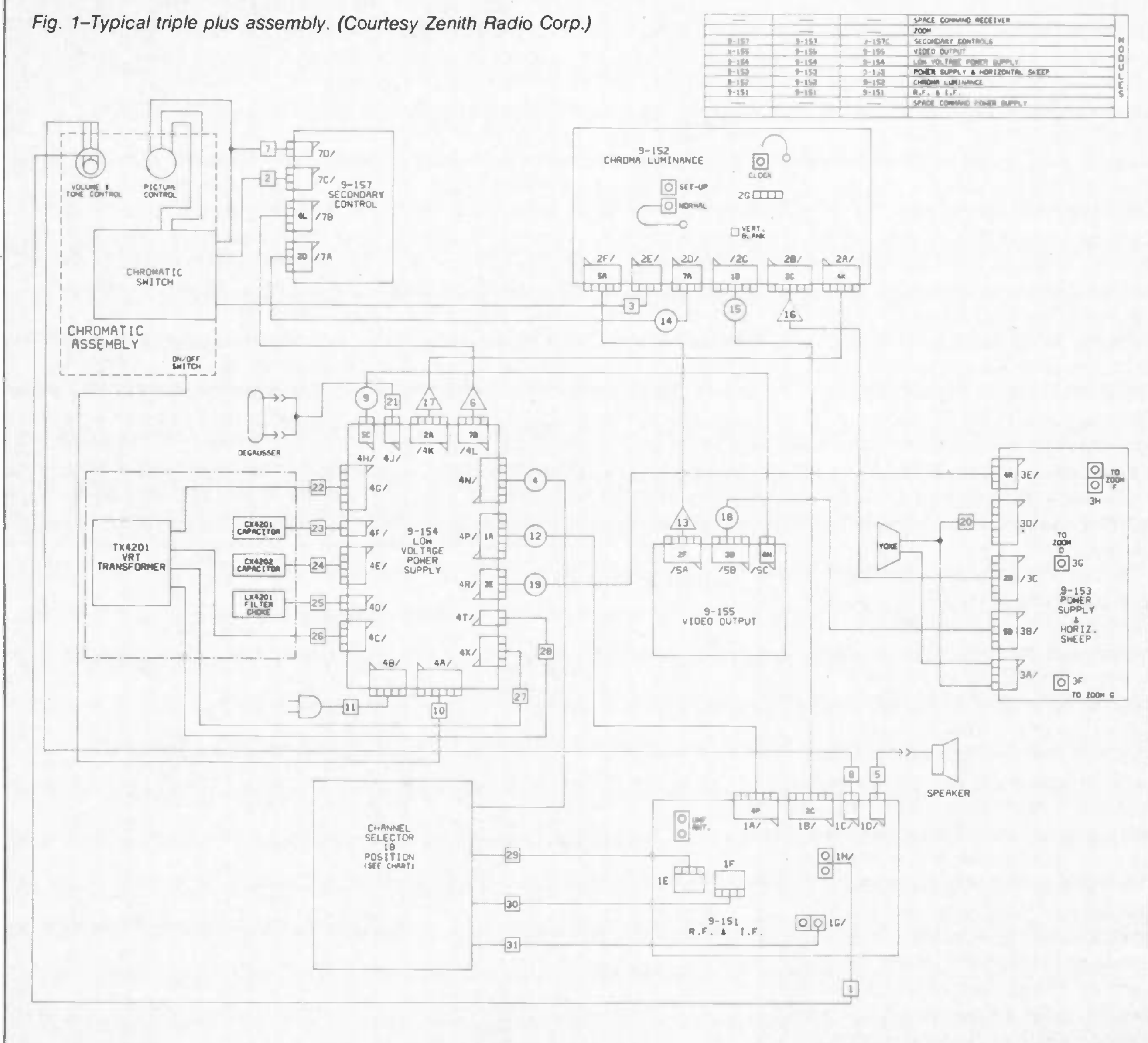


Fig. 1–Typical triple plus assembly. (Courtesy Zenith Radio Corp.)

such as rectifiers, regulator, and line fuse, mount on the M4 module.

ZOOM

The M9 module accomplishes six functions:

1. It expands the horizontal scan 50%.
2. It expands the vertical scan 50%.
3. It provides an increase in blanking.
4. It enhances color and contrast.
5. It turns on the ZOOM light.
6. It prevents an increase in high voltage.

Since it is used with in-line tubes, no convergence correction is needed.

The horizontal scan is increased by changing the tuning of the yoke, resulting in increased yoke current. (Fig. 6)) The vertical is expanded by effectively changing the vertical size by shunting the resistors in series with the size control. One set of relay contacts and a diode switching network increases the blanking level, enhances the picture and turns on the ZOOM lite. (Fig. 7) A capacitor is switched in to load the sweep and prevent the high voltage from rising.

This capacitor consists of four units in parallel so that if one opens the voltage cannot rise excessively. These capacitors also form part of the zoom horizontal blanking circuit (Fig. 8).

Tuning systems

Several control schemes are used to tune the varactor tuners which are on the M1 modules. The simplest is an 18 position switch which has been used for some time in Zenith manual only systems, as has been the 14 position push button system.

The Space Command 1200 remote is used with the all modular sets. This is a 14 position all electronic sequential system, not a random access system as used by several other manufacturers. It utilizes a 7 function electronic transmitter. The functions are: On-Off, Volume Hi-Lo, Channel Hi-Lo, Zoom, and Mute.

Service tips

Occasionally a lockout condition (mistuning) may occur and produce very confusing symptoms.

Lock-outs usually fall into one of three categories: AFC lock-outs, AGC lock-outs and APC lock-outs (for synchronous detector systems). An AFC lock-out can be identified if the condition occurs only when the AFC switch is in the "On" position. An AGC lock-out is usually caused by a sudden RF overload condition. If the condition can be cured by attenuating the antenna signal or by adjustment of the AGC delay control, the symptoms are indictative of AGC lock-out. Faulty

IF and/or AGC modules should be suspected in this case. APC lock-outs usually occur in combination with either AFC or AGC lock-outs since those conditions produce IF signals outside the range of synchronous detector lock. Under these conditions there is a considerable degree of video distortion and usually considerable audio distortion. An APC lock-out is suspected if the condition can be cured after fine-tuning the tuner with the AFC off, or by slightly detuning the IF oscillator coil. APC lock-outs are usually due to either a faulty 221-97 IC or a leaky APC filter capacitor in the IF module. APC lock-outs and video distortion can also be caused by non-standard modulators and amplifiers in cable antenna systems and some video games.

Since most problems involving lock-outs have been AFC lockouts, it is helpful to understand the mechanism involved in the condition. If, when the AFC turns on, the IF picture carrier (pix) is in a "positive" (+) region of the AFC curve, the "positive" AFC voltage will force the tuner to tune the IF carriers higher in frequency. Alternately, if when the AFC turns on, the IF picture carrier (pix) or sound carrier is in a negative" (−) region of the AFC curve, the "negative" AFC voltage wil force the tuner to tune the IF carriers lower in frequency. However, if, when the AFC turns on, the carriers are outside of the AFC pull-in range they will be forced further outside of the synchronous dectector hold-in range. Although this describes a lock-out from the "smear" side, a similar lock-out can occur from the "moire" side of detuning.

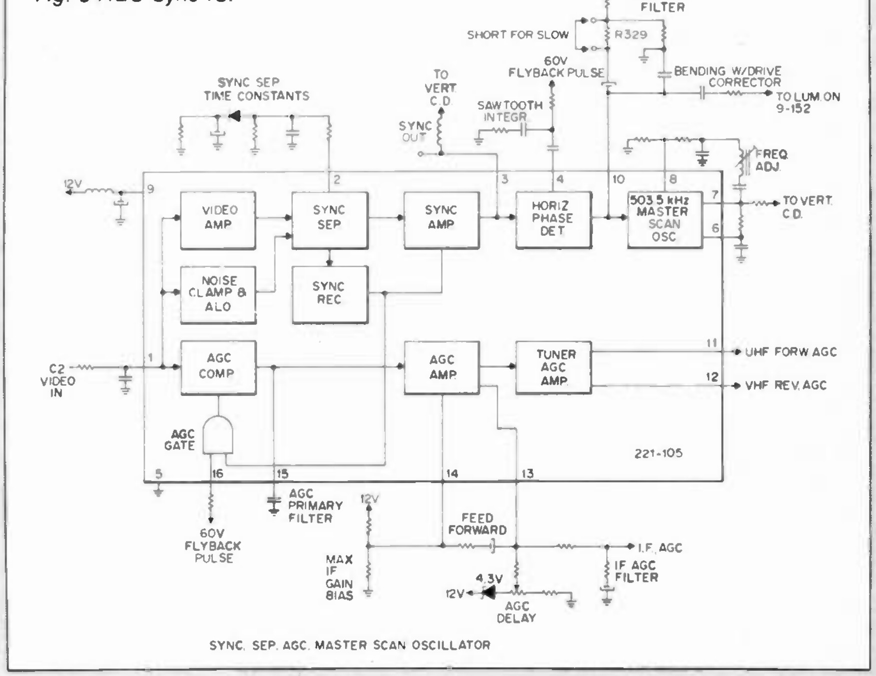
This last condition of AFC lock-out can occur if either the tuner is fine-tuned too far from the nominal tuning point, or the AFC turns on before the tuner has stablized to within the AFC pull-in range. The tuner must have a "positive" AFC voltage to be pulled higher in frequency toward its perfect tuning point. However, the picture carrier is in the "negative" region of the AFC response. This causes the AFC to provide a "negative" control voltage to the tuner, forcing the tuner lower in frequency toward a lock-out condition. The sensitivity or tendency to lock-out can be higher on certain channels (Ch. 5 normally) that have a higher sensitivity to AFC. The sensitivity can be lowered on problem sets by adding a 220 ohm resistor in series with the amplified AFC voltage from the tuner control center to the tuning package.

Most AFC lock-out conditions involve the timing of the AFC turn on to tuner frequency stabilization. If the tuner has not drifted or stabilized in frequency to within the AFC pull-in range at the instant the AFC is manually or automatically turned on, an AFC lock-out condition will exist. This AFC turn on timing is controlled by the R-C time constant of the AFC defeat circuit (Fig. 9).

The output impedance of the IF AFC defeat circuit together with the 47 microfarad capacitor on the AFC defeat switch determines this time constant.

In order for the AFC to turn on, the voltage on pin 14 of the 221-97 IC must increase to greater than 4 volts.

Fig. 3-AGC-Sync IC.



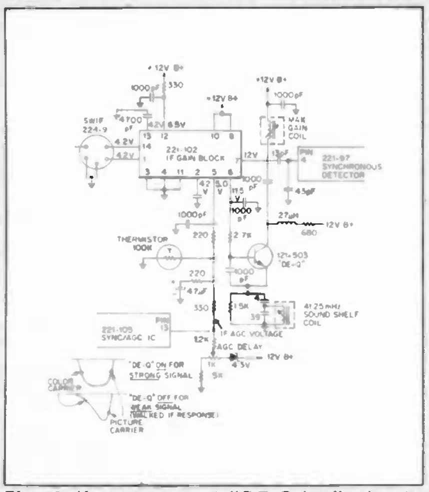


Fig. 2–If system and "DE-Q-ing" circuit (Courtesy Zenith Radio Corp.)

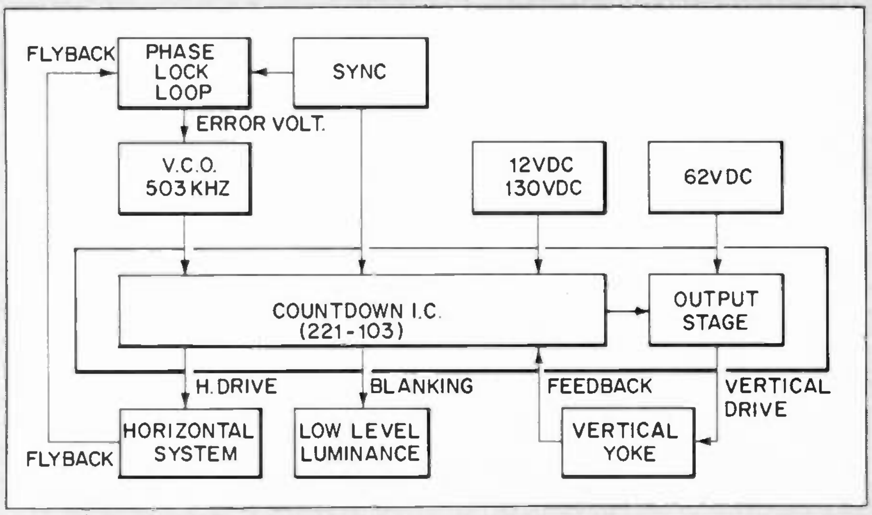


Fig. 4–Vertical countdown system.

Typically, when the AFC is on, this voltage is at approximately 8 volts. When the tuner is switched between channels (operating the interchannel AFC defeat switch), or when the TV receiver is turned off, the 47 microfarad capacitor is discharged to zero volts. When channel changing is completed or when the TV receiver is turned on, the AFC is still defeated (turned off) for the time it takes to charge the capacitor to 4 volts or greater through the resistance of the IF AFC defeat circuit to B+. This time delay is optimized to allow the tuners to stabilize to within the AFC pull-in range.

If the AFC defeat time delay circuit malfunctions, or is bypassed, or if the tuner takes an unusually long time to stabilize, the TV receiver will have a tendency to AFC lock-out on highly AFC sensitive channels. AFC lock-outs generally occur in this manner under one or two conditions: changing channels or power on-off-on.

If the inter-channel AFC defeat switch is inoperative, is not connected to the AFC defeat line, or is not present, the AFC will tend to lock-out on channel change. Some mechanical VHF tuners and all mechanical UHF tuners have no inter-channel AFC defeat switch. On some mechanical VHF tuners, the switch is wired to the AFC output lead instead of the AFC defeat lead. Early synchronous detector receivers include an audio muting function connected by diodes to the inter-channel AFC defeat circuit. If a diode fails in the circuit, the conditions will exist for AFC lock-out.

If the TV receiver is turned "off" and then "on" quickly, the AFC defeat 47 microfarad capacitor does not have time to discharge. Under this condition the AFC will remain "on" while the tuner is still stabilizing, producing a tendency for a lock-out.

A rare condition that could cause AFC lock-out occurs when the antenna signal is suddenly removed and then re-connected. If the IF or AFC system tends to be regenerative at maximum IF gain, the AFC may lock-out. This condition can be checked by noting the AFC output voltage with a strong signal and properly tuned receiver, and then removing the signal entirely. If the AFC output voltage changes enough (greater than ±1 v), the AFC may lock-out when the signal is reapplied.

Most lock-outs are aggravated if the tuner has drifed into, or is fine-tuned into "smear" before the AFC is turned on. This extends the time for the tuner to stabilize in frequency. It should be noted that in a receiver incorporating the 150-190-01 synchronous detector IF module, because of the extended tuning range before color drop-out and "moire," it is difficult to determine the extent of detuning of the tuner.

Thus, even though the receiver is detuned into smear to a point where color is still present, the tuning may be outside of the 1.5 Mhz to 2 Mhz AFC pull-in range.

Another problem which produces obscure or/and intermittent symptoms involves the remote on-off triac. These can cause occasional troubles over a long period of time. When the triac becomes intermittent it can cause side flutter, kick the circuit breaker and then heal for a period of time. The trick here is to confirm a history of flutter. **ET/D**

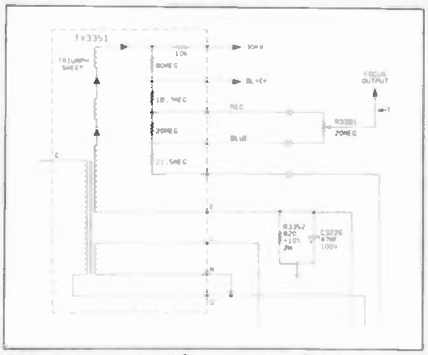


Fig. 5–Horizontal Sweep transformer.

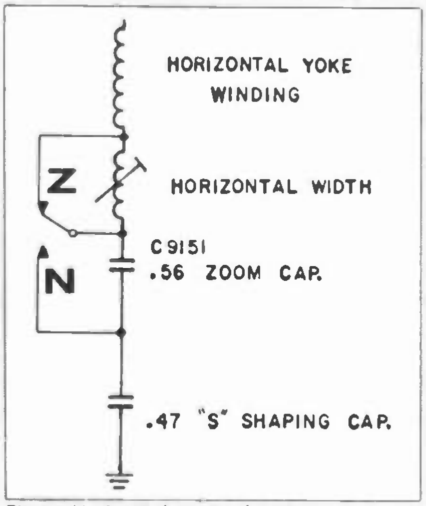


Fig. 6–Horizontal expansion.

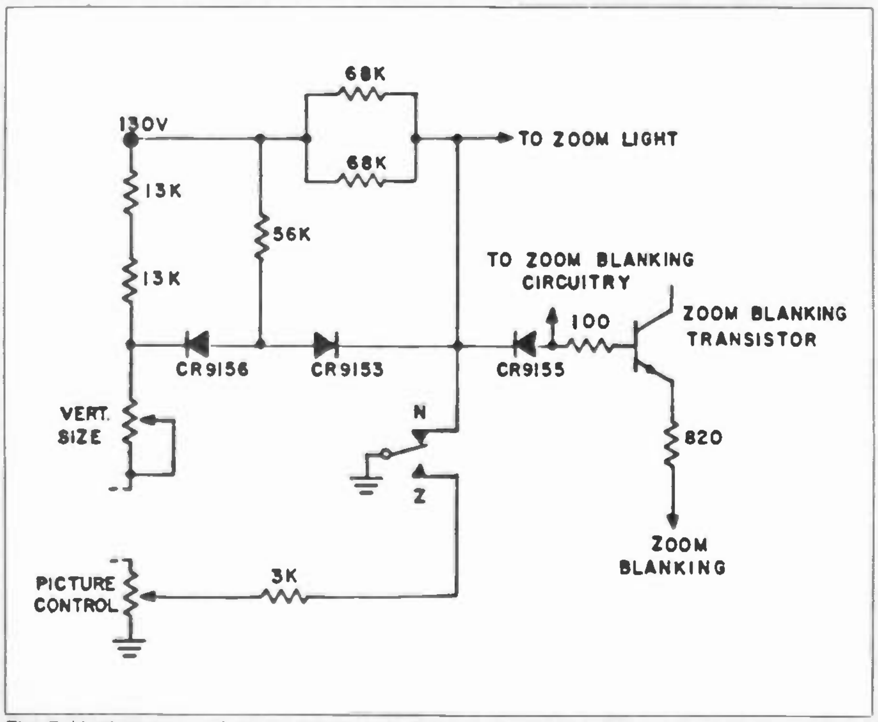


Fig. 7–Vertical expansion, zoom, etc.

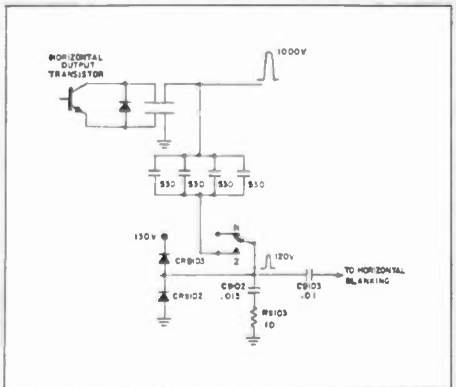


Fig. 8–High Voltage Reduction Circuit.

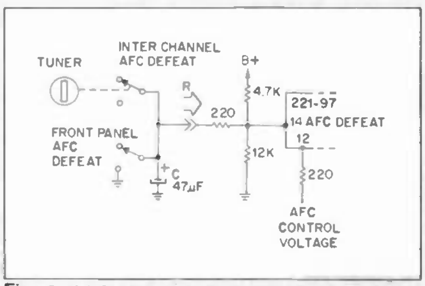


Fig. 9–AFC defeat circuitry.

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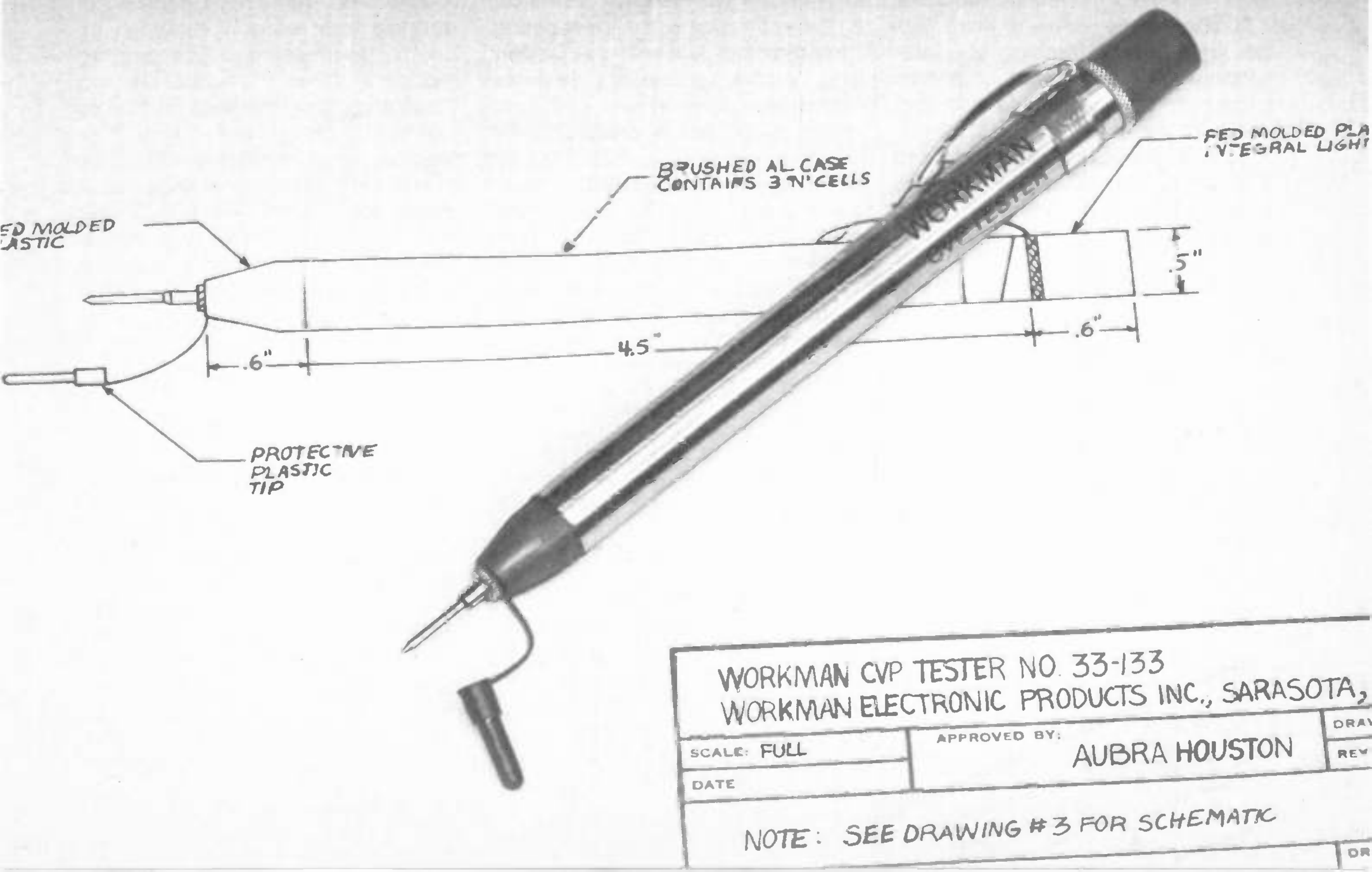

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CVP TESTER
BRUSHED AL CASE CONTAINS 3 'N' CELLS
RED MOLDED PLASTIC
INTEGRAL LIGHT
PROTECTIVE PLASTIC TIP
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.6"
4.5"
.6"
WORKMAN CVP TESTER NO. 33-133
WORKMAN ELECTRONIC PRODUCTS INC., SARASOTA,
SCALE: FULL
APPROVED BY:
AUBRA HOUSTON
DATE
NOTE: SEE DRAWING #3 FOR SCHEMATIC

BULLETIN BOARD

The oscilloscope is a primary measuring and troubleshooting instrument. Unfortunately, too often its capabilities and uses are not well understood by the technician. Some technicians are, in fact, reluctant to use the oscilloscope because of this lack of understanding. **"Oscilloscopes"** by Rien van Erk, is an attempt, in the words of the publisher, to bridge the information gap between the operator's manual and the application of the instrument to the problem at hand. The book begins by explaining the theory of the basic oscilloscope and then the theory of more sophisticated features, such as delayed sweep, and special instruments, such as memory oscilloscopes and sampling oscilloscopes. A number of examples of measurement setups are given. These are examined with a view to avoiding pitfalls which could result from a lack of understanding of oscilloscope limitations. An extensive glossary of terms and a chapter explaining oscilloscope specifications should make manufacturers' literature more understandable. **"Oscilloscopes"** gives a more than adequate basic explanation of oscilloscope usage. It is particularly good when explaining special features and specialized types of oscilloscopes. **"Oscilloscopes: Functional Operation and Measuring Examples,"** Rien van Erk, 270 pages, 248 illustrations, $16.50, *McGraw-Hill*.

Fordham Radio has just published its **1979 Catalog** of 164 pages featuring a great variety of test equipment, tools and supplies for the service industry. Most of the major consumer electronic test instrument manufacturers' equipment is included; tool kits as well as individual tools, are prominently featured; and a broad range of replacement parts are listed. The catalog is available free from *Fordham Radio Supply Company*, 855 Conklin St., Farmingdale, NY 11735.

"Understanding Solid State Electronics", new and updated third edition is now available. Written in very understandable, nontechnical language, it covers semiconductor devices and technology to provide a basic understanding of diodes, transistors, thyristors, digital and linear integrated circuits, MOS and large scale integrated circuits and the technology used in their fabrication. The book should be a good review for the technician and could clear up areas of hazy understanding. It is available for $3.95 (softback) from *Texas Instruments Inc.*, P.O. Box 3640, M.S. 84, Dallas, TX 75285.

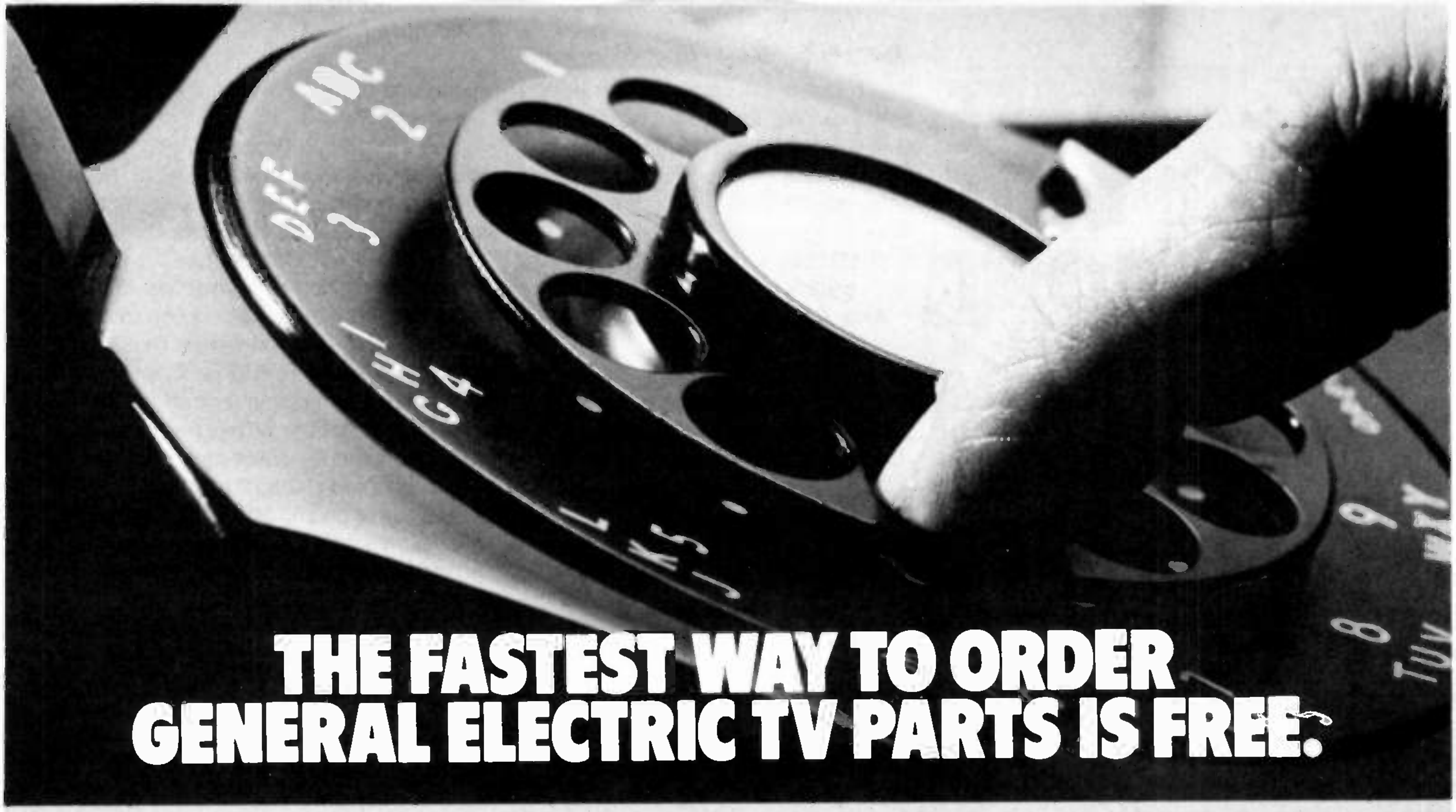
A great quantity of sophisticated high-fidelity audio equipment exists today and often confuses the technician with its complexity. Some television technicians refuse to repair stereo high-fidelity equipment. A direct coupled audio system can have apparent problem in one stage caused by a defective component in earlier stages. Feedback circuits can further complicate troubleshooting. **"Handbook of Audio Circuit Design"** and **"Audio Technology Systems: Principles, Applications and Troubleshooting."** both by Derek Cameron, can go a long way toward solving audio service problems. **"Handbook"** covers basic design, transistor biasing, feedback, amplifier configurations, and temperature compensation, for example. **"Audio Technology Systems"** covers amplifier types, distortion, measurements, and troubleshooting, and FM tuner and stereo decoder troubleshooting. Several chapters cover electronic music and electronic organs. Some good basic information is offered on interference to audio equipment from outside sources such as radio transmitters and automobile ignition. Both books are published by *Reston Publishing Co.*, A Prentice-Hall Company, Reston, VA 22090. Price: $15.95 each.

A new catalog of tools for electronics and precision mechanics is now available from Jensen Tools and Alloys. The 152-page catalog offers over 3000 tools for technicians, instrument mechanics, locksmiths, and hobbyists. For a free copy write: *Jensen Tools and Alloys*, 1230 S. Priest Dr., Tempe, AZ 85281.

Technical Training on Sony Betamax VTR's is now available on a series of video training tapes. Eight tapes cover: operation, technical overview, luminance signal processing, chroma signal processing, servo system, system control and audio, mechanical maintainence, troubleshooting and head replacement. The tapes run between 30 and 45 minutes each and cost $24 each. A free catalog and additional information is available from: *Sony Corporation*, Training Tape Production, 700 W. Artesia Blvd., Compton, CA 90220.

A new Test Instrument short form catalog was recently released by *Leader Instruments*. The catalog reportedly covers many new test and measurement instruments introduced during the past several months. It is said to describe eight oscilloscope models, eight professional audio instruments, four multimeters, both analog and digital, two frequency counters, three color bar generators, including an NTSC Model, an FM multiplex generator, an LCR bridge and other instruments and accessories. The catalog is available from Leader distributors, or Leader Instrument Corp., 151 Dupont St., Plainview, NY 11803.

Automotive speakers and audio accessories are the major subjects of a new 1978-79 catalog from Almotronics. The catalog features single and coaxial and triaxial speakers and systems with and without enclosures, audio plugs, jacks, and cables, CB accessory mounts, speakers, plugs, cables and antennas, and telephone jacks, plug, and cords. It also illustrates displays for these products. For a free copy write: *Almotronics*, 9815 Roosevelt Blvd., Philadelphia, PA 19114. ET/D



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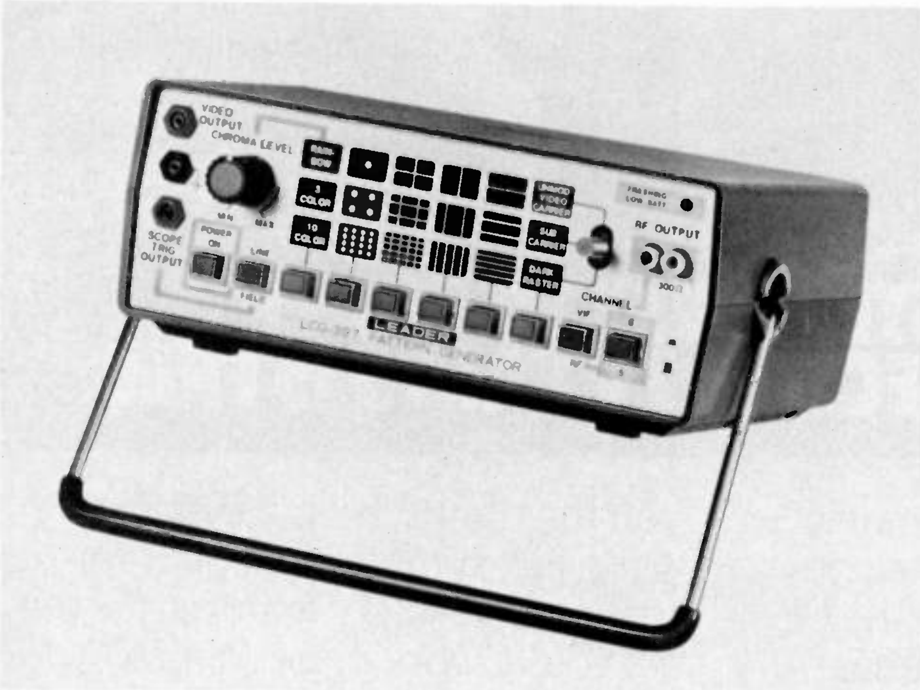
GENERAL ELECTRIC

TEST INSTRUMENT REPORT

Leader Instrument's LCG 397 Pattern Generator

Packed with signals

By Richard W. Lay



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

Don't call them color bar generators anymore. We are long since past the time when the typical "color generator" provided only three or four color and line patterns. The new and modern breed of video generators have evolved into sophisticated video signal generating test instruments.

And Leader's LCG 397 Pattern Generator fits perfectly into this evolving trend of more punch per pound by providing alternative versions of the most often used video test signals and in ex*tremely* portable form.

But, this isn't all, this state of the art high technology piece of equipment is—pound for pound—among the most versatile generators on the market.

Weighing 1-½ pounds with a front panel 6-⅛ by 2-¼ inches, the LCG 397 is as ideally suited for bench work as it is adaptable to field service. The unit is controlled by 10, color coded, front panel pushbuttons, a three position slide switch and a variable color burst amplitude control knob.

Also located on the front panel is a power indicator LED that automatically signals low battery power by flashing when the four C-cells drop below 3.6 Vdc.

The relatively new entry from Leader, introduced officially at this year's NEWCOM show (see ET/D, July P. 18) really does go a step beyond, all things considered. Six blue front panel pushbutton controls, in conjunction with the slide switch, provide the 18 video substitution signals for use in television or VTR troubleshooting work.

The RF/VIF, 300 ohm output jacks work in conjunction with one of two green control pushbuttons to determine the mode of the output—either channel 5 or channel 6 RF frequencies, or (with the VIF/RF button engaged) the 45.75 MHz output for direct connection to the video IF input of the receiver. Thus the 397 maybe used as a tuner sub.

Another video output jack on the 397 supplies composite video and makes the unit a suitable source for VTR work.

The final two of the 10 control buttons select power on and off (red button) and the yellow works in conjunction with the scope trigger output to select either line (15.75 kHz) or field (60Hz).

Fifteen of the signals are for general use in convergence or video bandwidth response checks. There are the three color patterns plus the 12 dot and line patterns—the latter being the traditional vertical, horizontal, and crosshatch.

The LCG 397 provides two gated rainbow displays, the 10 bar display includes R-Y, B-Y and -R+y, the third, sixth, and ninth bars. Rapid phase checks may be made with the LCG 397 by selecting the three bar gated display which effectively shuts off all but the third, sixth and ninth bars.

In the ungated mode, the unit produces a continuous rainbow on the CRT.

One feature of the LCG 397 which facilitates quick color bandpass response is that all of the color bars are of equal 100 per cent amplitude, unlike the broadcast standard color signal which is attenuated to around 45 per cent in the G-Y range and boosted to 130 per cent of correct amplitude in the B-Y range. Thus by feeding the 10-bar gated rainbow into the receiver under test and reducing brightness while observing the screen, a general idea of the receiver's overall chroma bandpass may be obtained since the green bars should be first to disappear followed by red, and leaving blue.

Another interesting feature of this Leader generator is the variable color burst amplitude control dial for quick color killer threshold checks. In the calibration position the LCG provides a 100 per cent burst level. However, this is adjustable from zero to about 150 per cent of correct amplitude.

A rough check of video bandwidth is possible with the Pattern Generator with the help of the crosshatch patterns. Receivers with restricted bandwidths are unable to pass the high harmonic content of the narrow vertical line pulses, thus these lines appear washed out on the CRT screen under such conditions.

The three additional signals available from the 397 are the unmodulated video carrier and the unmodulated subcarrier. By depressing the blue pushbutton farthest to the right and selecting the sub carrier with the slide switch, a quick calibration check of the unit is possible. (For gated rainbow operation this should be 3.563795 MHz, plus or minus 20 Hz.)

Similarly by moving the slide switch to the upper position, a calibration check of the unmodulated video carrier is possible (77.25 for Channel 5, 83.25 for Channel 6, and 45.75 for VIF).

The 18th pattern available is gray raster for purity checks.

Perhaps the feature that makes the LCG 397 easiest to use, however, is the scope trigger output which permits triggered input for all pattern displays with rock solid lock in.

Priced at $295, the unit is available with an AC adapter for bench use. ET/D

Specifications

PATTERNS:

Offset sub-carrier system
3.563795 MHz ± 20Hz

BURST LEVEL
0 to 150% variable

BAR LEVEL
100% fixed

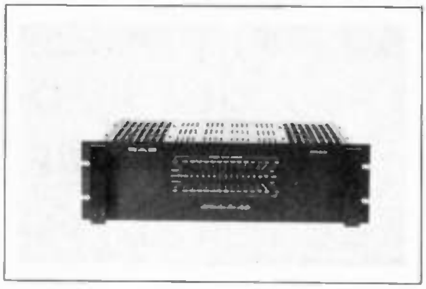
COLOR BARS
10, 3 and rainbow

CONVERGENCE
Dots, intersection of vertical and horizontal bar, white on black background, 15 × 21, 7 × 11, center dot.
Crosshatch, white lines, black background, 15 × 21, 7 × 11.
Vertical lines, white, black background, 21, 11, 1.
Horizontal lines, white, black background, 15, 7, 1.
Gray raster, 0% level, black raster.
Subcarrier, continuous color subcarrier, no sync.

RF/VIF Output
Channel: 5 or 6; VIF
Impedance: 300Ω balanced
Output: 10mv or more

COMPOSITE VIDEO
Output: App. 2v p-p
Polarity: Negative sync
Impedance: App. 10KΩ

DEALER'S SHOWCASE



Stereo High-Fidelity Equip.

Circle No. 132 on Reader Inquiry Card

A line of high end stereo high-fidelity equipment is available from *Scientific Audio Electronics, Inc.* Included in the line are a new power amplifier, the Model 2300; the model 8000 FM stereo tuner; the Model 2900 stereo preamplifier; and other items of sophisticated audio equipment, such as the Model 500 impulse noise reduction system.

The Model 2300 power amplifier, according to the manufacturer's specifications, delivers 150 watts per channel minimum RMS power into 8 ohms from 20 to 20,000Hz with no more than 0.05% THD and features full thermal protection, relays to protect the speakers from low frequency damage and electronic protection against transient overload and short circuits.

The Model 800 tuner has a digital readout, a linear phase IF section which allows stereo distortion of 0.2% or less, a MOSFET front end which produces a spurious response rejection of over 100dB and an IHF sensitivity of 1.6 μv, according to SAE.

The Model 2900 preamplifier, SAE states, features parametric equalization, 0.01% THD and IMD and a phono signal to noise of 90dB (IHF "A" weighted).

The suggested retail price of the Model 2300 is $700. The Model 8000 is $700. And the Model 2900 is $500.

Audio Cabinet

Circle No. 133 on Reader Inquiry Card

Gusdorf offers a new unit of electronic furniture intended to house audio components. It has four adjustable interior shelves which can accomodate most types of equipment. The lower section of the cabinet is storage compartments with slide up doors and removable record dividers. The full back has access holes with removable plugs to organize

connecting wires. The Model #1435 stands 48 in. high, the left compartments are 23¾ in. wide, the right compartments are 19½ in. wide and the compartments are 19½ in. wide and the unit is 17 in. deep. The retail price is approximately $144.

Time Lapse Video Recorders

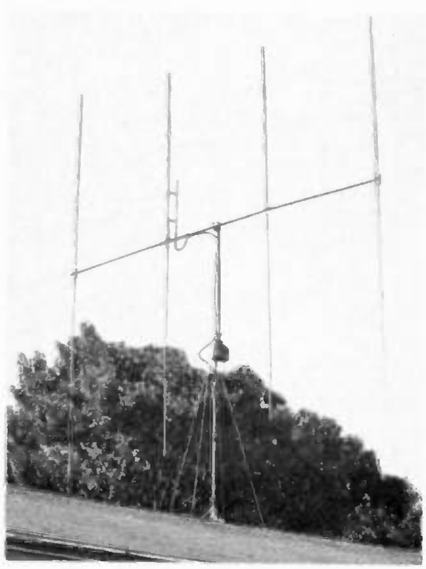
Circle No. 134 on Reader Inquiry Card

RCA Closed-Circuit Video Equipment has announced two new time lapse recorders for closed circuit TV security systems. The recorders, the standard TC3250 with an internal time/date generator and the low-cost TC3200 without this feature, use ½ in. VHS cassettes instead of the reel-to-reel' tapes used previously in most such systems. Both models permit the user to select any of 50 different record/playback speeds, permitting a maximum recording time of 200 hours at the slowest speed. The TC3250 model incorporates controls that position the time/date display on the screen and also control with width of the display. An alarm memory stores the time and date of an alarm, automatically displaying this information when the recorder is stopped. Thus, recorded events at specific alarm times can easily be located and reviewed. A remote alarm can trigger a change in recording speed to any of four pre-selected rates. Switches also permit the user to choose alarm duration, as well as any of 15 camera switcher pulse rates. Both models will be available at optional user prices of $3090 for the TC3250 and $2775 for the TC3200.

Preassembled CB Beam

Circle No. 135 on Reader Inquiry Card

Channel Master has introduced a new CB beam called Signal Tracker. The Signal Tracker is a high efficiency beam made of drawn aluminum tubing. The company claims it can be completely assembled and ready for mounting in less than ten minutes. It has a boom length of 12.0 ft. Channel Master claims it has a 13.5 db gain over an isotropic source and front-to-back and side separation of 30 db, thereby outperforming beams up to 25% greater in length. It is gold EPC coated for weather protection and can be adjusted for optimum performance on a desired channel, covering all forty channels. The Model 5059's price is $79.95. ETD



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Circle No. 107 on Reader Inquiry Card

NEW PRODUCTS

Combination Microphone and Speaker

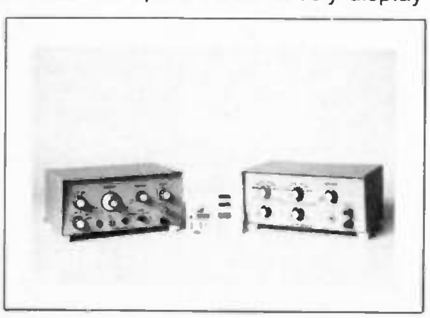
Circle No. 136 on Reader Inquiry Card

The same miniature transducer in user's ear can be used as a microphone and a speaker with The Ear Com system available from the Electronic Instrumentation Division of Lear Siegler, Inc. It allows hands-free, two-way communication in high ambient noise situations. The manufacturer states it is being used by SWAT teams, refinery and chemical plant workers and fire fighters as well as under cover and surveillance work by police agencies.

Time Marker Generator/Sweep System

Circle No. 137 on Reader Inquiry Card

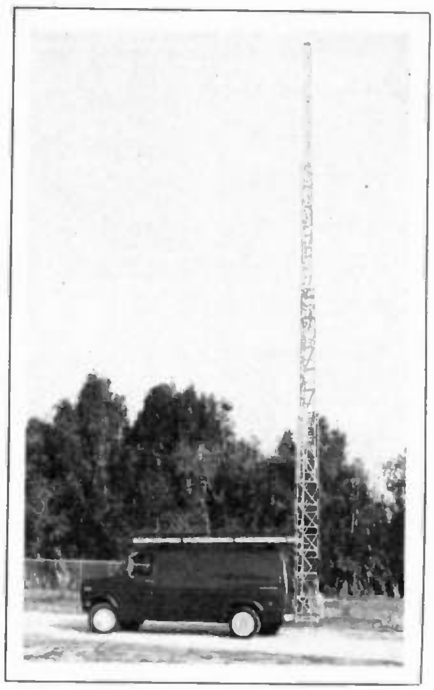
A low cost, time marker frequency sweep generator for commercial, educational, or hobby use in calibrating oscilloscopes is being introduced by *A. E. Corp.* of Needham, MA. The Time Marker frequency sweep generator lets an oscilloscope simultaneously display



the amplitude of a sweep signal at a number of different frequencies marked by a calibrated reference reticle. It is adjustable from 1hz to 100khz in factor of 10 increments. The A. E. Corp. Time Marker frequency sweep generator consists of a Model 12 sweep function generator and a Model 20 pulse generator linked by a Ramp and Marker interface. The Models 12 and 20 may be used independently and, if desired, a clock or oscillator may be substituted for the Model 20. The A. E. Corp. Time Marker frequency sweep generator retails for $155 (kit) and $240 (assembled). The Model 12, Model 20, and Ramp and Marker interface are also offered individually.

Mobile Towers

Circle No. 138 on Reader Inquiry Card

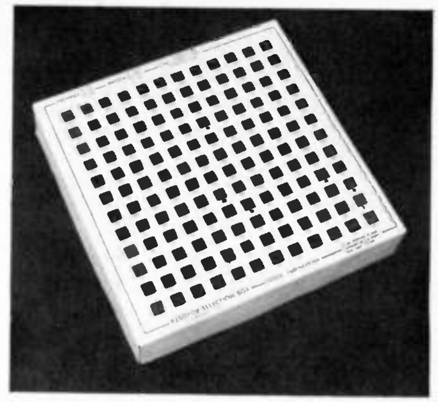


Aluma Tower Company has introduced a new series of "Mobile Van Towers" for communications and test work. The manufacturer states the towers can be mounted on a standard ladder rack on top of a van, tilted to a vertical position and cranked up to the desired height easily by a single operator. Several models are available including two intended for use with internally mounted rotators.

Resistor Storage Box

Circle No. 139 on Reader Inquiry Card

LOWCO Engineering's model RS-144 resistor selector box provides separate storage for 144 resistor valves, with "instant" visual inventory of all resistors. Ten to twenty-five resistors will fit in each of the 144 compartments, depending on whether 1/4, 1/2, or 1 watt carbon or carbon film resistors are stocked. All compartments are individually pre-marked with the 5% range from 1Ω to 990KΩ. The size is 14 × 14 × 3''. The price is $4.75. Stocked with 1440 carbon film resistors, 10 of each value, the price is $79.45.



Wire-Wrapping Kit

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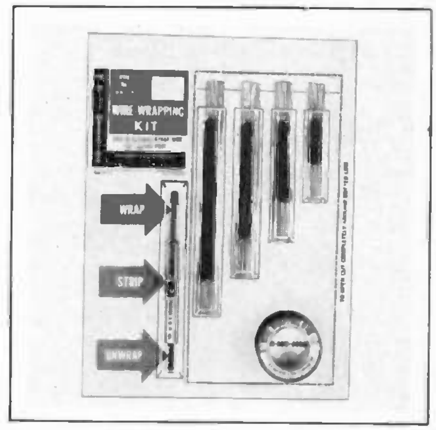
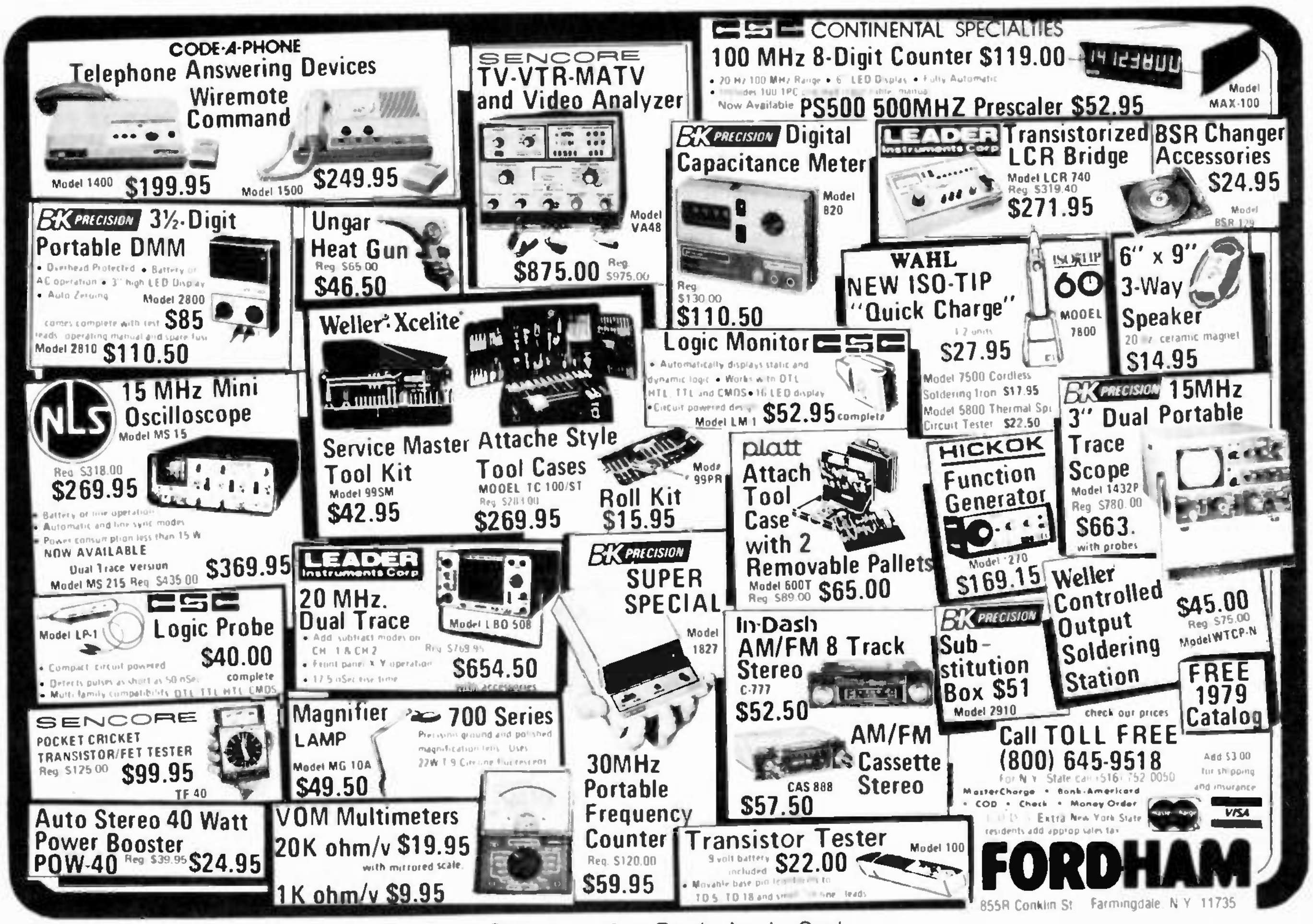


A new wire-wrapping kit for the prototype builder or hobbyist is available from *OK Machine and Tool.* The kit includes the Model WSU-30, a combination wrap-unwrap tool and stripper for 30AWG wire, and a 50 ft roll, plus assorted 1 to 4 in. lengths of 30AWG Kynar insulated silver-plated copper wire. Wire colors available are red, blue, yellow and white. The kit is priced at $12.95.

Digital Multimeter

Circle No. 141 on Reader Inquiry Card

Sinclair Radionics has recently introduced a new bench portable digital multimeter, the DM235. This 3½ digit LED display meter is intended for portable use according to the manufacturer who states it weighs 1½ pounds and is only 1½ inches thick and operates on 4 "C" cells with a rechargeable battery pack and an ac adapter/charger available as options. The price is $89.95.



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101	.90	1.76	162	4.40	8.40	226	1.75	2.92
102	.87	1.58	163A	5.95	10.75	228	1.15	1.31
102A	.92	1.68	164	4.50	8.40	229	.90	1.53
103	.99	1.84	165	7.25	13.50	230	3.40	5.11
103A	1.09	1.90	166	.95	1.68	231	4.00	5.85
104	.97	1.60	167	1.10	2.05	232	.59	.98
104MP	1.94	3.20	168	1.26	2.25	233	.62	1.02
105	2.45	4.22	169	1.84	3.05	234	.57	1.00
106	.52	.95	170	2.75	4.95	235	3.50	6.30
107	.68	1.35	171	1.25	2.15	236	6.25	10.40
108	.85	1.53	172A	.50	.90	237	4.60	8.10
109	.24	.33	173BP	4.30	6.54	238	12.25	15.75
110MP	.32	.54	175	1.25	2.25	239	2.75	3.63
112	.55	.87	176	2.21	3.94	241	1.35	2.29
113	.35	.60	177	.50	.90	242	1.55	2.52
114	.35	.60	178MP	.54	.95	243	1.85	2.69
116	.38	.66	179	5.01	8.88	244	2.60	3.63
117	.35	.60	180	4.98	8.84	245	3.10	4.40
118	1.35	2.95	181	4.15	7.50	246	3.95	4.77
120	.55	.90	182	2.90	4.40	247	3.25	4.77
121	1.70	3.18	183	3.25	5.00	248	4.50	6.42
121MP	3.40	6.36	184	1.10	1.99	249	5.65	8.38
122	1.80	3.30	185	1.30	2.29	250	5.95	8.50
123	.59	1.05	186A	1.30	2.29	251	5.90	8.38
123A	.70	1.32	187A	1.45	2.50	252	5.95	8.50
124	1.20	2.30	188	1.20	2.20	253	1.45	2.06
125	.45	.79	189	1.30	2.50	254	1.60	2.41
126	1.02	1.85	190	1.70	3.10	261	1.50	1.95
127	3.90	7.50	191	2.10	3.80	262	1.65	2.16
128	.99	1.75	192	1.00	1.80	263	1.50	1.95
129	1.10	1.85	193	1.05	1.86	264	2.25	2.93
130	1.95	3.80	194	.55	1.05	274	2.40	2.80
130MP	3.80	7.60	195A	2.40	3.95	280	4.20	6.30
131	1.75	2.84	196	1.65	2.70	281	5.40	8.20
131MP	3.50	5.68	197	1.60	2.52	282	4.50	6.45
132	.88	1.60	198	1.58	2.65	283	6.75	9.40
133	1.00	1.80	199	.46	.81	284	6.70	10.10
152	1.20	2.20	210	1.15	1.99	285	7.30	10.95
153	1.30	2.50	211	1.35	2.29	286	6.70	8.20
154	1.85	3.30	218	3.10	5.25	287	.60	.86
155	1.95	3.42	219	3.25	6.49	288	.65	.93
156	.70	1.30	220	1.40	2.50	289MP	1.70	2.20
157	1.10	2.15	221	1.50	2.68	290	.99	1.26
158	.99	1.86	222	1.80	2.90	291	1.70	2.49
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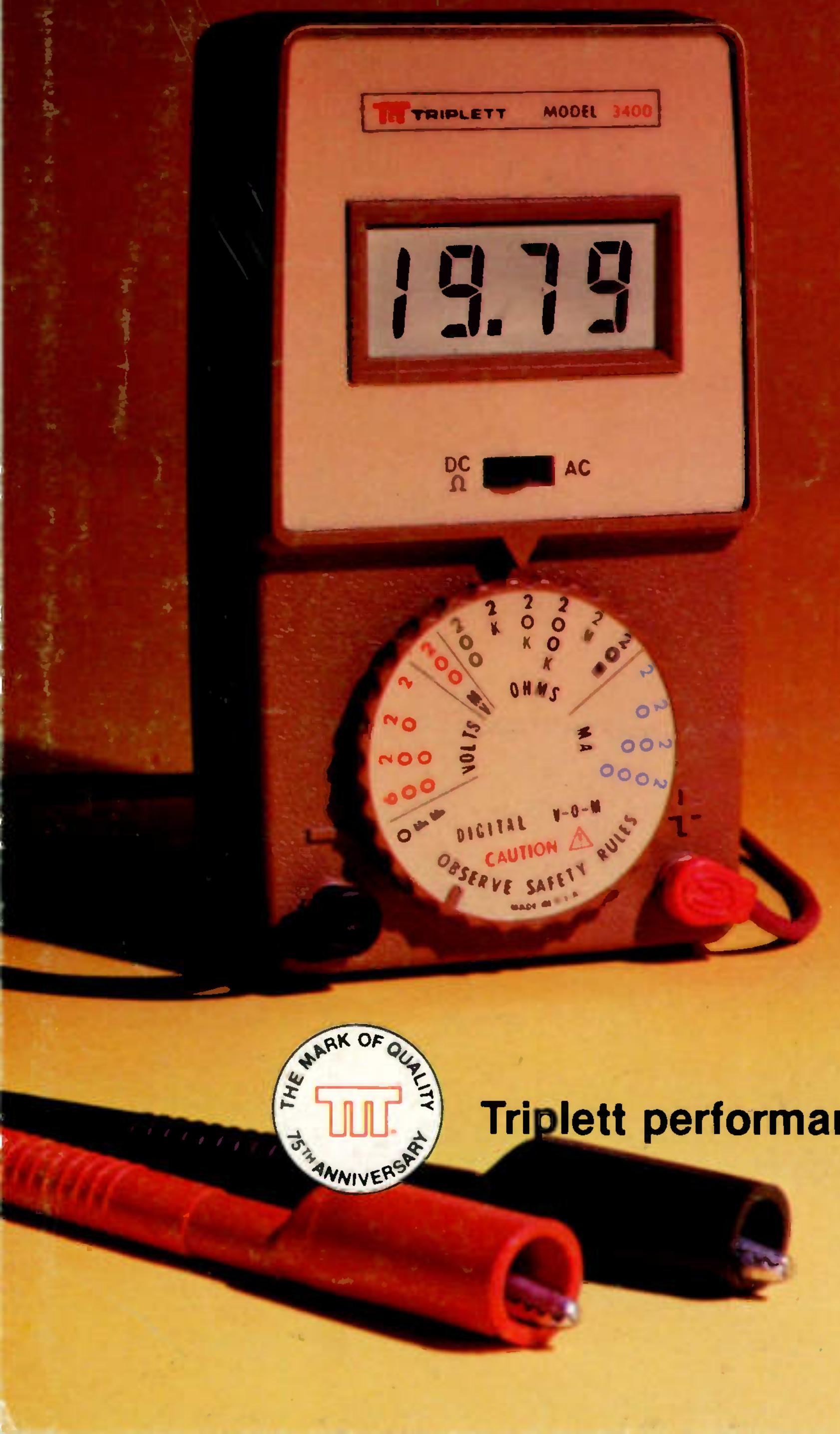

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