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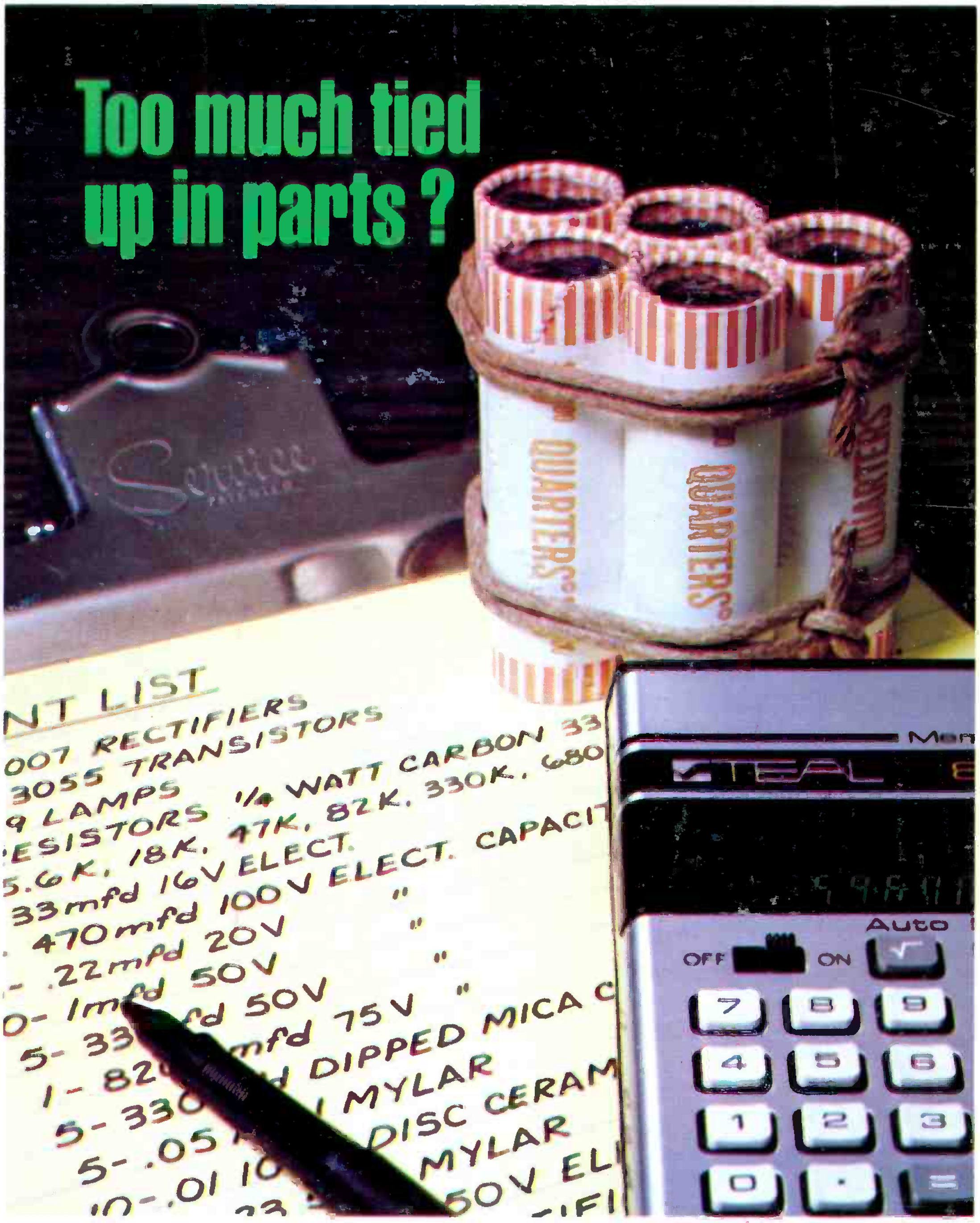
LEADING THE CONSUMER AND INDUSTRIAL SERVICE MARKETS



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INDUSTRY REPORT

Florida Sets 16th Annual Meeting

The Florida Electronic Service Association has announced its 16th annual meeting for Don CeSar's Beach Hotel at St. Petersburg Beach, Fla., July 10-13.

According to a FESA spokesman, the meeting opens Thursday July 10 with four technical seminars scheduled. Also during the first day there are plans for a CET test for those hoping to qualify. Friday's activities will be highlighted by FESA's three-hour long business management school.

Other activities scheduled during the four-day event are a dealer-manufacturer "rap" session, an insurance seminar, the election and installation of officers and a board of directors meeting.

More information is available from FESA by writing 13850 Walsingham Road (E), Largo, Fla. 33540.

NESDA Announces Program Agenda

The annual weeklong Electronics Service Convention sponsored by NESDA/ISCET will be headquartered this year in Louisville's Galt House.

The convention, August 18-23, will be highlighted again by a business management school, technical seminars, the national service conference—which is a general discussion of the state of the industry—and many social events.

Kicking off the week-long activities will be the annual golf tournament sponsored by ET/D magazine on the 18th. A new feature for this year's convention will be a conference for electronics instructors featuring such subjects as curriculum development, program standards, and student motivation.

Registration fees are $110 for a single and $200 per couple. Registration information for individuals or companies is available from NESDA, 2708 West Berry, Ft. Worth, Tex., 76109.

In a separate announcement, NESDA reports its new booklet, Careers in the Electronics Industry, is now available from the office of the International Society of Certified Electronics Technicians. The publication covers such things as job opportunities, pay, employment outlook, and working conditions. The cost is 10 cents per copy.

Zenith Reports Reduced 1979 Earnings

Despite record sales of $1,075 million in 1979, up $980 million, Zenith's 1979 earnings fell 23 cents to $1.01 per share due to increased labor, materials and interest expenses, the company's 1979 annual report states. And due to the uncertain economic outlook at this time Zenith has reduced its quarterly dividend to 15 cents.

In an overview of its operations during 1979, Zenith reported the acquisition of the Heath business and the formation of Zenith Data Systems to concentrate on the development and marketing of small computer systems.

In commenting on its agreement with RCA to market the RCA developed capacitance format video disc player, Zenith said it expects the video disc player to be a significant business opportunity during the 1980s. "We intend to be an important factor in this market." Zenith plans to begin selling the players by mid 1981.

"In another diversification," Zenith said, " . . . Zenith has contracted to manufacturer decoders to unscramble over the air subscription television . . . In addition, plans are now underway for the introduction of a line of cable television converters for use by cable TV subscribers."

ETA-I Picks Ames as Convention Site

The Electronic Technician's Association-International (ETA-I) has set July 11 and 12 as the dates for its annual convention which will be held this year in Ames, Iowa.

According to Ron Crow, ETA's director of certification, the convention format will follow that of previous educational sessions held in Indianapolis and Hastings. Certification exams, electronics instructors conferences and election of officers will take place during the two days.

Among the technical session topics will be satellite ground station receivers, Microwave oven familiarization, VTR alignment, Micro computer servicing and troubleshooting digital IC circuits. Scheduled business session topics will be managing your technicians, hourly rate setting, calculating your productivity, and service shop advertising.

Further information is available from ETA, 7046 Doris Dr., Indianapolis, Ind. 46224.

NATESA Slates Convention Program

NATESA's Executive Director Frank Moch has announced this year's program agenda for the association's annual convention Aug. 7-10, at Ramada, The O'Hare Inn, in Chicago.

An extended business management session will occupy one of the days. Included in the presentations will be a report by the RCA Service Company on profitability in the industry; a round table discussion to explore specialization versus diversification; and a program on financial management.

Also included is a general overview of electronic servicing in the 1980s and this

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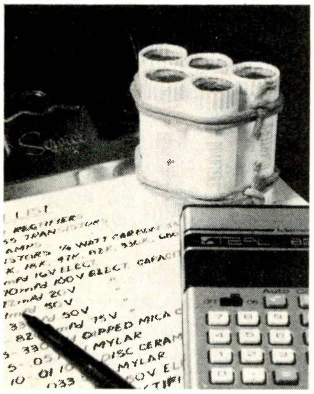
FEATURES



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102A	.40	135A	.40	171	2.25	231	4.90	298	1.10	381	3.10	720	1.50	791	2.80	975	1.60	1036	3.20
103A	.80	136A	.40	176	1.30	233	.80	299	.75	382	1.00	721	3.80	793	3.20	978	1.60	1037	3.00
104	2.00	137A	.40	176	1.10	234	.40	300	.70	383	1.10	722	1.50	801	2.00	987	1.40	1040	1.40
105	3.90	138A	.40	177	.25	235	1.60	302	1.30	390	1.10	723	1.50	802	8.80	990	4.80	1041	1.20
106	.40	139A	.40	180	4.60	236	1.80	306	1.30	391	1.10	724	2.80	803	8.80	992	1.80	1042	2.40
107	.80	140A	.40	181	3.40	237	2.40	307	.50	500A	12.40	725	1.50	804	2.90	1002	1.20	1043	3.90
108	1.20	142A	.40	182	3.20	238	3.35	308	7.40	506	1.50	726	3.50	805	3.20	1003	1.20	1045	2.60
109	.20	143A	.40	183	3.75	276	7.90	310	7.40	523	18.80	728	3.80	806	3.80	1004	2.40	1046	3.20
110	.40	144A	.40	184	1.30	277	7.80	312	.60	525	1.35	729	4.20	807	3.20	1006	2.20	1049	3.90
113	.55	145A	.40	185	.90	279	7.40	313	.80	526A	18.80	731	1.50	814	4.00	1009	2.20	1050	2.00
116	.20	152	1.30	186A	.60	280	3.40	315	1.00	551	2.00	737	3.80	815	3.80	1010	2.20	1051	5.90
117	.20	153	.90	187A	.80	281	4.60	320	10.60	601	.30	738	4.80	818	3.80	1011	2.25	1052	1.00
118	.90	155	2.90	190	1.80	282	2.00	321	3.60	605	1.65	739	3.20	823	1.20	1014	1.90	1053	2.70
121	2.75	156	.60	192	.45	283	4.60	323	2.20	612	.35	740A	2.60	824	2.50	1016	2.20	1054	1.70
123A	.35	157	1.50	193	.55	284	4.30	324	2.50	613	.40	742	4.20	904	6.90	1019	1.20	1055	2.70
124	2.00	158	.40	195A	2.00	285	6.20	325	29.20	703A	1.50	743	3.80	905	4.50	1020	2.20	1056	2.80
125	.20	159	1.10	196	1.30	287	.70	333	19.00	708	1.50	744	5.20	912	2.40	1021	2.20	1057	3.10
126	.80	160	1.80	197	1.50	289	.60	334	19.00	709	1.50	746	3.80	917	3.20	1024	4.20	1058	1.95
127	2.95	161	1.20	198	1.50	290	.60	335	26.00	710	3.00	748	2.80	923	1.30	1025	5.90		
128	1.40	162	4.60	199	.60	291	1.30	336	26.00	712	2.25	749	2.90	925	7.80	1027	4.90		
129	1.20	163A	4.60	220	1.60	292	1.50	373	2.50	713	1.50	778A	1.80	941M	.90	1028	10.40		
130	1.30	165	3.35	221	1.40	293	1.00	374	2.60	714	2.80	780	3.20	955M	1.40	1029	2.60		
131	1.00	166	1.45	222	1.60	294	1.10	375	1.50	715	3.20	783	2.60	966	1.30	1030	3.60		
132	.60	167	1.45	229	.80	295	.60	376	2.25	718	1.50	788	1.50	973	1.80	1032	2.90		
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Many more items to choose from but space does not permit listing them all.

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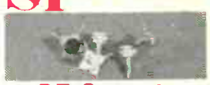

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session will deal with such topics as types of equipment that will be needed, education, anticipated products and circuitry, and a presentation by the Electronic Industries Association on what they are doing related to the service industry.

Preceeding the opening of the convention will be the annual golf tournament sponsored by ET/D magazine. Registration will be $35 per person.

House of Future Features Computer Technology

The "house of the future," a modernistic, energy efficient unit now open to the public in Phoenix, Az., leaves little doubt as to the role of consumer electronics in the American home of the future.

Within the walls of this solar oriented environmental system is a sophisticated microcomputer control system designed and implemented by Motorola's consumer strategic marketing group.

The home itself, by Presley of Arizona, and designed after consultation with the Frank Lloyd Wright Foundation, uses theories spawned by the leading edge of sociology, ecology and technology to "show the public an alternative to the homes they were used to," according to the developer.

The microcomputer control systems monitors five functions. They are environmental control, security, electrical load switching, energy management, and information storage and retrieval.

According to spokesman for the project, the computer can open doors and windows for passive heating or cooling. "There are three different ways to actively heat the house—solar, heat pump, and resistive electrical heating. There are three different environmental zones within the structure and different temperatures can be maintained in each.

"Most of the system's security functions are carried out by sensing the state of smoke and motion detectors located in almost every room. Motion detectors can be used even to turn lights on or off depending on the direction of the motion into, or out of a room.

There are no keys either. Instead of a keyhole there is a calculator keyboard near each door—simply type in the code combination and the door opens automatically.

In case anyone is asking—is there a place for consumer electronics repair in the home of the future? Take a guess.

Collins Gains Medal of Honor

Arthur A. Collins, a pioneer in the application of electronics communications for aviation and specialized military uses and founder of the Collins Radio Company, has been named winner of the Electronic Industries Association's highest award, the EIA Medal of Honor.

In 1931 Collins founded the Collins Radio Company and during the next 40 years built it into one of the nation's major electronics firms. He currently is chief of the Arthur A. Collins Corporation, a company which conducts research and development in communications in Dallas, Tex.

Matsushita Sets Sales/Earnings Records

Matsushita Electric, the giant Japanese electronic-industrial firm, says 1979 results showed record sales and earnings.

Sales of $9.38 billion in 1979 were up 9.2% and earnings of $390.4 million rose 9.3% over 1978, according to the company's financial statement.

Consumer electronic products, including TV, VCRs, and audio equipment lead the firm's sales gains. Consumer electronic sales of $4.1 billion were up 9%. according to Matsushita, consumer electronics comprises 43 per cent of its total world-wide business. ET/D

Correction

In *Sony for '80* (Feb. '80, ET/D), two illustrations contain errors. Corrected data from Sony indicates the channel up and down function designations at pins 23 and 24 of ICO32 to be reversed in Fig. 2, as are the same functions on 16-17 and 18-19 of IC 2002 in Fig. 6.

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NEWSLINE

MAGNAVOX GETS AM STEREO NOD. Despite the fact the Federal Communications Commission has selected Magnavox's system of AM Stereo to be the industry standard over competing technologies from Motorola, Belar, Harris and Kahn, there won't be any headlong rush into the new concept. For one thing manufacturers need time to rid inventories of conventional AM devices and then there is the case of already depressed audio compact/stereo FM sales. While Magnavox refused any comment on the decision or speculation as to when AM stereo broadcasting would begin, several observers indicated dates way past mid 1981 due to lengthy hearings, appeals, and possible court actions that may develop.

SONY KEYS ON RESEARCH AND VIDEO. Sony Chairman Akio Morita says company's future will be heavily into semiconductor research technology and video and magnetic tape products. Sony plans to up new facilities spending 50 per cent to $200 million annually following 1979 results which showed Betamax accounted for about 20 per cent of firm's revenues--second only to TV business. Meanwhile, first quarter results for 1980 showed consolidated net up an incredible 343 per cent to $79 million.

TALKS ON HOME EARTH STATION PROJECT END. Negotiations between Comsat and Sears involving the creation of a direct to home satellite television system have ended. Sears, which apparently would have been the installation and service organization for Comsat's rooftop satellite antenna system, felt a seven-to-10 year delay for a return on their investment was simply not good business. Comsat, however, says it is proceeding with the idea and talks are currently underway with other parties.

MAGNAVISION ADDS 8 NEW MARKETS. Magnavox video disc players will be available in a total of 16 U.S. markets by mid May, according to company statement which says St. Louis, Tampa, Denver, Detroit, Portland, Cincinnati, Kansas City, and Knoxville are the latest to be added. By the end of the year, Magnavox says, Magnavision will cover 65 per cent of all TV households. The stereo capability of the Magnavision optical player is thought to be the ace in the hole by company officials who say 90 per cent of all current Magnavision owners also own stereo hi-fi equipment.

CONTINENTAL SPECIALTIES CORPORATIONS BECOMES GLOBAL. Continental Specialties Corporation, a manufacturer of electronic test instrumentation, has announced a name change. According to President R. J. Portugal, the firm will henceforth be known as Global Specialties Corporation.

WESCON SOLD OUT. WESCON, sponsored jointly by the Institute of Electrical and Electronics Engineers and the Electronic Representatives Association, has sold out all space for this year's show Sept. 16-18 at Anaheim, Calif. The show annually attracts some 45,000 engineers, industry execs, and marketers.

SERVICE SEMINAR

RCA

RCA CTC 87, 88, 96, 97 vertical deflection troubleshooting
The vertical deflection system consists of a high grain power amplifier whose output drives the series-connected yoke (controlled by a free-running RC relaxation oscillator). The vertical oscillator acts as a switch to discharge ramp capacitor C3110. The vertical oscillator is not dependent on feedback from the output to sustain operation.

For the purposes of explanation, the entire vertical amplifier system can be thought of as an operational amplifier, having extremely high gain and two inputs—one inverts the output signal with respect to the input and one does not. A negative feedback path consisting of current sampling resistor R3123 (1 ohm) and 100-ohm resistor R3125 delivers a sample of yoke current to the inverting input of the operational amplifier.

The effect of the negative feedback is to linearize the vertical deflection yoke current, as well as stabilize the gain of the amplifier. A secondary voltage supply of -15 v is developed by the voltage divider action of the vertical output devices. (This is the "auxiliary" voltage source to which the vertical oscillator is ground referenced.)

The input signal for the operational amplifier is a 60Hz sawtooth signal produced by the charging and discharging of "ramp" capacitor C3110. Notice that capacitor C3110 is charged from the 30-V source through resistor R3127 and the vertical height control, R3081A. Because of the high closed-loop gain of this amplifier circuit, the actual sawtooth voltage developed by capacitor C3110 is limited to approximately 1 V p-p. This sawtooth signal drives the non-inverting (+) input (Q3017) base) of the amplifier. Any nonlinearity in the output sawtooth waveform is cancelled by the feedback signal applied to the amplifier is a 55 V p-p signal to drive the vertical yoke. The output signal is a 55 X gain replica of the input signal which is modified by the retrace switch circuit.

Test procedure
Place service switch in "service" position. This establishes a common or static condition for performing checks.

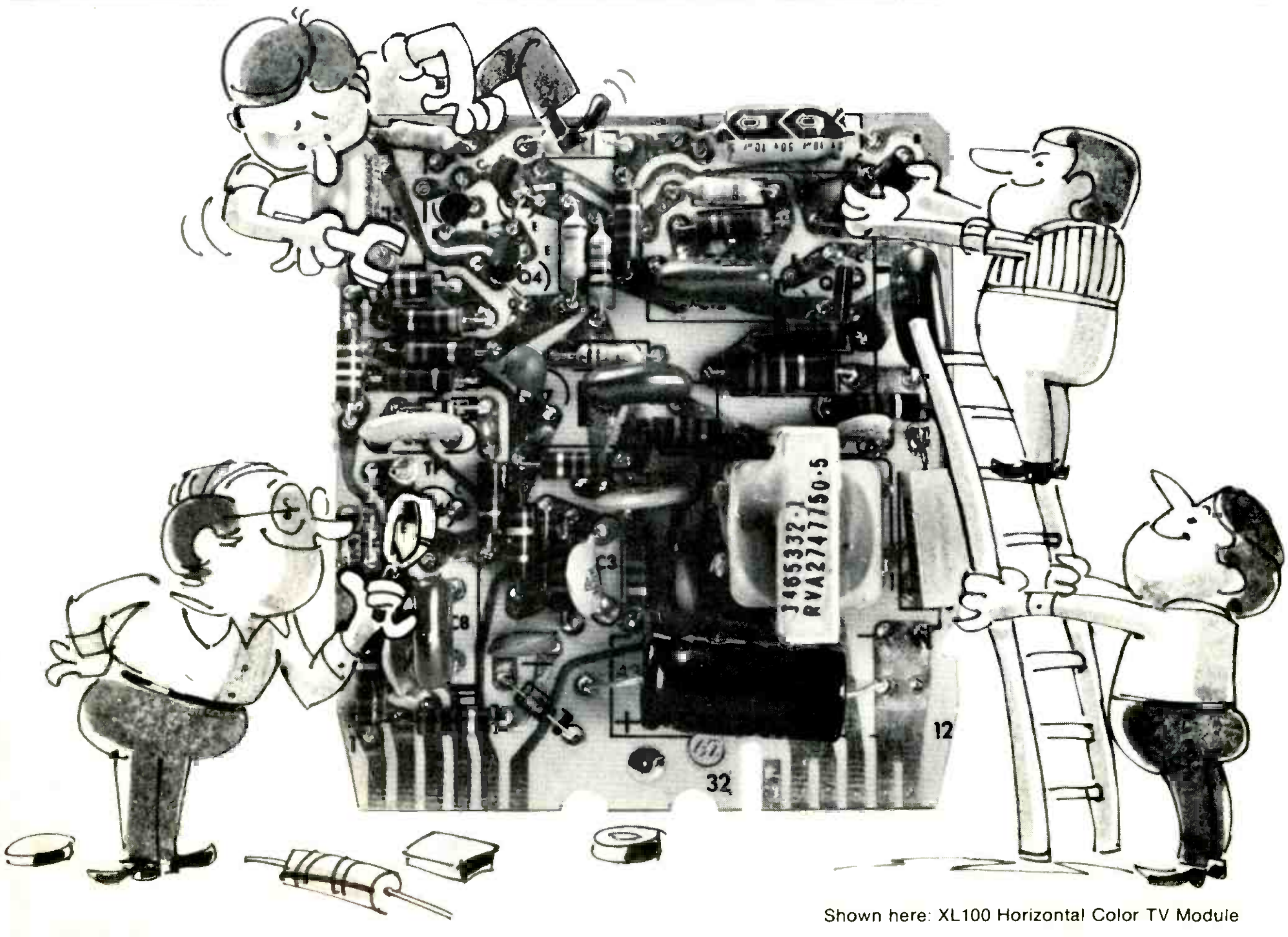
Check B+ supplies to the vertical circuit.

- +27 V (junction of R3156 and CR3106)
- +180 V (PW 3000-M1)
- −30 V (PW 3000-J1)—will read about -37 v when vertical deflection is unloaded (service switch in "service" position).

Step 1. Check Point: Measure the vertical output midpoint voltage (junction of Q3022 emitter and Q3024 collector—PW 3000-Y1); Expected Results: Normal reading is about half of -30 V source voltage (-17 to -18 v); Conclusion: A normal voltage is proof of correct fixed bias on the error amp and normal conduction of the error amp pre-driver and top and bottom drivers. Normal midpoint voltage also proves neither output transistor is shorted.

Step 2. Check Point: Using a 470 ohm resistor, "tickle" the emitter/base junction of the error amp Q3017; Expected Results: This should produce full up and down movement of the horizontal line; Conclusion: This confirms normal operation of the error amp pre-driver, top and bottom drivers, continuity of the yoke circuitry, and again confirms neither output transistor is shorted. Successful completion of this check.

Step 3. Check Point: Monitor the midpoint voltage while momentarily shorting together the emitter/base junction of the



Shown here: XL100 Horizontal Color TV Module error amp Q3017. Expected Results: The voltage should be to +15 V and decay to +1.5 V. Conclusion: This proves the retrace switch Q3020 is turning "on."

NOTE: Do not prolong this check as the retrace switch is saturated. Also, in chassis employing a fixed resistor (R3156, 18 ohm) in place of PTC 3001, the voltage will not decay.

Step 4. Check Point: Short the emitter to the collector on the error amp Q3017. Expected Results: The midpoint voltage should go to the -30 V source potential (about -37 V). CONCLUSION: Full -30 V source voltage at midpoint under these conditions indicates the bottom driver/bottom output stage is conducting.

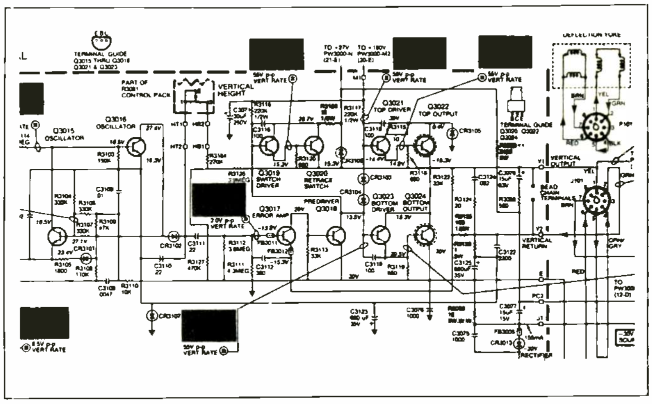
Step 5. Check Point: Measure the voltage drop across the retrace switch Q3020 collector load resistor (thermistor PTC 3001 or fixed resistor R3156). Expected Results: The voltage drop normally is .05 to .1 V. Conclusion: A normal reading indicates the top output Q3022 is conducting. A high reading (around 1 V) indicates a top output Q3022/top driver Q3021 circuit defect (probably open), or a shorted Q3020.

Oscillator operation

The vertical oscillator is a relaxation type: it consists of NPN transistor Q3015 and PNP transistor Q3016. The free-running frequency is determined by an RC network consisting of capacitor C3102 and the combined resistance of R3102 and the vertical hold control.

The vertical oscillator is basically a switch that discharges ramp capacitor C3110. When sync is injected, the oscillator locks to the vertical rate and produces a synchronized scan.

The vertical scan, transistors Q3015 and Q3016 are turned "off," allowing capacitor C3110 to charge. While C3110 is charging, capacitor C3102 also charges; Q3015 is at cutoff until C3102 charges enough to forward bias the emitter/base



of Q3015, at which time Q3015 conducts, applying negative bias to the base of Q3016, driving the device to saturation. With Q3016 conducting, the anode of diode CR3102 is connected to the -15 V reference point and capacitor C3110 discharges to initiate vertical retrace. At the same time, diode CR 3101 is forward biased to discharge oscillator timing capacitor C3102 which turns "off" both oscillator transistors. At turn off, the collector voltage of Q3016 goes to -30 V which back biases diodes CR3101 and CR3102 and vertical retrace starts.

By making the vertical oscillator time constant variable (established by C3102, R3102, and the vertical hold control), its free-running frequency can be set close to 60Hz so that incoming sync will "fire" the oscillator at the correct instant and thus lock it to the field rate.

Step 1. Move service switch to "normal" position.

Step 2. Check for presence of -30 V on both sides of R3110 and -15 V at Q3016 emitter. If these voltages are missing or incorrect, troubleshoot the amplifier circuitry.

Step 3. Check at the anode of CR 3102 for oscillator operation—should be 1 V peak-to-peak sawtooth (ramp).

Step 4. Check sync input waveform at the junction of R3101 and R3108.

Step 5. Check RC network components C3102, R3102 and the Hold control.

Step 6. Check all DC voltages on Q3015 and Q3016 oscillator transistors. ET/D

Symptom Description	Components
Poor interlace	CR 3002 reversed CR 3101 (open)
Vertical jitter	MCK 002A module
Noise lines in picture	Q3017
Insufficient vertical sweep	Q3021 Q3022 Q3017 (shorted) Q3024 R3111 Q3015 CR 3102 Q3018
Retrace lines	R3116 (open) R3043 (up in value)
No vertical deflection	Yoke Q3024 (shorted) Q3017 (open E-B) C3101 (shorted) C3115 (leaky) C3119
No vertical sync	C3101 (open C3109 (leaky)
Heavy retrace lines at top	Q3020 (leaky) Q3019 (short E-B) R3116 (open) Replacement Q3020 installed wrong (see 1979 C-1 or C-5 Service Information Goldenrod)
Raster stretched at top 2 to 3 inches of raster	R3122 (open)
Intermittent vertical roll	CR 3101
Intermittent shutdown after losing vertical deflection	CR 3013
Retrace lines in top half of picture	Q3019 Q3020 (leaky)
Intermittent vertical sweep	C3111 (intermittent short) Q3016
Gradual loss of top half of vertical sweep, Q3020 overheats	R3117 (open) R3112 (open)
Intermittent vertical deflection, foldover lower half	Q3024
Vertical stretches when hot	CR 3102
Vertical overscan and retrace lines in top half of picture	CR 3102 (leaky)
Extreme top and bottom foldover	C3116 (shorted)
Vertical foldover	C3110 (open)
Sweep distorted at top	CR 3104
Reduced vertical deflection, off frequency	Hold control (leakage to case)
Extreme vertical overscan	C3110 (open) CR 3102 (leaky)

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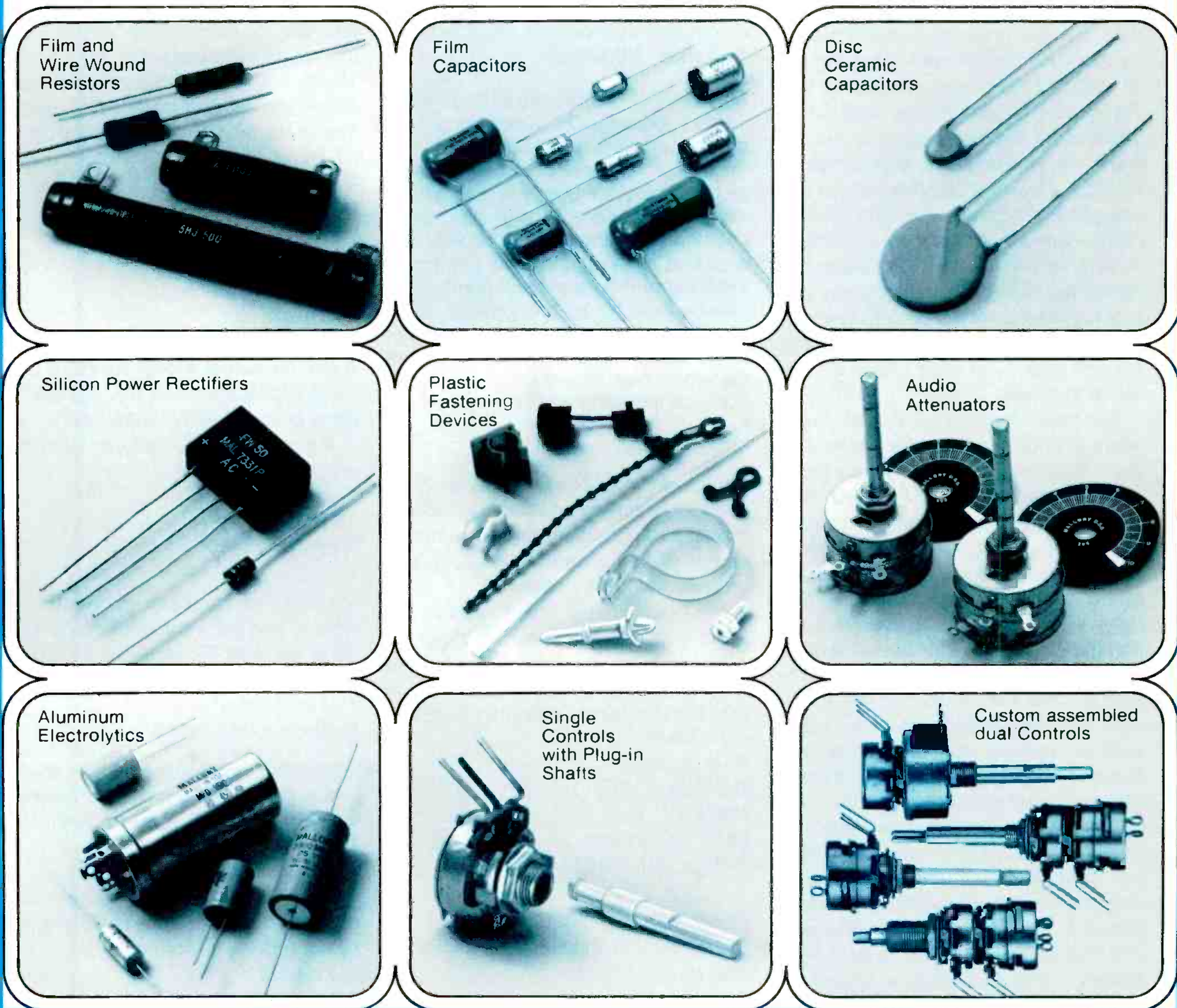

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LETTERS

BOUQUETS:

Just a note to say I enjoy your fine magazine very much and have for many years. For far too many years (18 or more) Computer Technology was purposely made as hard to understand as possible. The effort had to be intended or it would have mellowed and integrated for easy understanding after 4-6 years. The series by Bernard B. Daien is the best I've seen to date and he also states this policy and was carried in our last EEA issue by ETA. This whole crazy field needs to grow up, and efforts such as these will go far towards helping this to evolve. I have been associated with the Consumer Electronics field for 27 years and the biggest problem we have, and continue to have is "wolves in sheeps clothing" leading us to the slaughter! We cannot continue this betrayal or our very existence will be totally threatened. A man installing water softeners will think nothing of making several hundred dollars on a simple installation. His organization encourages this and he may even brag about making 30-50 thousand a year.

Our manufacturers have all these years bragged about how many sets they've sold–often at a loss–many going out of business–Arvin, Packard Bell, Crosley, Tele King, Olympic, Truetone, Firestone, Motorola, Philco, Admiral, Sentinel, all American radio manufacturers, many CB manufacturers, and many more–yet they all have advocated that the Retailer & Servicer follow their policy & do likewise. ETA is designed to help the total field–all technicians–to realize that past policies have not really worked, (simply required the technicians and shop owner to do 3 to 5 times the work that should have been required to make a reasonable wage and profit), nor will it work for the future. We, our total field–(including your trade magazine) must recognize that electronics is not a hobby, it is a business and should be conducted as such from bottom to top! The hobbyist should be left to him for himself as all other fields do. He will exist as he always has but should not be given special importance as has been the case in the past.

I want to thank you personally for the coverage you've given to ETA–our Seminar on Hastings covered in your Feb. issue, etc.

As Sec. and Nat. membership director for ETA I have more than a passing interest in this group and have spent many, many hours working towards its good. The structure is unique to our field and I personally feel that it may well be our last chance to put some order to our field. I'm sorry that I've not taken the time to type this letter–but had a few moments and didn't want to put it off.

In closing–keep up the great work–it is much appreciated by us field technicians and please advise Bernard B. Daien of my very high approval of his series of articles.

If I can ever be of any help–please advise.

George Savage, CET
National Secretary and Membership Director
Electronics Technicians Association
Doniphan, NB 68832

Editor: ET/D has been cognizant since its very inception 26 years ago of the great span between the hobbyist and the true professional electronics service technician. With hobbyist magazines abounding, and with our main competitor now having vacated the field with a public renounciation of the home entertainment/consumer electronics service industry as unimportant, ET/D remains the sole survivor and main supporter of this major and vital segment of the electronics industry.

We do indeed intend to carry the banner.

Enough already! The February issue arrived this morning and I've just finished a solid six hours initial study including a search of the basement for my old texts on split sound detectors.

Poor old brain is "bent" almost beyond tolerance but keep up the good work you're doing a fine job of providing the "Continuing Education" those of us who plan to stay in this screwy business must have.

Best regards,
Bob Buker, CET
Bob's TV
2542 Yellowstone
Billings, MT 59102

HELP NEEDED:

Please publish in your letters section of next issue:

I need a schematic for Philco TV 49-1278 or Sams #92, 93A.

Clingan's Electronic Repair Service
4406 Teen Barnes Rd.
Jefferson, MD 21755

I have an RCA home study kit HSK-T2 black and white TV set in my shop for repairs.

As the company's home study school is no longer in business, I don't know where to order parts. RCA parts needed are 40-757 and 51-137.

Would you know where these parts could be ordered?

Darrell Smith C.E.T.
R.R. 5, Box 116
Portland, IN 47371

P.S.: This same TV set was pictured in the Dec. 1979 issue of ET/D on page 13 with a Heathkit ad.

Editor: These numbers do not check out with any RCA numbers we can find. Can anyone help?

Do you know or any of your readers know who the distributor or company address for International Audio Visual Inc. or Eiki Industrial Co. is. I have a 16mm sound projector that I need a schematic for and parts list. Projector Model No. ST-OH, Sound Board Series ST-O.

Thank you.
W. H. Vanderbilt
Vanderbilt's TV & Refrigeration
Box 143
Lynxville, WI 54640

I need vertical centering control, 15 2W 8 tap, for Singer Model HE-8015 Color TV. Manufacturer part No. 489763-078 (new or used) EVW56AM10BC1.

If any of your readers can help me I would appreciate it.

Eino O. Williams
18 Russell Ave.
Troy, NH 03465

I would like to obtain information on where I can get a schematic for a 12 in. B&W Goldstar TV Model # 310EUB4.

Serra Video
19 Leroy Drive
Burlington, MA 01803

Editor: The model number given sounds like a picture tube number. However Goldstar is at 330 Madison Ave., New York, NY 10017.

I need help in obtaining a schematic service manual (if possible) for a Pilot radio receiver Model G-184.

J. Zevallos
PO Box 369
New York, NY 10001

Help! I need a schematic for a waterman S-17A Pocketscope and/or a tube base diagram for the 3YP1 CRT. The information would be worth any nominal fee.

Mike Mutchka
1031 Findley-4
Pittsburgh, PA 15221

I need service information for a Bradford B&W 9 inch portable Model D-MAT55988–Chassis #H866. I need value and type information on resistor #420 and transistor TR42.
Russell Post
Post TV
154 5th St.
Hudson, FL 33568

Schematic and power transformer for a Philco chassis #91. Any information would be appreciated. Will buy or copy and return.
Barry Braton
707 Arbutus Ave., S.E.
Roanoke, VA 24014

Need for a Zenith Trans-Oceanic radio: 3Q5G, 1LD5, 1LN5, 1LA6, 1LE3. Please state quanity and price.
Terry Satrang
Satrang's Service
424 County Rd. 19
RR #1
Aberdeen, SD 57401

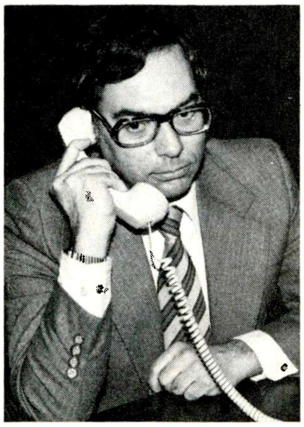
I need service data and parts list for a Zenith Model 2D30-7D30 Extended Stereophonic Hi Fi. Please run this in your letters column. Sams no longer available.
Jim Estes
Electronic Service Shop
922 E. 3rd St.
Jackson, GA 30233

TEKFAX NEEDED:
I need TEKFAX 113 and all volumes before 110. Thanks.
Tom Lutz
614 Edwards St.
Aurora, IL 60605

TEKFAX FOR SALE:
I turned 65 over 11 years ago and had very little need of ET/D but continued subscriptions to get TEKFAX to add to my collection, starting with #1 September 1952 a "Circuit Digest" of Admiral Series N chassis. I have 9 binders to date. I would sell the complete collection it there are any nostalgic TEKFAXians around.
John A. Dipinto
47-19 197th St.
Auburndale, NY 11358

I have TEKFAX from #200 (1958) to date for sale to anyone who wishes to make an offer. Also I have TEKFAX volumes #100, 101, 103, 111, 112.
Richard McDaniel
715 N.E. Ainsworth
Portland, OR 97211 ET/D

FROM THE EDITOR'S DESK



I recently was privileged to spend the most educationally rewarding—and personally astounding—two days I have enjoyed since I became editor of ET/D magazine almost three years ago.

This occasion was as a guest of Mr. Geoffrey Power, the young and aggressive national service manager of the Yamaha Audio Division, at their 1980 National Service Advisory Council held at American headquarters in Buena Park, CA. For three solid days and nights (I was there for only two) the 15 members of the council—all service managers from widely divergent service settings ranging across every geographic sector in the United States, spent most of their time crammed together in a motel room that was really too small, and often too stuffy, discussing areas of mutual concern to their service businesses back home and of equal concern to Yamaha—a worldwide manufacturer. That's right, I said discussing service problems of *equal* concern to Yamaha.

They talked about problems. But more importantly from my standpoint, they talked about what was right with their industry. During this three day period, each participant—some dealer/owners, some independent service shops owners, and some service managers of dealer operations—told how they as professionals ran their service departments and businesses and how they related to other manufacturers across the audio and video industries.

As for myself, an observer attempting to gain insight into the audio service business, it was an eye opener.

Why, I asked when I learned to my astonishment that Yamaha is the only audio manufacturer to conduct regularly scheduled instructional service seminars for its service dealer network, only Yamaha?

Why, I asked, when I learned that Yamaha has been conducting similar national service advisory councils for five years, only Yamaha?

Why, I asked, when I learned that Yamaha has opened up a two-way avenue of communications between itself and the service industry, only Yamaha?

Why, I asked, when I learned that Yamaha marketing people were invited to attend as well as several representatives of competing manufacturers, was Yamaha doing this?

Anyone who as a member of the independent consumer electronics service industry has experienced the "doormat" image of service fostered by far too many manufacturers in the broad spectrum of consumer electronics would—like myself—have to ask: "What is going on here?"

There is no question that Yamaha audio is charging the market hard, annual U.S. sales having grown from about $3 million some five years ago to over $50 million last year. They are a major factor in high end audio.

Mr. Power and his small yet highly skilled and professionally polished national service staff enjoy a unique relationship with Yamaha's marketing and sales divisions. They respect each other as professionals in their own right and consequently they *talk* to each other—regularly. This rather unique relationship in a consumer electronics industry that has seemingly gone bananas for marketing at all costs, has spawned another unusual attitude at Yamaha which has filtered down through the entire national network of authorized Yamaha service/dealers. This is a basic recognition that the service aspect of consumer electronics is to be regarded as a highly skilled profession dedicated toward excellent performance and is—in the final analysis—really a major factor in the overall marketing program. Why? Well, because in high end audio, you see, they sell "specs," not sound. And, these things do have to work right.

Mr. Power, during his five years as national service manager at Yamaha, has developed another "unique" theory about service. "The 1980s," he says, "is indeed the age of service. There is a lot of money to be made in both manufacturing and service—if it is done right."

Doing it right, from his point of view, means satisfying the customer from every conceivable point of view—through product excellence and from the standpoint of a professional, competent, and profitable service industry.

"We are professionals," he will tell you, "but too few people realize this. It is up to us to pull ourselves up and elevate the service industry to its proper status because no one else will do it for us."

With such an attitude, displayed not only through his philosophy but through the *actions* of the Yamaha audio division, I hope I will be excused if—on a scale of ten—I rate Yamaha right at the top.

Why Yamaha?

You figure it out.

Sincerely

Richard W. Lay

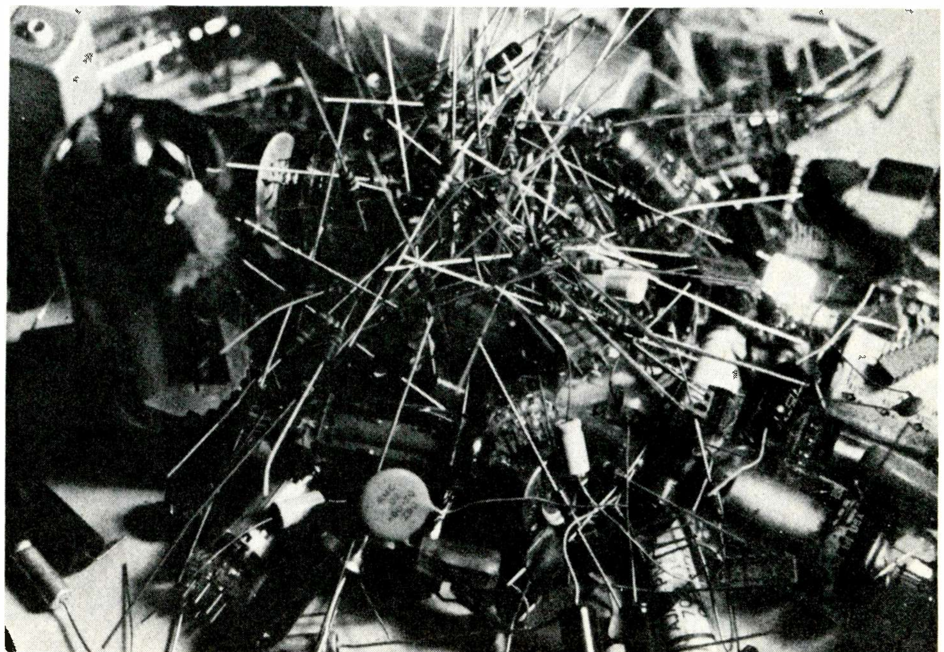
The Tools.
Boker, Crescent, Lufkin, Nicholson, Weller, Wiss, Xcelite.
The right tool makes the job easier. And Cooper makes the right tool for the job. Whether you're making or mending, cutting or joining, measuring or stripping, there's a Cooper tool that's just right. Don't take chances on tools. Specify Cooper and get 'em right the first time!
from Cooper The Toolmaker.
COOPER INDUSTRIES
The Cooper Group
BOKER® CRESCENT® LUFKIN® NICHOLSON® WELLER® WISS® XCELITE®
P.O. Box 728, Apex, North Carolina 27502. Tel: (919) 362-7511. Telex: 579497.
Circle No. 108 on Reader Inquiry Card

Managing repair parts inventories

Too much or too little?

The only two sources of profit for your service business are labor and parts sales. While many shops have attempted to deal with labor and parts pricing systems, the hidden key to parts profitability—inventory management—is often ignored. In this article the author, a veteran of some 30 years in the service industry, shows you exactly how to upgrade your parts inventory system to a high level of productivity.

By William Joseph



Spare parts inventory: Is it eating away your profits?

In many ways, repair parts are the orphans of the service business; not because they merit that status, but, like Rodney Dangerfield, they just don't get the respect they deserve. The fact is that repair parts may be the most underrated asset in our business.

Your inventory of repair parts serves two separate purposes in the successful operation of your service organization. While these functions are interrelated, each is important in its own right and should be analyzed separately.

First, your parts inventory serves as a support arm for the technical services you perform. As you know, electronic service is heavily dependent on the use of repair parts and components. Having the right part at the right place in the right quantity is what parts management is all about.

You don't have to be in the business to understand the frustration that develops when a repair job must be delayed for the lack of a needed part. Just ask any customer who has waited (usually too long) for a service technician to show up, only to be told that a part not carried in the truck is needed for the repair.

While the customer *and* the technician are suffering from the frustration brought on by "lack part-itis," the service dealer must bear the costs of lowered productivity and lost customer goodwill.

Referring to the world of business in general, someone once said, "Nothing happens until somebody sells something." In the service business, we might paraphrase that old chestnut by saying; nothing happens if you don't have the part you need."

The other role played by your repair parts inventory is direct and measureable—it makes (or should make) an important contribution to the *profits* of your business.

It's natural to think of the service business as dealing primarily with labor charges. The truth is that most service dealers must make significant investments in the parts inventories required to support their work, and this inventory plays a more important part in the success or failure of the business than is sometimes realized. Your parts inventory can be a source of significant profits, thus justifying the investment, or it can be a serious-even terminal-drain on profits.

We'll talk about the direct financial aspects of the parts business a little later on. Let's look first at repair parts in their role as a vital support arm for your service operation.

Level of service

Ideally, of course, your parts department would supply a 100% level of service. That is, every repair part would be on hand every time you needed it. Obviously, that objective is impossible to meet because it would require that you stock an infinite number of parts (which would require an infinite amount of money).

On the other hand, you could completely eliminate the need for any investment in inventory by maintaining a zero level of service. This is also unacceptable since the need to purchase each individual part as it is needed would cost far more than maintaining a reasonable inventory; not to mention the incalculable loss of customer goodwill that would result from such a policy.

The object, then, is to develop a repair parts inventory that provides a level of service somewhere between 0% and 100%. the precise point at which that figure should fall depends on such things as the nature of your service operation. The urgency of your parts needs, the cost of the parts you use, and your own interpretation of all these factors.

A business providing service for medical equipment or a fleet of jet airliners will normally demand a higher level of service than would a service dealer repairing TV and stereo sets (although I know a few TV viewers who would challenge the hypothesis).

Let's say that for your purposes you have set 90% as the objective for your level of service. Here's how you can tell how you've been doing: for a given period of time, count all repair jobs for which a part was required. For the same period, count all jobs for which the required part was on hand in your inventory. Then divide the number of on-hand parts calls by total parts required calls, and the result is your level of service.

$$\frac{\text{parts on hand calls}}{\text{parts required calls}} = \text{level of service}$$

Experience in various parts of the industry sets 95% as about the highest level attainable within the constraints of economic reality. And remember, 95% is the *highest* practical level, attainable only by dealers who specialize in a narrow range of products or brands. Most service dealers have to settle for a lower figure. An objective of about 90% is a reasonable goal for most operations.

If you do road calls as well as bench service, you may want to calculate your level of service separately for each. In most cases, road calls will be handled on a somewhat lower level of service because of the practical limitations on the amount of inventory that can be carried in the truck.

If you review the arithmetic involved in calculating the level of service, you will readily see that an increase beyond any given point requires an increase in inventory. In actual practice, this will usually be be a geometric progression; that is, a small increase beyond a reasonable level of service will require a disproportionately large increase in inventory. This relationship has been used in many computer programs to determine optimum inventory levels. When shown in graph form (see figure 1), the impracticality of service levels beyond 95% becomes readily apparent.

Another relationship that has shown a surprising consistency has resulted in what is now called the 80/20 rule in parts usage. That is, 80% of your parts requirements will be met by about 20% of the stockkeeping units in your inventory. This is another good illustration of the price that must be paid in inventory investment in order to reach the higher levels of service. Conversely, any decrease from your current level of service will permit a reduction in your inventory. How, then, do we determine the optimum level of service for your business?

How much inventory?

Unfortunately, customer satisfaction is a subjective consideration that does not lend itself to precise measurements—and it must be balanced against practical financial limits if the business is to survive. And so, in a practicing service organization, inventory level of service will be weighed against another parameter: inventory turns.

Probably the best way to determine your own optimum inventory is through the measurement of turnover. As the name suggests, turnover simply measures how many times the "average" part in your inventory is used (turned over) in one year's time. In general, a range of three to five turns per year will be encountered in well-run parts operations. Many experienced parts managers consider four turns as the optimum figure. This will vary, of course, with the requirements of the service level chosen. Using four turns as your objective, the formula for optimum inventory is:

$$\frac{\text{cost of parts sold}}{4} = \text{optimum average inventory in dollars}$$

Unless your present parts management is better than average, this formula applied to your sales for the past twelve months will probably show that you are carrying too much inventory. If, on the other hand, your actual inventory is far less than the optimum shown in the formula, your level of service is low and may be affecting both technician productivity and customer satisfaction.

This same formula can be transposed to give you a means for measuring how well you are doing in meeting your objectives for turnover:

$$\frac{\text{cost of goods sold}}{\text{average inventory}} = \text{turnover}$$

To determine average inventory, add the *cost* value of inventory on hand at the beginning of the period being measured to the *cost* value at the end of the period; then divide the total of these figures by two.

Please note that these formulas specify cost and not selling value of inventory. Actually, selling value can be substituted without altering the final result, so long as you do not attempt to mix cost and selling value in the same formula. However, generally accepted accounting practices call for the use of cost values when working with inventories and I recommend that you stick to that rule. It simplifies things and lessens the chances for errors.

To illustrate how the formula works, let's say that the cost of parts sold for the past year was $88,000, and that your average inventory during the same period was $25,200.

$$\frac{\$88{,}000}{\$25{,}200} = 3.49 \text{ turns}$$

For periods of less than a full year, the answer must be multiplied by the appropriate factor to get the annual rate. For example, if the figures used were for a six month period, the answer must be multiplied by two to arrive at the effective annual rate of turnover; for quarterly sales, the answer is multiplied by four.

Turnover is a highly regarded means

for evaluating the effectiveness of parts management. If you have a parts manager responsible to you, you would be well advised to review his turnover performance on a regular basis. If you're the one responsible for parts performance, you may want to tear out this page before the boss sees it because *poor turnover means lost profit dollars.*

A turnover less than optimum means that you have invested more money in your inventory than needed to support your requirements. A turnover significantly higher than the optimum figure may seem desirable at first blush, but hold on. When you relate it back to service level, you can see that having too little inventory can be at least as bad as having too much.

If you've been paying attention up to now, you know that the optimum size of your parts inventory is determined through careful consideration of the level of service you would like to provide, balanced by the rigid restraints of your purse strings. Calculating the amount of money that you can afford to invest in your inventory is just a matter of applying the turnover formulas to your own records of sales and inventory. Once you have determined *how much* to buy, however, you still have the job of deciding *what* to buy.

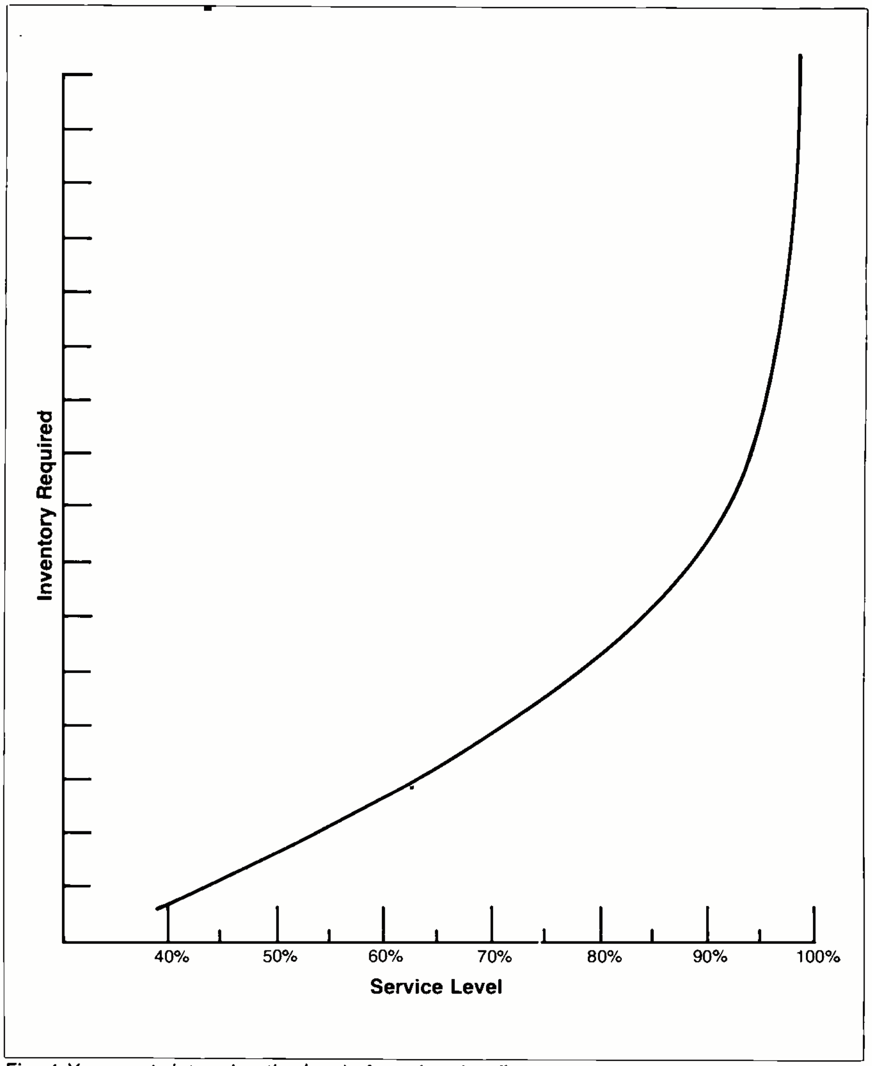


Fig. 1 You must determine the level of service that fits your service situation best and the level of inventory required to maintain that level.

Which parts?

Using the history provided by your records of last year's sales, and a careful application of the formulas for optimum inventory, you could wind up with a theoretically correct inventory that would put you in big trouble. The size of your inventory is, of course, vitally important. However, knowing *how much* to buy is not enough; you must also know *what* to buy.

The cruel fact is that computing how much inventory to buy is kid stuff compared to the job of determing specifically which parts to buy, and in what quantities.

Record keeping does not rank very high on the list of favorite activities for most service dealers that I know, but when it comes to inventory control for repair parts, an accurate set of records is an absolute must.There is no other way to fulfill the requirement mentioned in the opening paragraphs of this article: The right parts in the right place in the right quantities.

Specifically, your parts operation must include a system that will record the use of each part you carry, and the parts that you must special-order. Only then can you determine the demand for any given stockkeeping unit (SKU). As I pointed out earlier, once you have determined how much you can afford to invest in your inventory, you must then make certain that you select the fastest moving SKU's for stocking.

There are, of course, an infinite variety of record keeping systems in use to supply this information. If you are part of a large corporation, you will almost surely have the advantage of a computer program for inventory control. Because of the amounts of detail required to do a good job, many smaller companies are turning to time-sharing computer arrangements available commercially or through trade associations such as The National Association of Retail Dealers of America (NARDA).

As with most record requirements, though, there are perfectly adequate manual systems that have been around since long before the first computer arrived on the scene. The so-called perpetual inventory system can be kept quite successfully by simply entering the necessary information on a control card designed for the purpose. Normally, a card will be maintained for each SKU.

In the final analysis, it makes no difference whether your system involves a sophisticated and complex computer program, or entries on ordinary 3×5 index cards, as long as it provides you with the information you need to make well-informed management decisions. Repair parts control cards specially designed for manual inventory control entries are available from such companies as VISIrecord Systems of Worcester, Massachusetts, and Acme Visible Records of Crozet, Virginia. Acme Visible's line includes special cabinets designed to provide ready accessibility to each card in the system.

Normally, a parts inventory control card will carry the part number, source or manufacturer, cost, and columns to record usage on a monthly basis:

- *Number on hand*
- *Number sold current month*
- *Number sold last month*
- *Number sold prior month*

This sort of arrangement allows you to see 90 days (one-quarter of a year) usage at a glance. Average annual usage can then be calculated simply by multiplying this figure by four.

The purpose of all this, of course, is to provide you with the information you need to identify the specific parts that you should be carrying in your inventory. If you have set four turns as your goal, you will stock every part that moves at least once every three months. In actual practice, an average inventory turnover of four will permit you to stock some parts that move less than four times because many parts will turn over at a much faster rate. Accurate records will help you to make sound decisions on which of the slower moving parts you can carry while still maintaining your average turnover objective.

Inventory deletions

Another purpose of the perpetual inventory system is to single out SKU's that should be eliminated from your inventory because they are no longer moving at the required rate. Since optimum inventory size is fixed by formula, any parts with little or no movement that are allowed to remain in your inventory take the place of parts that you should have on hand.

Once these obsolete parts are identified through your records, they should be marked-down (removed from your inventory both physically and in your records). Policy in larger companies will usually require that parts marked out of inventory be immediately destroyed and discarded. Of course, any parts that may be returned to your supplier for credit should be sent back.

If your company policy permits, parts marked out of inventory can be held. However, when such parts are sold, proper business and tax considerations require that the entire selling value be taken as income (zero cost).

Many business owners and managers, though, frown on the practice of retaining any merchandise once it has been marked out of the inventory. Repair parts held on the premises once they have been officially removed from the inventory records can be a temptation for employee pilferage. Also, the fact that some parts are in the inventory and some are not can lead to errors and confusion in record keeping and inventory control.

Out-of-stocks

Now that you know how large your inventory should be, and specifically which parts you should stock, you must see to it that those parts are on hand in sufficient quantities when they are needed. An empty parts bin is just as bad as no parts bin at all.

Keeping in stock is done through a disciplined ordering system based on the proper "order quantity" (OQ) and "minimum quantity" (MQ). Let's take a look at minimum quantity first.

MQ is simply the point at which it is time to place an order. The MQ may be written on the control card, on the parts bin, or on both. Let's say that the MQ assigned to a given part is eight. When the parts clerk notices that the quantity in the bin is down to eight, an order for a new supply is promptly placed. If the MQ has been properly determined, the replenishment stock will normally arrive before the on-hand quantity reaches zero; thus avoiding an out-of-stock condition.

The formula for determining MQ will depend on your own objectives and on the average time it takes to receive parts after they have been ordered. Assume that your records show an average to two weeks from the time parts are first ordered until they are received. In this case, you may decide to establish a two week supply as your re-order point (MQ), or you may prefer a three week supply to provide a safety factor.

Depending on the number of different sources from which you order, you may well have a number of different lead times for establishing MQ's. If, for example, you order many or all of your SKU's from a local distributor who provides dependable next-day service, you may well operate with a one week supply, or less, as your MQ on those parts.

If, on the other hand, the bulk of your parts are ordered through company channels or out-of-town sources, you will need to establish MQ's related to your experience with order life cycle.

The other half of your professional reorder program is the calculation and proper use of the order quantity (OQ).

Once your MQ signal has told you that it's time to re-order, you must decide on the proper quantity to order; this is your OQ.

One basis for determining OQ makes use of a figure known as insight. Insight is simply the total of the quantity on hand plus the quantity on order. Managers striving for four turns per year often establish three month's supply as the insight. Using your earlier example of a two week minimum quantity, that would leave a ten week supply as your order quantity. Thus, your insight at re-order time would be the two weeks on hand plus ten weeks on order for an insight of twelve weeks.

Remember, since MQ and OQ are based on actual usage of each part, they must be calculated separately for each part. In actual practice, you may have a number of different order life cycles from widely varied sources and manufacturers.

Special circumstances

The precise mathematics of minimum quantity and order quantity should not be treated as inviolable. Special circumstances such as seasonal fluctuations may call for you to massage the figures a bit from time to time. That's perfectly OK as long as it's done to permit the flexibility that would be lacking if you followed rigid rules without regard to changing circumstances.

For example, the frequency of ordering very low-priced items must be considered in light of the cost of preparing an order, receiving it, placing the parts in bins, etc. Careful consideration of these costs may lead you to conclude that the cost of carrying a one year's supply of some low-priced items would be less than the expense for ordering them four or five times throughout the year. In such a case, you may want to establish a one year's supply as your insight. Some examples of this type of part would be nuts, bolts, inexpensive gaskets and the like. Please remember, though, that this procedure must be an *exception* to your normal parts policy. Too much inventory can cause a lot of red ink.

A different problem is the SKU that is very large and bulky, requiring a disproportionate share of the space available for your inventory. In deference to the harsh demands of the real world, you may decide to stock a smaller quantity of this type of part than your formula calls for.

In actual practice, there are an infinite number of variations on this basic theme. What really matters is not so much the specifics that you use to establish your MQ's and OQ's, but that you *understand* the principles behind the simple arithmetic involved, and that you apply these principles in the manner that best serves the needs of your own organization.

Let me digress here long enough for a little reminder: You would do well to remember that your efforts to establish a professional inventory control system will be for naught if you and your people do not observe your reorder points and order quantities with meticulous care. If a parts order is not triggered as soon as the MQ is reached, a costly out-of-stock condition will usually result.

One simple system that can help to keep you on the straight and narrow is the divided parts bin. It requires only that each parts bin or container be divided into two sections. The smaller section contains the minimum quantity; the rest of the bin holds the balance of the stock. When it is necessary to take a part from the MQ section of the bin, it's time to re-order.

Stocking the truck

Normally, every part that is carried in your trucks is also carried in your regular bin inventory. Seldom, if ever, though, will every part in bin inventory be carried in trucks. Working up the proper sub-assortments to carry in your trucks, then, is a kind of spin-off of the basic job of selecting inventory.

The principles of good inventory control are precisely the same for stocking service trucks, except that the need for good recrods and careful control is even greater than for your regular inventory. The time of your service technicians is the most valuable commodity with which you will deal, and the waste that occurs when an outside technician needs a part that is not carried in his truck is compounded by the time and expense involved in his traveling.

The place to begin inventory control in service vehicles is in the vehicles themselves. A neat and orderly set of bins and shelves is an absolute requisite if top efficiency is to be expected. Every day, in the best of families, service technicians write lack-part calls when the needed part is in the truck all the time. A disorderly hodge-podge of parts scattered about in a service truck is a standing invitation to customer dissatisfaction and lost profit opportunities.

Maximum productivity from your truck stocks requires that all parts bins in the trucks must be numbered and that the placement of parts in these bins be standardized. Many service dealers also provide each road technician with an up-to-date printed list of the parts carried in his truck. These procedures not only minimize the chances of overlooked parts, they also make it a great deal easier to maintain accurate records.

Truck vs. shop stocks

For the most part, the fastest moving parts in your shelf inventory will be the most likely candidates for your truck stocks. However, you cannot rely on that rule-of-thumb to do the job for you. The work performed on outside calls will be different enough that parts usage in trucks must be analyzed separately.

Because the parts carried in your service vehicles are a part of your total inventory, they will have to fit within the limitations imposed by your overall policy on service level and turnover. You will want to remember, though, that a lack-part call on the outside will usually be more costly than would be the case for a shop repair.

For years, four turns per-truck-per-year was a familiar standard for stocking service vehicles. Today, with the cost of lack-parts calls climbing at a breaktaking rate, many service dealers are lowering their requirements to as little as two, or even one, turn per-year-per-truck. Where truck inventories were always well under $1,000 selling value a few years ago, inventories of $3,000 and more are not at all uncommon today.

The basic purpose of truck stock inventories is to keep lack-parts calls to a practical minimum, consistent with the cost of carrying the inventory. In some types of service operations, a goal of 5% or less lack-parts calls is not unreasonable. However a figure of 7 to 10% probably represents a more realistic objective for most electronic service dealers.

Lack-parts calls cost money; so does maintaining an inventory. As one service dealer puts it, "It costs you money to have a good inventory—it costs you money if you don't have it." Some dealers are losing *both* ways (by having lots of the wrong inventory).

Industry studies indicate that the average cost of maintaining an inventory of repair parts runs a little better than 2% per month (about 25% per year). This is the cost for such things as interest, taxes, overhead, insurance, obsolescence, and other items in the cost-of-doing-business. What it means is that a part that sits on your shelves for one year has actually cost you 125% of its original cost. Any parts that sit on your shelves for four years have cost you more than double what you originally paid for them (without even counting inflation). Obviously, these costs must be measured against the expenses incurred as a result of lack-parts calls in order to determine a reasonable level of service for your truck stocks.

Parts department profits

In order to generate a respectable profit from your investment in parts inventory, it is necessary only that you "buy right and sell right." Buying right is what we've been talking about up to now. Here are a few more tips on buying:

Beware of "package deals." Your suppliers have to deal with the same laws of economics as you do. When they find themselves with obsolete or slow-moving merchandise, they can unload them on you by putting together tantalizing "attractive" package deals. What does it matter how cheaply you may have purchased a supply of parts if they remain on your shelves unsold? And don't forget; while they are sitting there, they're accumulating expense to the tune of 25% per year.

Take every opportunity to return surplus parts to your sources or suppliers for credit. Make it a point to learn the exact surplus returns policy of every supplier with which you do business, and then be sure to take advantage of every chance to purge your inventory of unwanted SKU's. Cleaning out your inventory this way gives you the double benefit of a full or partial credit, plus the room that is created for inventory that will sell.

Parts pricing

Just as the amount of inventory that you buy must be carefully calculated, so does the amount you charge for those parts when you sell them to your customers. Careless, unprofessional pricing of repair parts is a common malady in service organizations—one that is responsible for the loss of untold profit dollars.

In order for you to do a professional job of pricing your repair parts, you must have a clear understanding of the basic terms involved, and their relationship to each other. The ones you will be working with most often are:

Markup. This is a term often confused with the term mark-on. If you pay one dollar for a part and sell it for two dollars, your markup is 50% not 100%. markup simply expresses the difference between the cost and the selling *as a percentage of the selling price.* Stated differently, cost of the goods plus markup equals selling price.

As you can see from the definition, *100% markup is not possible unless your cost for the item is zero.* Yet, you will frequently hear complaints about the merchant who gets "100% markup" for his goods. The mark-on (a seldom used term) in the example above is 100%.

Cost of goods. This is the actual price you paid for the goods, plus any direct buying expenses such as transportation costs.

Gross profit. This term is used to describe the difference between the cost of the goods and the selling price, less any allowances or returns. The gross profit in our example is one dollar.

Net profit. This is the final profit remaining after all other applicable expenses have been deducted from gross profit. The chances are that you will have to be satisfied with a determination of gross profit for your parts business. Computing true net profit for a specific department or portion of a business is an extremely complicated affair. It requires that all expenses for the business by precisely pro-rated, and this can be a nearly impossible task for anyone other than a qualified cost accountant. True net profit for the entire business, of course, is easy enough to compute. It is simply *all* expenses subtracted from *all* income.

These descriptions are necessarily brief and lacking in some important details. Your accountant (or a member of the accounting department if you work for a large company) will be able to round out your knowledge of these basic accounting terms. As they are presented here, however, they will be all you'll need to understand pricing fundamentals.

Pricing errors

The most common parts pricing error is the simplistic "across the board" markup. This approach requires that all parts, no matter what their price range, be priced at double their cost (or some other fixed multiple). This is a self-defeating system, particularly if you have a parts manager whose effectiveness you are trying to measure through his ability to generate gross profit for the business.

If you always set your selling price by doubling the cost, your gross profit will always by 50% no matter how carefully your parts manager makes his buys. In fact, if he is an especially shrewd buyer, you will actually make less profit.

Let's say your company has been paying $4.00 for a given part and that you have been selling it for $8.00. In this case, your 50% gross profit amounts to $4.00. Now let's say that your conscientious parts manager has found a supplier who will sell him that same part for $3.00. Your system of doubling the cost will now result in a selling price of $6.00. That same 50% gross profit now amounts to only $3.00. Dollars go in the bank, not percentage points.

There is nothing wrong with setting an *average* 50% markup as the objective for your parts business. It is, in fact, a widely accepted figure. However, the word "average" is an important key.

By their very nature, some parts may appropriately take much higher markups that others. For example, parts costing less than a dollar or two may require markups of 60, 70% or even higher because of the ratio of handling expense to selling price. Conversely, very expensive components such as picture tubes, complete circuit boards, etc. will generate quite satisfactory profits with less than your average markup.

As you know, there is some controversy over the value of the "recommended" or "list" prices furnished by the manufacturers of some parts. Whatever your position on the matter, these prices can supply good reference points for studying markup and setting your own prices.

A final word about pricing repair parts. Because of the consumer's universal dislike of paying for intangibles such as labor, too many service dealers have given way to the temptation of charging unrealistically high prices for parts in order to present the appearance of low labor rates in the final bill to the customer.

In addition to the serious moral, ethical, and legal implications of this practice, it's simply a lousy idea. A skilled electronic technician is a true professional in today's business world, and charging properly for his services is a responsibility to the profession.

As a service organization, you have two products to sell: skilled labor (see ET/D January 1980) and repair parts. Each must stand alone in a professional organization. Parts and labor are made up of separate ingredients; the pricing of each must be based on sound business principles. **ET/D**

Digital equipment power supplies

Basics and special requirements

Digital circuitry often places rather stringent requirements on associated power supplies. Here are methods used to solve the regulation and filtering problems these circuits present and a few trouble-shooting hints.

By Joseph J. Carr

The dc power supplies used in modern digital equipment must be regulated. It is not tolerable for dc voltage levels to vary markedly with changes in either load current or ac input voltage. The problem is aggravated somewhat by the fact that digital circuits use pulses, so the changes in load current are very rapid.

Different microcomputers often have very similar power supply requirements, even though the power specifications of the different IC logic families are quite different. TTL, for example, requires a well-regulated +5 volt dc source. The voltage level officially must be held within ±250mV, although experience has shown that many of the complex-function TTL devices become a bit flaky if the voltage is not 5 volts ±50 mV. Typical CMOS (and the related PMOS/NMOS) devices are quite happy with power supply voltages in the ±4.5 to ±18 volt region. Note that both positive and negative supplies can be used, although most use a positive voltage (+4.5 to +18V) and ground. When operated at +5 volts, however, the devices become somewhat more compatible with TTL.

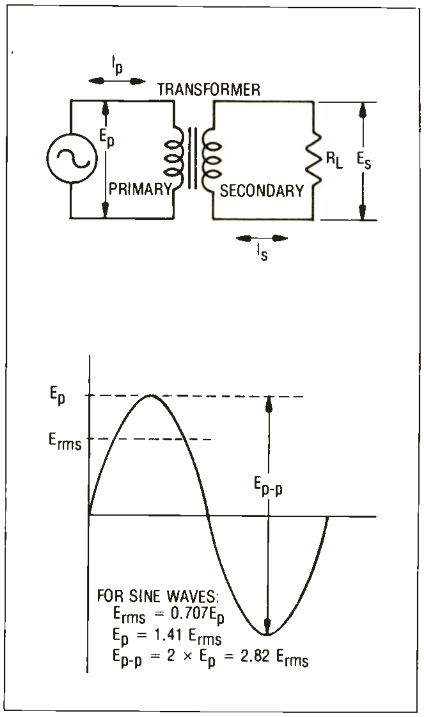


Fig. 1 A) Transformer circuit B) Voltage relationships

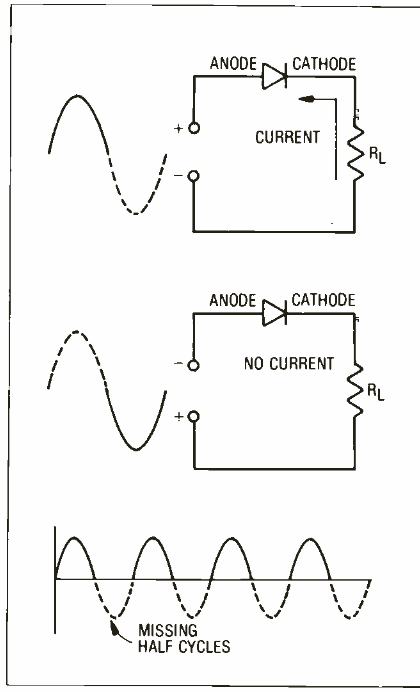


Fig. 2 Half-wave rectifier A) On positive half of input cycle, B) on negative half of input cycle, C) output waveform across R_L

CMOS and TTL also differ in their respective current requirements. Most TTL devices require between 15 and 25 milliamperes, while most CMOS devices are happy with as little as 50 microamperes. A digital computer made almost entirely of CMOS/PMOS/NMOS devices, then, requires only a lightweight power supply. But if an equivalent computer uses an appreciable number of TTL devices, then a high current +5 volt dc power source is required.

A typical microcomputer will actually have several power supplies on board. Several might be low current (i.e. 1 amp) circuits: ±12 (or ±15) volts, and (sometimes) −5 volts dc. In addition, there will be a high current power supply.

Two different protocols are in evidence regarding the high current power supply. In some machines, the power supply on the mainframe will be +5 volt operating level to the various PC cards in the computer. The other protocol uses an 8 to 10 volt unregulated supply on the mainframe, and then depends upon 1 to 3

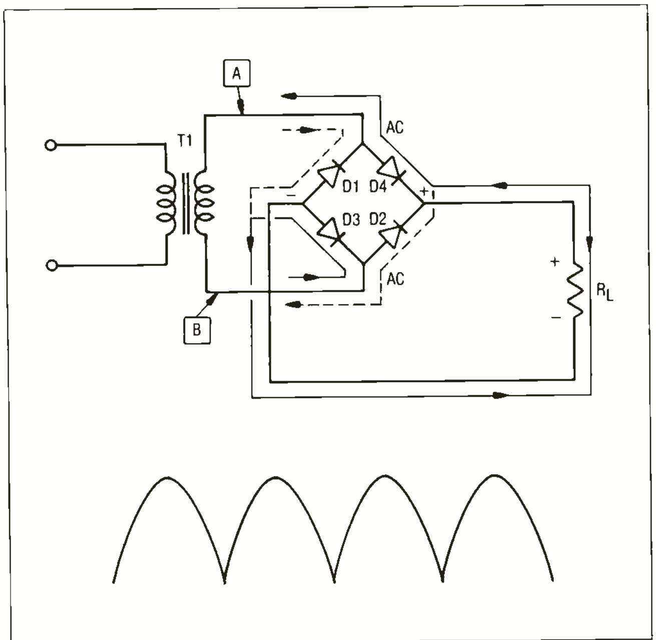


Fig. 3 A) Full-wave rectifier using center-tapped transformer B) Output waveform

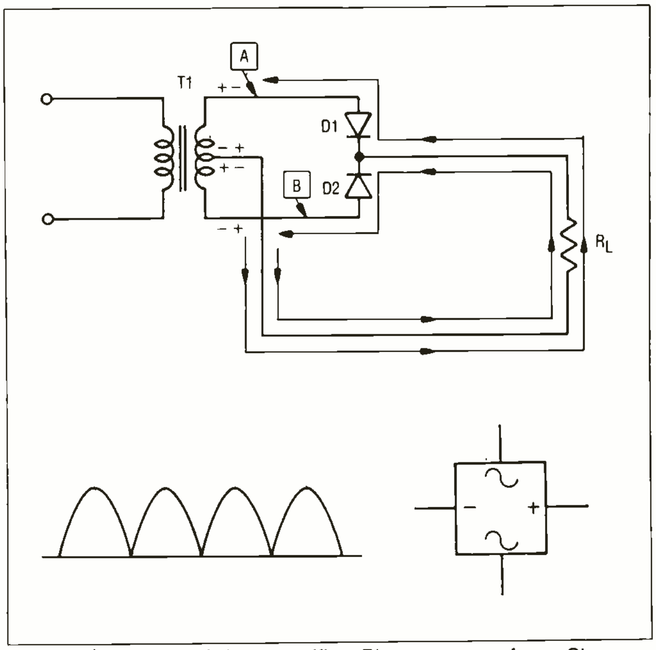


Fig. 4 A) Full-wave bridge rectifier, B) output waveform, C) prepackaged bridge rectifier.

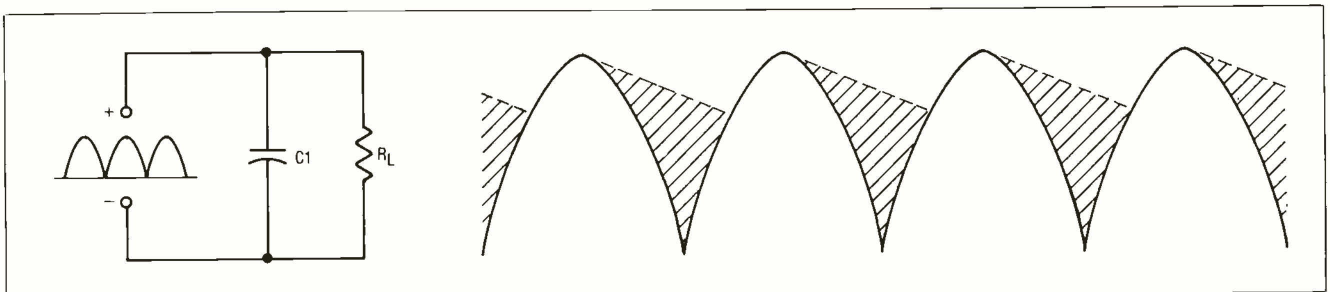


Fig. 5 A) Simplest form of power supply filter B) Solid lines show output waveform without capacitor C1, dotted lines show waveform with C1 connected. Shaded area represents energy dumped back into the circuit that had been stored in C1.

ampere, monolithic IC regulators on each PC card to supply the +5 volts. This system is sometimes called distributed regulation, and has shown certain advantages.

Power supply basics

Before studying the basic forms of regulator circuits used in microcomputer power supplies, let's first review some of the basics of low voltage dc power supply circuits.

Transformers. The transformer (Fig. 1A) is used to scale the 110 volt ac power line voltage down to the level required by the circuit. The transformer for most solid-state circuits, including digital circuits, must be a step-down type; i.e. the secondary voltage E_s is lower than primary voltage E_p. In microcomputer applications, the transformer E_s will be 6.3 – 7.5Vac for the +5 volt supply, and 25 – 26 Vac for the ±12 volt supplies.

Transformers operate only from ac sources, and will probably burn out if connected to dc mains (not very common in the public mains, but still found in some factories). Transformers will obey the eollowing relationship:

$$\frac{E_p}{E_s} = \frac{I_s}{I_p} \qquad (1)$$

Note from Eq. (1) that the current ratio is the inverse (i.e. it is upside-down) of the voltage ratio. A transformer that steps a voltage down will apparently step the current up. This sometimes causes confusion among new members of the electronics trade, because it doesn't square with observations. In truth, the secondary current I_s is determined solely by load resistor R_L and the secondary voltage E_s (remember, Ohm's law). It sometimes helps to express Eq. (1) in another form:

$$I_pE_p = I_sE_s \qquad (2)$$

We can see that the two sides must be balanced, so if I_s goes up, then I_p must also go up in order to keep the balance in effect.

Note that neither Eq. (1) nor Eq. (2) contains any term that expresses losses. Since most common transformers are 95 to 99.9 percent efficient, we are quite justified in using such a simple expression; the error terms are negligible.

Transformers have several different ratings. In addition to the primary and secondary voltages, and the secondary maximum current, there is also something called a primary VA rating. This is not too important in many servicing applications, especially where a transformer manufacturer provides a crossover number. But in some industrial digital servicing, we know for example that a 6.3/7.5 volt ac transformer is needed, so can make our own crossover from ordinary stock filament transformers. Here the primary VA rating is critical. We consider the primary VA rating (even in the light of Eq. 2) because the primary is usually wound closest to the core, and therefore does not dissipate heat as fast as the secondary. The primary VA rating is the product E_p times I_p (max), and cannot safely be exceeded. Some people try to get away with it, but this is possible only when the manufacturer has rated the transformer *conservatively*.

Note that all transformer voltage and current ratings are the rms values (Fig. 1B).

Rectifiers. A rectifier will pass current in only one direction; a useful property that allows them to convert ac (bidirectional) to pulsating dc (undirectional). The simplest form of rectifier is the halfwave rectifier of Fig. 2. On the positive half of the input ac (see Fig. 2A), the diode is forward biased, and so will conduct current. On the negative half-cycle, however, the diode is reverse biased, and will not conduct current (Fig. 2B). The output waveform shown in Fig. 2C is undirectional, even though it cannot be called pure dc as yet. It is called pulsating dc. Because of the missing half-cycles, the average output voltage is only 45 percent of the applied rms voltage. This means that a transformer used in a halfwave rectifier circuit must be able to deliver a primary VA rating (i.e. power) 40 percent higher than in the fullwave case.

There are two main reasons why the halfwave rectifier is not used extensively in digital power supplies: it is inefficient and it requires a much larger filter to smooth out the pulsations.

A simple fullwave rectifier is shown in Fig. 3A; it uses two diodes and a transformer equipped with a center-tapped secondary. If the center-tap is taken as the zero-reference point, then (on any given half-cycle) one end of the secondary will be positive with respect to ground, and the other is negative. On one half of the ac cycle, point A will be positive and point B will be negative. In that case, diode D1 will be forward biased, and D2 is reverse biased. Current flows from the center-tap, through load resistor R_L, diode D1 back to the transformer at point A.

On the second half of the applied AC cycle, the situation becomes reversed: point A is negative and point B is positive. Diode D1, then, is reverse biased while D2 is forward biased. Current flows from the center-tap, load R_L, diode D2 and back to the transformer at point B.

It is important to note that the *current flow through the load* is in the same *direction* on both halves of the ac cycle. This action produces the characteristic double-humped waveform of Fig. 3B. The average output voltage is twice that of the half-wave case; i.e. $2 \times 0.45 - =$

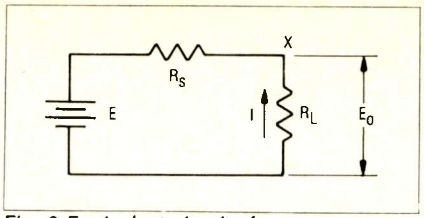


Fig. 6 Equivalent circuit of any power supply

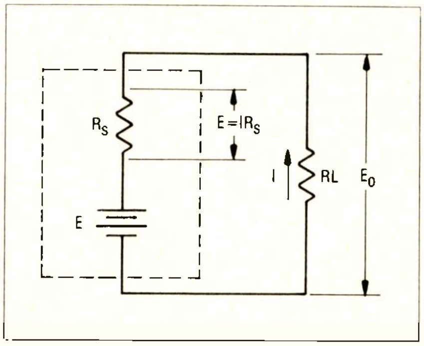


Fig. 7 Ditto from Fig. 6

0.90, or 90 percent of the rms.

A fullwave bridge rectifier is shown in Fig. 4A. This circuit does require two additional diodes. Note that probably a majority of the digital equipment power supplies use fullwave bridges instead of the regular fullwave rectifier.

On one half of the ac cycle, point A in Fig. 4A will be positive with respect to point B. In that case, diodes D3 and D4 are forward biased, and D1/D2 are reversed biased. Current flows from point B, through diode D3, load R_L, diode D4 and back to the transformer at point A. On the second half of the ac cycle, the situation reverses; point A is negative with respect to point B. Diodes D3/D4 are reverse biased and D1/D2 are forward biased. In this case, the current flows from point A, through diode D1, load R_L, diode D2 and back to the transformer at point B.

Once again we see that the current through the load resistor is in the same direction on both halves of the ac input cycle. The output waveform in the bridge rectifier (Fig. 4B) is the same as in Fig. 3B. Again the average output voltage is 0.9 times the applied rms voltage.

Remember that we do not need a transformer center-tap with the bridge rectifier. The zero-volts reference point is designated as the junction of the anodes of D1 and D3. This point is labelled negative (−), while the junction of the cathodes of D2 and D4 become the positive (+) point. Most equipment uses prepackaged bridge rectifiers (i.e. as in Fig. 4C), on which the +, −, and ac terminals are

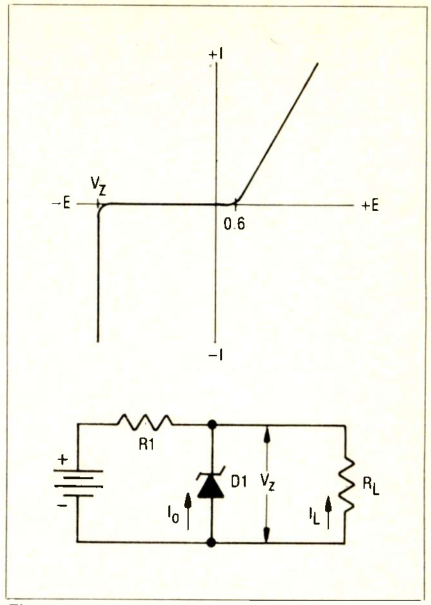


Fig. 8 A) Zener diode curve B) Typical Zener regulator circuit

marked. Note that either the sinewave symbol shown in the example (4C) will be used, or the letters "AC."

With any given transformer, the bridge rectifier will produce an output voltage *twice* that of the simple fullwave circuit of Fig. 3. This is because it uses the entire secondary winding of the transformer on both halves of the ac cycle. But unless the transformer is especially designated for bridge rectifiers,then we must draw only *half* of the allowable secondary current. Otherwise, the primary VA rating will be exceeded. The full "rated" secondary current can be drawn only when the regular center-tap fullwave rectivier circuit of Fig. 3 is used. The rating for bridge service will be one-half of this value.

The rectifier diodes used in digital equipment low voltage, high current, power supplies tend to be "horses." Of course, the low current supplies will use 1 amp diodes in the 1N4000 class, but that high current supply may very well use stud-mounted individual diodes, or a big bridge pack.

Filters. Most electronic circuits cannot use pulsating dc. They require instead pure, or nearly pure, dc. The pulsations are called *ripple* (which in this case is not a wine). Ripple is expressed both in *percent* and by *frequency*. Halfwave rectifiers have a ripple factor of 120 percent, and a ripple frequency (number of humps per second) of 60 Hz. Both fullwave rectifiers have a ripple factor of 48 percent and a ripple frequency of 120 Hz (in the USA and other countries with 60 Hz ac power mains).

A *filter* circuit is used to smooth the

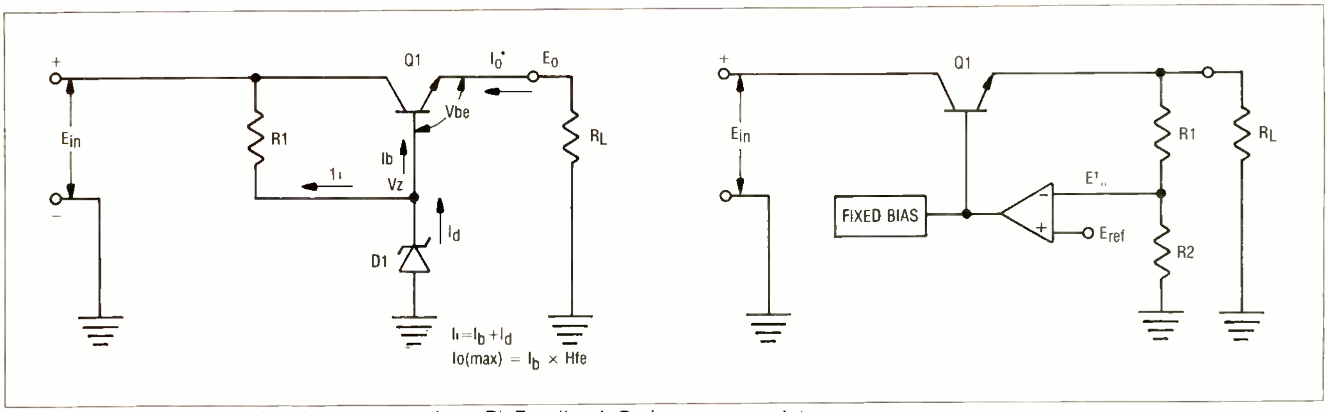


Fig. 9 A) Zener-referenced series-pass regulator B) Feedback Series-pass regulator.

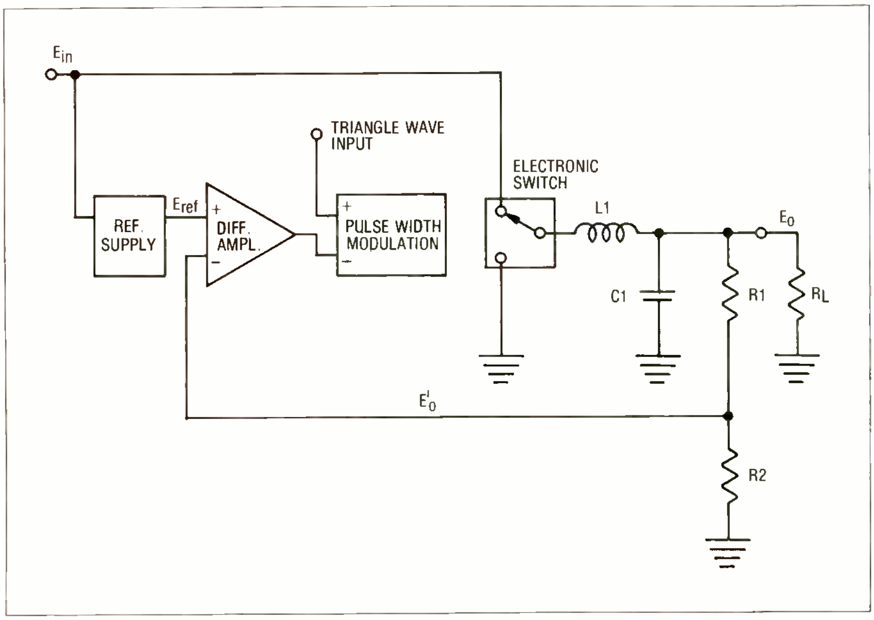


Fig. 10 Switching regulator

pulsations to produce nearly pure dc. In the simplest case of Fig. 5A (most often used in computer power supplies), the filter capacitor C1 is across the rectifier output, in parallel with the load. The action of the filter capacitor is shown in Fig. 5B. The solid line indicates the pulsating waveform without the filter, while the doted lines show the output waveform with the filter capacitor connected. Capacitor C1 will charge to approximately E_p. But after the peak has passed the charge in the capacitor will return to the circuit; i.e. it is dumped across the load. The effect of the charge returning from C1 is to fill in the area between pulses (shaded zone in Fig. 5B). The filter reduces the ripple factor to a low value.

The value of capacitor C1 is critical in the correct operation of the circuit. In general, the required minimum value of capacitor C1 is higher in halfwave circuits than in fullwave (due to the difference in ripple factor, 120% vs 48%). For low voltage power supplies, C1 should be at least 500 µf (up to 500 mA), or 1000 µf (to 1 amp). For supplies delivering over 1 ampere, the rule of thumb is *at least* 1000 µf/amp, with some authorities asking for 2000 µf/amp. This means that the minimum value of the filter capacitor in a 12 amp computer power supply (i.e. +5 volt) is 1000 µf/amp times 12 amps, or 12,000 µf (with some asking for 24,000 µf!). Most microcomputers currently on the market beat this minimum by a considerable margin; i.e. they use power supply filters in the 30,000 100,000 µF range.

The circuit of Fig. 5A accurately represents the mainframe supply of machines using distributed regulation. Even if the filter capacitor is grossly oversize for the current load, however, some small amount of ripple will remain. A voltage regulator circuit will reduce that ripple almost down to nothing, even though its main function to maintain the output voltage at a defined level. This has lead some manufacturers to claim, for their low-voltage dc supplies used on service benches, that they had a "filter capacitor amplifier (?)" that made the 10,000 µf capacitor look like 1 farad! I bet that readers in the auto electronics business long enough to know what an OZ4 is remember that claim! What they referred to was the fact that their supply used a voltage regulator, and it reduced the ripple to a point that would require a 1 farad capacitor to duplicate.

Practical power supplies

A "typical" power supply for small microcomputers, and microprocessor-based digital instruments will deliver either ±12 Vdc, or ±15 Vdc, and −5 Vdc at 1 ampere on the low current side. There will also be a high current, +5 volt, regulated power supply for TTL devices. The high current power supply might deliver as little as 1 to 3 amperes in very simple, small scale, devices, or as much as 200 amperes in large mainframe computer power supplies. Most, though, seem to be rated in the 5 to 25 ampere range; 10 to 12 amps being especially common.

A principle requirement of computer/digital power supplies is good *voltage regulation.* It seems that all dc power supplies have a certain amount of internal, or *source,* resistance (R_s). When a load current I is drawn from the power supply, then a voltage drop $I \times R_s$ = E will occur across the internal resistance.

The value of the internal resistance can be "determined" by using Ohm's law. The voltage used in the calculation is the power supply open-terminal (i.e. load disconnected) voltage. This voltage is measured with load R_L disconnected, and the output current is zero (see Fig. 6). The current used in the calculation is the current that would flow if the output were short-circuited (i.e. R_L = 0). DON'T ACTUALLY TRY THIS... few power supplies can withstand an

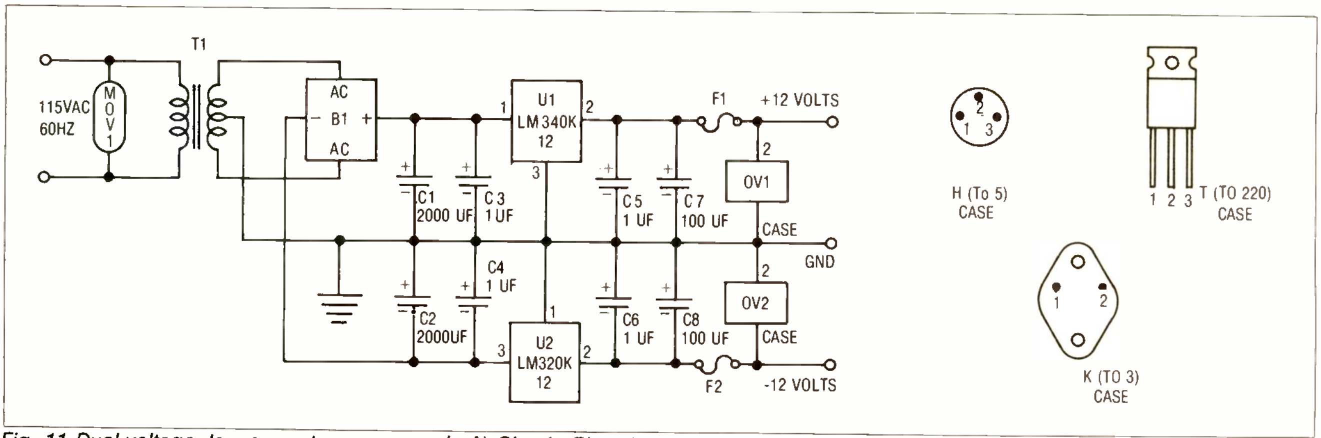


Fig. 11 Dual voltage, low current, power supply A) Circuit, B) typical three-terminal IC regulator case styles.

output short circuit without being destroyed. We can use an alternative method for calculating the internal source resistance R_s:

$$R_S = (E - E_O) / I$$

Where:

R_s is the source resistance of the power supply

E is the open-terminal output voltage

E_O is the loaded (i.e. R_L not equal to 0) output voltage.

I is the load current that produced E_o

Voltage regulation is a measure of how stable the output voltage remains between loaded and unloaded conditions; i.e. as the load current varies. Figure 7 shows how output voltage changes occur with changes in load current. Note that internal resistance R_s is connected in series with the load resistance R_L. The output voltage, then, can only be a fraction of the open-terminal voltage because R_s and R_L effectively form a resistor voltage divider. The full load output voltage will be:

$$E_O = (ER_L) / (R_S + R_L)$$

Voltage regulation is usually specified in terms of a percentage, which is calculated from:

$$\text{Percent Regulation} = (E - E_o)(100\%)/(E)$$

An electronic circuit that keeps the voltage stable is the voltage regulator (good choice of words, eh?)

There are four basic forms of regulator circuit used in common power supplies: *Zener diode, Zener-referenced series-pass, feedback,* and *switching.*

The Zener (pronounced *zen-ner*) diodes have a property that allows them to be used as voltage regulators in electronic circuits. Fig. 8A shows the *I-vs-E* curve for a Zener diode. In the +E, or forward biased, region they

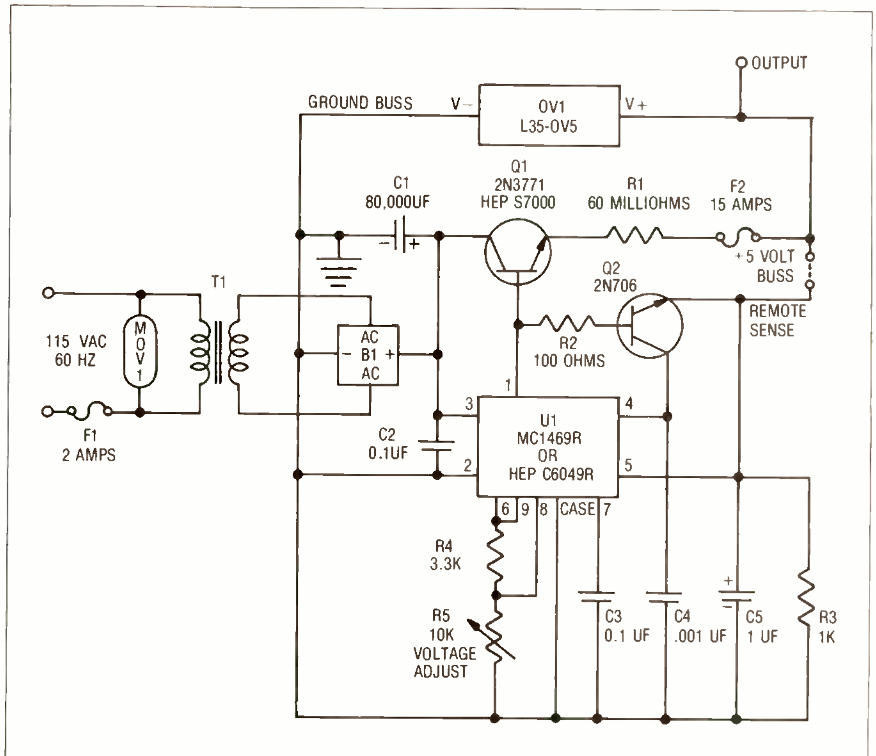


Fig. 12 +5 volts DC, high current power supply

operate exactly like any other PN junction diode. But in the −E, or reverse biased, region they behave quite differently. From D_0 volts, to a point called the Zener point (V_z), they are like other diodes; i.e. only a small leakage current will flow across the PN junction. But when −E reaches the Zener point, the diode will avalanche (i.e. breakover) and conducts a reverse current. V_z tends to remain constant (unless the temperature varies markedly), and it is to this voltage that the diode will regulate the applied voltage.

Figure 8B shows a typical Zener diode voltage regulator circuit. Diode D1 is connected in parallel with the load R_L. Resistor R1 is a series current limiter that protects D1 from excess current flow. If R1 were not used, D1 would burn out.

Unfortunately, the simple Zener diode regulator circuit can only be used in applications that are "light duty." A general working rule is that the load current should be held to 10 or 20 percent of the zener current... hence the limitation to light service.

A better solution is to use a zener diode as a reference source that controls a series-pass transistor, as in Fig. 9A. In this type of circuit, the actual control element is the series-pass transistor, Q1. Zener diode D1 is used only as a reference source. The output voltage in this circuit is a function of the reference voltage V_z and the base-emitter voltage of Q1. It can be found approximately from

$$E_O = V_Z - V_{be}$$

The maximum output current is

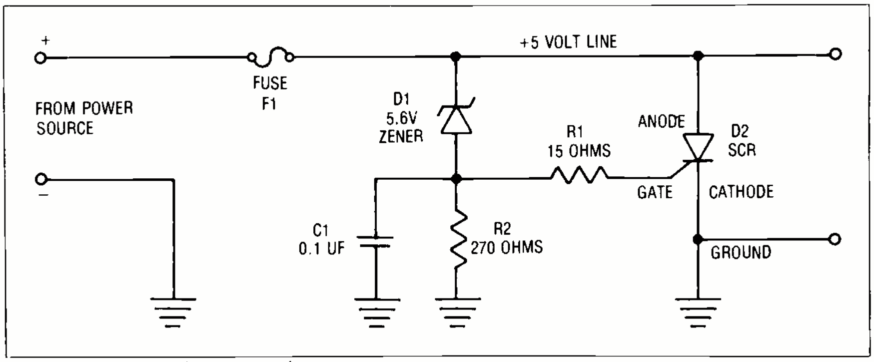


Fig. 13 SCR Crowbar overvoltage protector

approximately the normal load current I_b allowed by the Zener diode, multiplied by the beta of the transistor; assuming, of course, that neither the maximum collector current, nor collector power dissapation are exceeded at that level.

The feedback regulator, of Fig. 9B, is another type of circuit that uses a control element and a series pass element (Q1). In this case, however, the control element is a differential amplifier, used in this case as an error amplifier. In most cases, the amplifier will have unity, or very low, gain. A reference potential is applied to one input of the error amplifier, while a sample of the output potential is applied to the other input. The output of the error amplifier is used to drive the base of transistor Q1. This output is proportional to the *difference* between E_{ref} and the output voltage sample E_o. As long as these voltages are equal, then Q1 is in equilibrium. But changes in E_{in} reflected as changes in E_o, either turn on, or turn off, Q1 a little bit and bring the circuit back into equilibrium.

All forms of series-pass transistor suffer from at least one fault: there is a high input/outputdifferential (E_{in}/E_o) across the series pass element. This means that the series-pass transistor must dissapate a large amount of power, and so is inefficient. A TTL supply operating from a +10 volt source, for instance, is only 50 percent efficient, at best.

One solution to this problem is to use a *switching power supply*, or *switching regulator* circuit. An example of one of the many different types of switching regulator is shown in Fig 10. The LC elements L1/C1 form a low-pass filter to smooth out the high frequency components (many kHz) from the switching action. The key to this circuit is a *pulse width modulator* stage. The PWM produces output pulses to drive the switching element. The duty cycle of these pulses (i.e. the ratio of HIGH/LOW time on the squarewave) is determined by the difference amplifier output. This amplifier serves a function similar to that served in the feedback regulator circuit; i.e. it produces an output that is proportional to the difference between the reference potential E_{ref} and the sample of the output voltage E_o. Then the output voltage rises, then the duty cycle of the switching pulses narrows in order to keep the L1/C1 network disconnected from input voltage source E_{in} a little longer. But if the output voltage drops, as when the load current demand increases, then the pulse width widens, thereby keeping the filter network connected to the source a little longer portion of each second.

The switching regulator can be very efficient, indeed. If an electronic switch is made from a transistor with a low V_{ce} saturation voltage, and inductor L1 has a high Q, then the efficiency can approach 90 percent. Switching power supplies, then, are a lot smaller in physical size for a given output current rating. In one microcomputer, a 15 ampere, +5 volt dc switching power supply takes up only 40 cu. in. of inside-chassis space, and weighs only a couple of pounds... try getting a regulator 5 Vdc @15 amp regulated supply in that space!

Some typical circuits

Most microcomputers use relatively common components in the dc supply. Few of them will be a great mystery to the up-to-date service technician. In the low voltage, low current, supplies and on indivudual boards where distributed +5 volts is used, they will usually have three-terminal IC voltage regulators. These are shown in Fig. 11. The circuit in Fig. 11A is a dual voltage (i.e. ± 12 Vdc) low current power supply. Fig. 11B shows the various case styles of the common three-terminal regulator devices.

Capacitors C1 and C2 are the main filter capacitors. These are rated at 2000 µf, in keeping with the 2000 µf/amp rule given in part 1; i.e. this is a 1 ampere supply. Similarly, capacitors C7 and C8, which are used to improve the output transient response of the circuit, are rated according to the rule 100 µf/amp. Capacitors C3, C4, C5 and C6 are used to improve the immunity to noise. Devices OV1 and OV2 are overvoltage protectors, about which more later.

There are four basic families of three-terminal regulators: LM320, LM340, 7800, and 7900. The LM340 and 7800 devices are positive regulators, and are essentially identical to each other. Similarly, the LM320 and 7900 devices are equivalent negative voltage regulators. *Note!* There are pinout *differences* between positive and negative regulator families... take a close look at U1 and U2 in Fig. 11A!

The different IC regulator case styles offer different output current levels. The H-style case, for example, will pass up to 100 mA of current in free air, although some manufacturers will try to get 150 - 200 mA by heat-sinking. The H-style package is the same as the transistor TO-5 package. The T-style case, which is the same as a transistor TO-220 (i.e. "P-66") package, is usually rated 750 mA in free-air and 1 ampere when heat-sinked. The K-style package, a transistor TO-3 package, is capable of delivering 1 ampere in free-air and 1.5 amperes (some push to 2 amps) when heat-sinked.

The voltage rating of these IC regulators is fixed, and will be given by a suffix on the type number. A 7805, then, is a 5 VDC regulator. In the LM- series, even the case style will be specified: An LM-340T-5 is a 5 volt, positive, regulator in a T style package. Similarly an LM-320K-15 is a 15 volt, negative regulator in a TO-3 (K-style) package.

One of the older regulators available is the LM-309. These are only found in 5 volt models, but are available in H (100 mA) and K (1 amp) sizes. The LM309K is essentially the same beast as the 7805 and LM-340K-5.

Several manufacturers are offering 3 amp (LM323) regulators and even 5 amp regulators in the five volt size. Lambda Electronics offers a complete line of regulators, from 100 mA to 30 amperes, at voltages ranging from 5 volts to 30 volts.

Figure 12 shows a typical microcomputer power supply for the +5 volt, high current, source. I built this circuit from Motorola application notes for my own 26K Digital Group Z80 system. The transformer is a 6.3/7.5 volt, 25 ampere Triad filament transformer. It is rectified by a 25 ampere bridge stack, and filtered by an 80,000 µF /10 volt electrolytic capacitor. A high current transistor, Q1, is used as a series-pass element. A 50 to 100 cu. ft. min. whisper fan was necessary to keep Q1 cool, and was positioned to blow directly across the heatsink on which Q1 was mounted. The regulator was an IC type, although not a three-terminal device. In this case, the Motorola MC1469R (also sold under HEP number C6049R) device. The output voltage of this IC is applied to the base of the series-pass transistor. The level of this voltage, hence the output voltage, is set by potentiometer R3 (*voltage adjust).*

I selected my own power supply circuit, or rather Motorola's, because it illustrates two features of most high current digital power supplies: *overcurrent protection* and *remote sensing.* The purpose of overcurrent protection, also called current limiting, is to protect the power supply and the +5V/ground foil patterns on the computer's PC boards in the event of a short circuit. If a short occurred on one of the PC boards, for instance, and the supply was able to deliver 20 amperes, or so, then all of the foil between the power supply and the affected card would likely vaporize. The supply would also probably be damaged. The MC1469R provides current protection through pin no. 4. If this pin goes LOW, then the regulator turns off the output voltage. The mechanism of the protection circuit includes a small (60 milliohms) series resistor and control transistor Q2. Q2 is normally turned off, because its base-emitter voltage is less than 0.6 volts. The effective bias on Q2 is formed by the voltage drop across the 60 milliohm series resistor. Since the original supply was designed for 10 amps output, the value of the resistor (0.060 ohms) will drop 0.6 volts. If any higher output current is drawn, then Q2 is forward biased and turns on. This lowers the voltage at pin no. 4 of the regulator IC and turns it off. This feature saved my mother board when a piece of the aluminum foil that the DMOS devices were wrapped in found its way across the +5 volt high current line and ground.

Remote sensing is required to keep the voltage at the *PC boards* up to the specified level. Pin no. 5 of the regulator IC is the feedback amplifier input for E_s (i.e. the sample of the output voltage. It is run as a separate line out to the PC lands where it is required to keep the voltage close to +5 volts dc. We have to become aware of things like the IR drop of power distribution leads in digital devices. Even though the PC lands are quite wide, and very low resistance, they will drop the voltage a few dozen millivolts. In my own microcomputer, the voltage at the last card on the mothorboard was only +4.65 Vdc when the input voltage was 5.05 VDC. Using the sense raised the voltage at the last card to +4.98 volts, reasonable for TTL. A point must be selected for the sense line, where it is connected to the +5 VDC line, that will keep the voltage level at the farthest card within spec, yet does not place too high a voltage on the first card in the computer!

Overvoltage protection is mandatory on computer systems. The TTL devices used in computers and other digital applications will burn out if a sustained power supply potential of more than +5.6 Vdc occurs. Can you imagine what would happen to several kilobucks worth of computer if the series-pass transistor in the power supply went out? The +8 to +30 volts from the main filter capacitor would be applied to the +5 volt line...

continued on page 45

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The audio bench

Test instruments for audio service

There is an entire area of test instruments for specialized stereo Hi-Fi, audio, servicing. Here's a rundown on what those instruments do and a tabulation of many of those available.

By Walter H. Schwartz

The troubleshooting and repair of audio equipment, particularly if you wish to do warranty repairs on one or more brands of quality equipment, requires at least as much specialized test equipment as does TV service. In addition to the basic test instruments, scopes, semiconductor testers, VOMs, DMMs, etc., such instruments as distortion analyzers, stereo generators and WOW-flutter meters are necessary to satisfactorily test amplifiers, tuners, tape decks and turntables.

We are going to discuss and tabulate here many of those instruments intended *specifically* for audio troubleshooting and ignore those equally necessary but more universal such as the oscilloscope.

You will find a wide price range between instruments of similar function. Here you can base your decision on cost on your intended approach to audio service. If you wish to simply be able to repair most equipment satisfactorily—and perhaps spend a little more time doing it—you can get by quite well with test equipment of somewhat relaxed specifications. If you intend to warranty work for one or more of the manufacturers of high-end audio equipment you may find them very particular indeed as to the specifications of the test equipment

	Test Sets, Analyzers Combination Instruments	Harmonic Distortion Analyzers	Intermodulation Distortion Analyzers	Audio Oscillators/ Generators	Audio Millivoltmeters	Wow, Flutters and Drift Meters	Audio Dummy Loads	FM/Stereo Signal Generators
Amber	201	202	203					
B&K-Precision				204[1]				
BPI	205	206	207			208	209	
EICO		210	211	212	213			
Fidelipac						214		
FSI	215							
Heath		216[2]	217[2]	218[2]	219[2]		220[2]	
Hewlett-Packard		221[3]		222[4]	223[5]			232[6]
Hickok				224				
Kikusui		225[7]		226[8]	227[9]	228[10]		
Krohn Hite		229[11]		230[12]				231
Leader	233	234		235	236	237	238	239
Marconi		240		241		242		243
Meguro	244	245[13]	246[14]	247[15]		248[16]		249[17]
3-M	250	251				252		
Radiometer		253				254		255
Sound Technology	256	257	258	259				260
Sencore	261							262
Tektronix				263[18]				
VIZ				264				

1 Two models.
2 In kit form, unassembled.
3,4,5,6,7,8,9,10 Several models of each.
11, 12 Several models of each.
13,14,15,16,17 Several models of each.
18 Part of the TM 500 Series.

Manufacturers of test instruments for servicing stereo Hi-Fi equipment. For more information check the reader service numbers as indicated in the appropriate column.

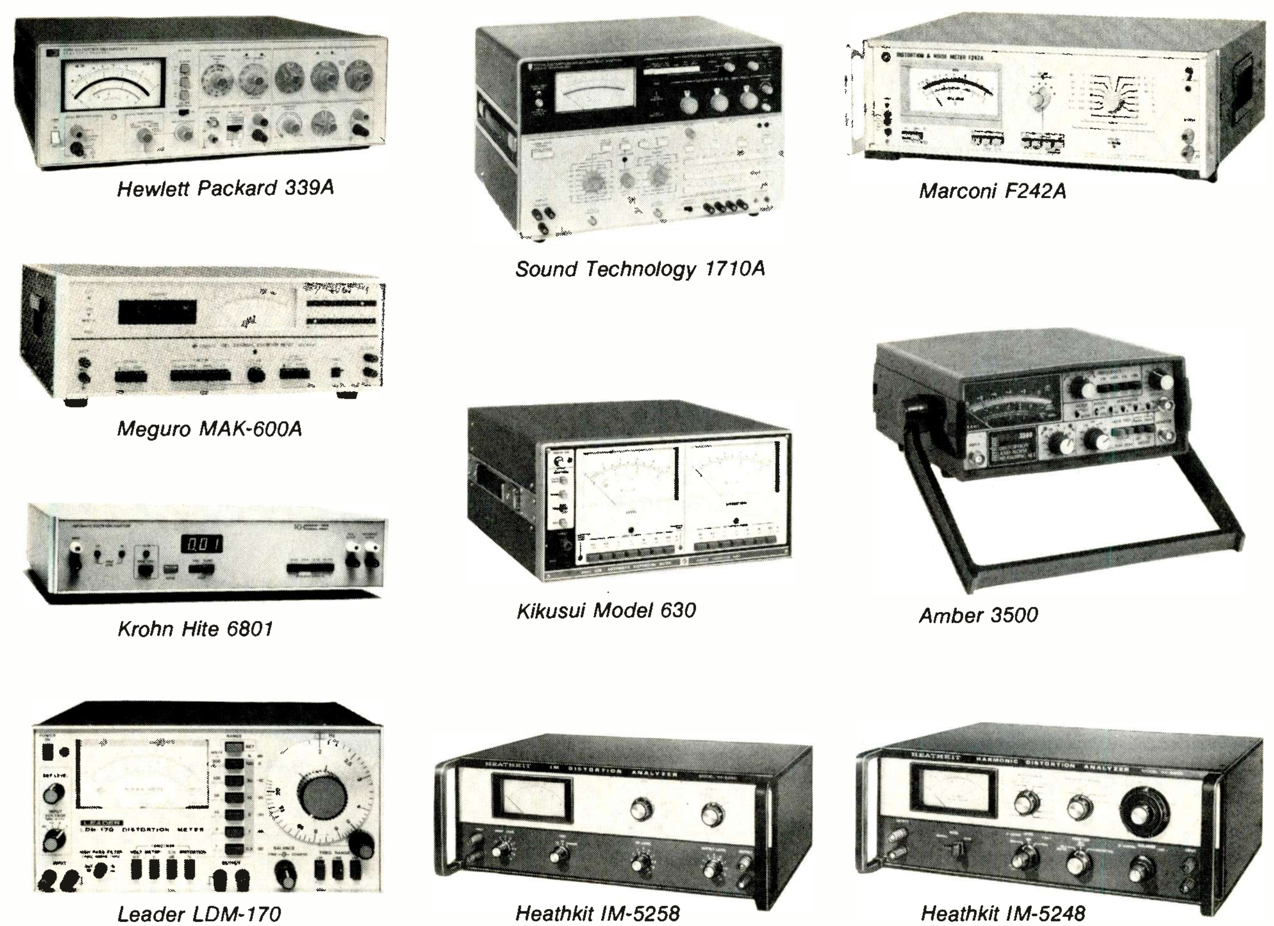


Fig. 2 Harmonic and Intermodulation Distortion Meters.

Fig. 3 FM-Stereo Signal Generators

you use. The cost difference from one bench to the other might be as much as five to one.

Harmonic distortion analyzers

Perhaps the first really special instrument that comes to mind when considering audio work is the harmonic distortion analyzer. In simplest terms, the harmonic distortion analyzer is an audio oscillator, an audio voltmeter and a null network. The oscillator signal drives the amplifier under test and the voltmeter measures the output across a load. The nulling network eliminates the fundamental—what is left is the harmonics. The harmonic contribution of the oscillator and the instrument amplifiers and whether the nulling is automatic or manual all contribute to the cost differences between instruments. A typical lower cost instrument will measure down to 0.03% distortion; the most costly ($1600-$2000) can measure to 0.002% and automatically track the oscillator and the null filters. Most of the harmonic distortion meters allow use of the voltmeter and oscillator independently of the THD (total harmonic distortion) function and an occasional instrument does not have a built-in oscillator.

Intermodulation distortion analyzers

Another form of distortion occurs when two frequencies mix in the nonlinearities of an amplifier to produce sum and difference products. Generally 60Hz and 7kHz frequencies are used to drive the amplifier under test, in a 4 to 1 ratio. The high frequency

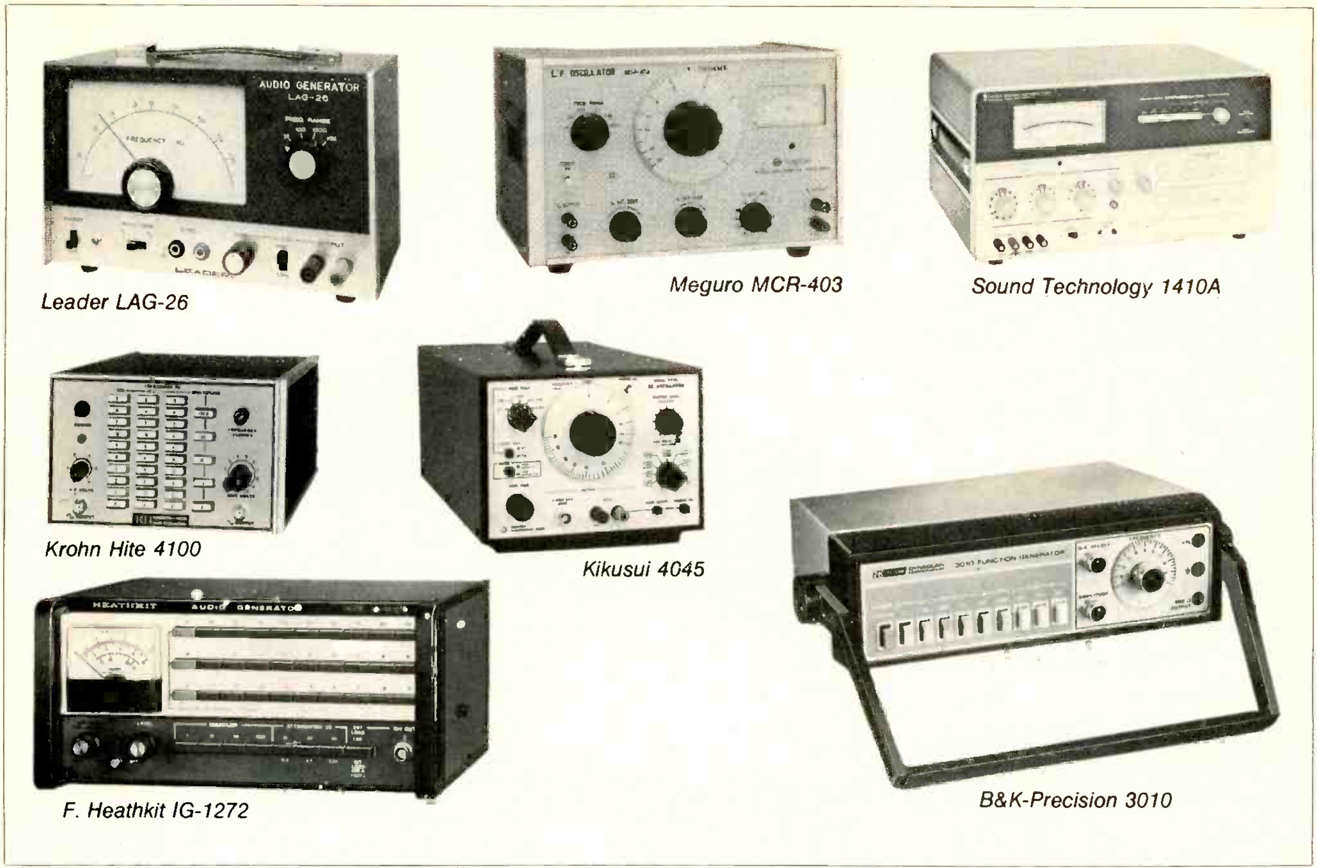


Fig. 4 Audio Oscillators

components are filtered out and demodulated. The degree to which they have been modulated by the low frequency (60Hz) is expressed as a percentage intermodulation distortion (IM).

WOW and Flutter meters

WOW and flutter are mechanical problems of tape equipment and turntables, which result in variations in tape or record speed and consequent effects in the sound produced by the system. WOW is variations in the frequency range of 0.1Hz to 10Hz. Flutter is frequencies above 10Hz. Another factor, drift, is extremely slow tape or turntable speed variation. A reference frequency, usually 3150Hz, is used, derived from a built in source or a test tape or record; the play back frequency variations can be expressed as per cent drift, wow or flutter.
There are several weightings (different standards to which these measurements are made) possible for these readings. IEEE/DIN standard is reportedly the most popular.

Audio oscillators

In this category we can include almost any audio signal source from simple audio generators to sophisticated instruments with audio burst output, audio sweep capabilities, and function generators which offer square wave, and triangular wave output (and other waveforms perhaps) as well as sine waves.

For simple signal injection troubleshooting a rather elementary signal source will do. If checking distortion, the *source should be very low distortion*. A wide frequency range and square wave output are useful for checking for frequency response and a good output attenuator is necessary when driving low level stages. Output level flatness is convenient; you will not have to readjust the output when changing frequency.

Cost varies greatly; in inverse proportion to distortion for example. Low priced oscillators of 1% distortion can be one fifth the cost of an oscillator with 0.002% distortion.

Audio millivoltmeter

The audio millivoltmeter is used to measure signal levels; the output of tape heads and cartridges, to make stage gain measurements, of ac voltage from a fraction of a millivolt to several hundred volts. Usually the millivoltmeter is also calibrated in dB. A few instruments have a choice of linear or logarithmic volt and dB scales.

Remember that most of these meters are average reading meters calibrated in terms of sine waves—they are in error when distortion is present.

RF/FM/Stereo signal generators

This signal generator must supply signals for troubleshooting and aligning the front end of receivers, a sweep signal for IF and discriminator alignment and supply a composite stereo signal for stereo decoder adjustments or be capable of being modulated by a separate composite stereo generator.

Adequate stability, reasonable dial accuracy, low leakage and an output attenuator capable of reducing the output to a fraction of a microvolt are also necessary features of the RF generator.

Special Instruments

These instruments are the test sets, analyzers, combinations of instruments, for convenience of use or to simplify troubleshooting or testing. They can range in sophistication from Leader's LAV-191 which is an audio oscillator and an ac voltmeter in one package to Amber's 4400A which can thoroughly analyze an amplifier, and with the addition of an X-Y recorder, plot the results automatically.

Sencore's SG165 Analyzer is an

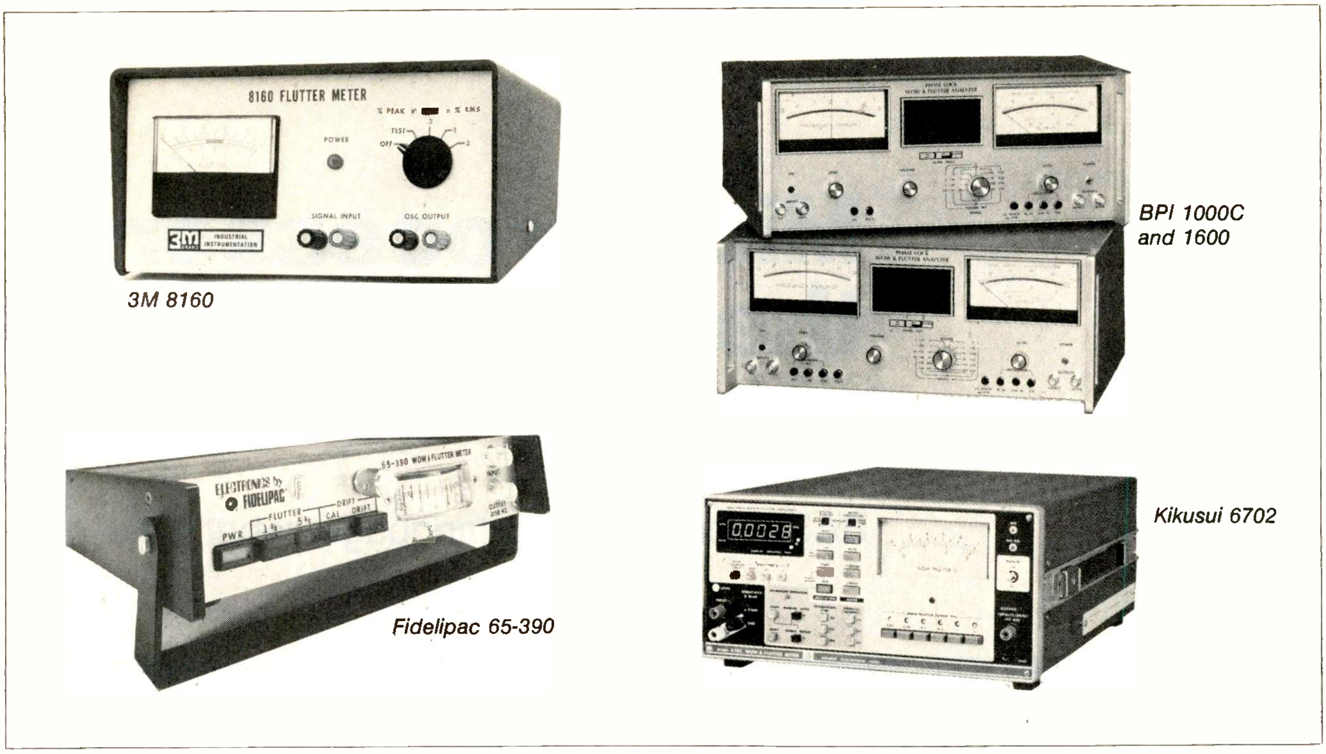


Fig. 5 Wow and Flutter-Meters

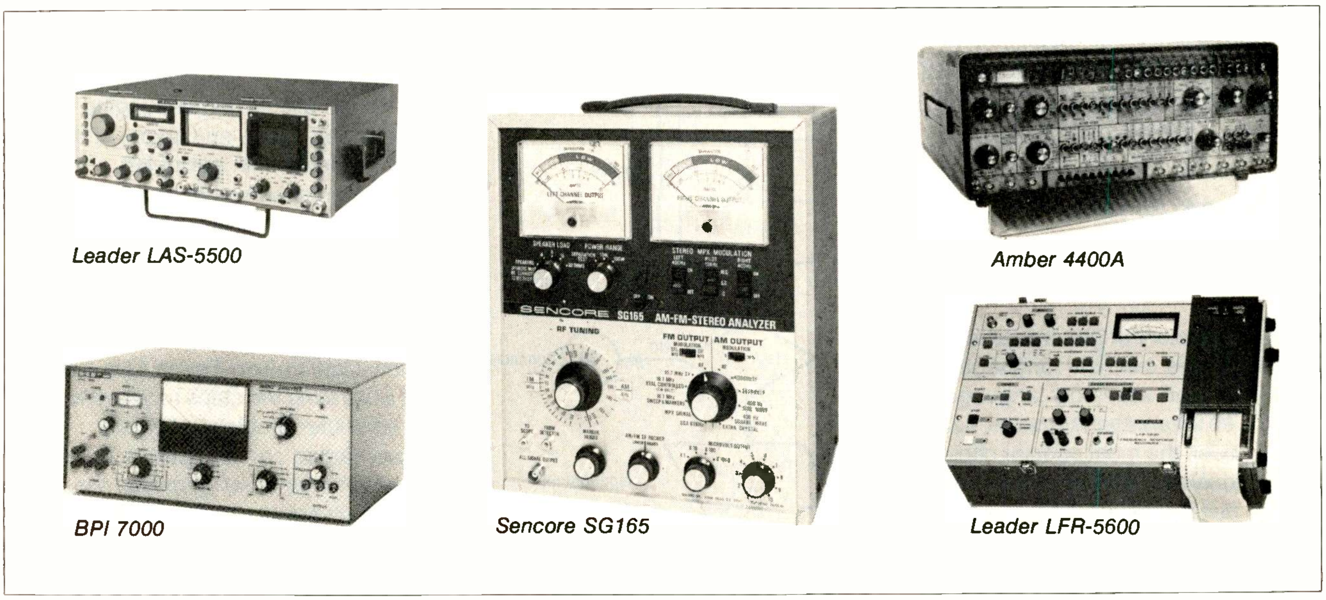


Fig. 6 Test Sets, Analyzers

AM/FM/Stereo signal generator, audio signal source, speaker dummy load and output meter combination. It provides all the signals necessary for routine service of AM/FM/stereo receivers. BPI's 7000A Audio Analyzer combines the functions of an audio oscillator, a harmonic distortion analyzer, an ac voltmeter, and wow, flutter and drift meters in one package. Sound Technology's Model 1500A is intended for complete testing of tape recorders, as is 3-M's Model 6500.

The Meguro MAT-143 is an instrument which traces frequency response on an oscilloscope; Leader's LFR-5600 plots frequency response on a strip chart recorder.

Miscellaneous

Finally, don't forget 4/8/16 ohm load resistors capable of handling the power output of the amplifiers you are testing. Sony has recommended Dale NH250 and RCL ALN-250 noninductive resistors for some time. These require large heat sinks if full rated power is to be dissipated; they (Sony) recommend mounting them on a sheet of ⅛ inch aluminum 72 inches long and 16 inches high, and mounting the assembly behind the bench.

Also a valuable instrument, is a good quality bench receiver and a pair of speakers—which can be used as necessary to check out anything you want to listen to.

Last, but definitely not least, don't forget a variable auto transformer Variac™, Powerstat™, or whatever. It need not be an extremely large one; a five amp unit can handle, if used correctly, up to 600 watts. Careful use of this one simple device can save you from major disaster and untold anguish and embarrassment.

Again, I repeat, dependent upon your needs, the equipment required for satisfactory audio service can vary in

continued on page 45

Microprocessors the easy way, part VII

BASIC or assembly language, what's the diff?

Thank God for high level languages. Within a few years all but design engineers and a few hardcore hobbyists will have washed their hands of lower level languages. For the reasons why—continue on.

By Bernard B. Daien

Most introductory or general texts about MPUs discuss machine language, and briefly mention assembly language. BASIC, an intrepreter language, has up to now, been the most popular choice of professionals for MPU programming. BASIC (for Beginners All-purpose Symbolic Instruction Code) is one of the easier languages to learn and use. This article discusses both assembly and BASIC, providing some comparison between them, to help the reader understand the neglected area that falls between architecture and programming.

It is generally accepted that for every dollar spent on the MPU's hardware, ten or more dollars will be spent on programming. It is obvious that the greatest savings can be made by improving programming efficiency, and this is easily done with a higher level language, such as BASIC, instead of programming in machine code or assembly language.

In the beginning

Before a program can be written in *any* language, the programmer must go through some preliminary steps. First the problem must be understood. The problem then has to be defined, and following that, it must be stated. Next, a solution must be found for the problem, and finally, the solution is written in the computer language used.

The instructions so written are fed into the computer's memory (termed, "loading" the computer). The program is then run through a dummy run, and errors corrected (debugging), in order to avoid errors cropping up when the computer is actually performing its programmed task. The debugged program is run, and if O.K. is recorded in permanent form (documentation). If there are still errors, debugging is performed again, and again, until there are no detectable errors left. Documentation includes a written record of the above described steps, including problem definition, solution, language used, flowcharting, etc.

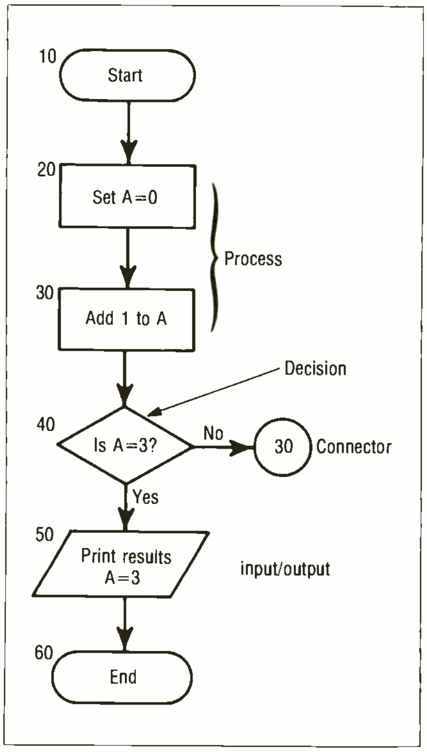


Fig. 1 Some flowcharting symbols. This is a flowchart of a silly little program which continually increments a varable until it equals three and then prints the result, A-3 before ending.

Flowcharting?

Flowcharting (see Figure 1) is a means of illustrating the steps required to solve a computer problem. (Actually flowcharting can be used to solve problems for other purposes too.) Although not used by all programmers, it is especially useful for beginners, since it helps to clearly visualize each step in the solution of a problem, and because it also provides a sort of schematic diagram of the steps used. Documenting in this manner provides a record that enables others to understand what you have done, and why you did it.

Figure 1 shows some symbols used in flowcharting. Although they are shown with a label inside of each, labels are not always used in actual practice. The *shape of the symbol* indicates its use, just as the standardized signs now used on many highways tell the driver what each sign means, by shape.

The "Start" and "End" symbols are self explanatory, indicating the beginning and end of each flowchart. The "Decision" symbol is more interesting. This symbol has input, from the previous steps in the solution, but it has *two* outputs, for the two possible conditions resulting from the decision symbol shown asks, "Does A equal 3?" If it does, we go on to the next step in the process, below. If A does not equal 3, we go off (out the side), to another step towards the solution.

The rectangle indicates a processing step, such as adding, as shown, or subtracting, or any other processing operation.

The slanted rectangle, or parallelogram, is another flowcharting symbol used to indicate either an input or output condition, i.e., either the operator inputing information to the computer or the computer printing out information on a CRT or teletype.

The numbers adjacent to the flowcharting symbols indicate the line number of the program which that particular flowchart symbol represents.

Sometimes we may want to go off to another point in the program, without having lines cris-cross into a mess. In that case a little circle is used, with a number in it, which signifies the computer is to jump to the flowchart symbol identified by that number.

These procedures are considered to be good programming practice, but quite often, when an experienced programmer writes a short program, he skips some of them, on the assumption that any other programmer can easily follow his program. Unfortunately, what is immediately obvious to one person, may not be at all clear to someone else. It is advisable that the reader who pursues programming further, use full documentation in all his early attempts at programming. Errors can be readily spotted, in the flow chart, and other steps. Your memory is a poor substitute for them!

The road map

There are some other symbols used in flowcharting, but for the purpose of this article, the point is made. Most programming texts include a full list of the symbols used, and it is advisable to commit them to memory (a simple task), because the flowchart is as useful in programming, as a road map is in planning an automobile trip.

A look at assembly language

Earlier in this series we discussed the instruction set that each MPU has, and the various languages used for computer programming. An instruction set for the Motorola 6800 MPU was reproduced (ET/D, Dec. 1979, P. 16), and we are going to repeat part of that set now, in Figure 2, and discuss its use a bit.

Referring to Figure 2, we have taken only two operations out of the seventy two in the set, to use as examples for the points we are trying to understand. The examples chosen are: "Load accumulator A," and "Clear accumulator A," both very common instructions. Notice that four different addressing modes can be used for loading accumulator A; immediate, using 2 clock cycles, or direct, taking 3 clock cycles, or, indexed, taking 5 clock cycles, or, extended, taking 4 clock cycles. You are probably saying, "I would use the immediate addressing mode, because it only uses 2 clock cycles, and therefore must be the fastest, simplest, most efficient operation," and your logic would be very reasonable. The trouble is that the addressing mode is dictated not only by the op code (which is the instruction part of the program statement, and is what we have been talking about), but is also determined by the operand which follows the op code.

This sounds complicated, but becomes much easier to understand when we proceed with our two examples, with the aid of Figure 2, and the following definitions of the different "addressing modes."

Operation	Mnemonic	Addressing modes (number of MPU cycles in parenthesis)					Boolean arithmetic operation
		Immediate	Direct	Indexed	Extended	Inherent	
Clear accumulator A	CLRA					4F (2)	00→A
Load accumulator A	LDAA	86 (2)	96 (3)	A6 (5)	B6 (4)		M→ A

Fig. 2 Some typical instructions for the Motorola 6800 MPU.

Addressing modes

DIRECT. Direct addressing is the most frequently used mode and is often referred to as "Absolute" addressing. In direct addressing, the address is incorporated in the second 8 bit byte of a two byte program instruction. (The first byte is the op code.) When a three byte program instruction is used in this mode of addressing, the address may be the last *two* bytes, and in this case may also be referred to as "extended" addressing.

IMPLIED. Implied addressing is often referred to as "Inherent" addressing, and both names are appropriate, since the address is implied by the op code, or, rephrased, the address is inherent in the op code. An example will clarify this: Suppose the program instruction says "Increment accumulator A." The action indicated is incrementing. The address is the register being incremented. Both are contained in the one byte instruction. Implied is usually used for nonmemory purposes (as in this example), and therefore does not require an address in memory.

IMMEDIATE. In immediate addressing the *data* to be operated on is usually the second byte in the program instruction, and thus is immediately available for processing. This is better understood when compared with direct addressing mode. In direct addressing, the data might be held in memory, at a specific address, and that address would be the second byte of the instruction (in the case of extended addressing, the address would be the second and third byte). The data would then be available only after reading out the contents of the memory, and therefore would not be *immediately* available, as in the immediate mode. Thus the immediate mode is used when speed is important (and the situation permits).

INDEXED. Indexing utilizes the ability of the index register to modify addressing operations. (Refer to the previous material in this series discussing the index register.) The address of the memory location desired is formed by adding the address in the program instruction to *the address held in the index register.*

RELATIVE. In relative addressing, the address desired is the address in the program instruction, *added to the address in the program counter.* (Refer to the previous material in this series discussing the program counter.) Remember, the program counter increments by one, and contains the address of the next instruction to be retrieved from memory, in sequence. Thus in relative addressing, the second byte in the program instruction is used to change, or "displace" the program counter, and is often referred to as the "displacement." By this means the program counter can be relocated anywhere in memory. The first seven bits of this second byte determine the amount of displacement, and the eighth bit indicates whether we want to add to, or subtract from the contents of the program counter.

REGISTER. The op code specifies a register *in which the operand is stored*. Thus no operand need be noted.

REGISTER INDIRECT. The op code specifies a register in which the *memory address* of the operand is stored. (In this case the operand is stored in memory, and the address in memory is being held in a register.)

I/O. Input/output addressing, also known as "port addressing," selects an input or output device by means of the address word (or words in the program instruction. (Refer to I/O material earlier in this series.)

By now you should know that an operand can be a data word, or an address in memory in which data is held, or the address of a register in which data is held. In any event, we eventually operate on the data desired, the difference being in the number of steps required to do so. So, although the Motorola instruction set has only 72 instructions, many of these can be addressed in several different modes, yielding almost two hundred different hexadecimal machine codes! The larger the instruction set is, the more flexible and useful the MPU is, and the more difficult it is to master, as a general rule.

Now, back to assembly language.

Figure two tells us that when we use an op code for loading accumulator A, we transfer the contents of a memory address into accumulator A. This is shown by the symbols under the heading "BOOLEAN/ARITHMETIC OPERATION." (Long ago a Mr. Boole stated the math rules for operating under the restraints that binary machines face, hence the names "Boolean Logic" and "Boolean Mathematics" are often encountered in computer books.)

In this case the symbols are, M → A which says "transfer the contents of the memory into accumulator A," and is really a self obvious sign language. Of course we can't transfer the entire contents of a large memory into a small accumulator...we are talking about transferring the contents of a particular memory address into the accumulator. But, we said earlier that sometimes we may use a two word address, and store information in two locations in memory. So now we see that the op code tells us what we want done, but the information being moved around (or operated on), can be one word, or two words...or, as you have already seen, no words at all! Now here is where these pieces all fit together, and start making some sense...

It really makes sense

If we have one, or two, *words of data* following the op code in the program instruction, then we use the immediate mode. If the data is found *at a one word address* (in memory), then the word following the op code *will be an address*, and we use the direct mode. If the data is to be found at two locations, held in memory, then a two word address will follow the op code, and we use the extended mode. If the data is at an address which is formed by adding the operand to the index registers contents, then we must use the indexed mode.

Stated another way, the op code in the instruction set tells the MPU what we want done...but that is only half of the story. We must also tell the MPU what we want it done to: the memory word, or data we want moved...and that means we have to consider the operand (which can be data, or an address). So we must ask ourselves, "Is the operand data, or an address? And is it a one word operand, or a two word operand?" The MPU has to handle each differently, with a different number of clock cycles. The more movements, the more clock cycles; the more words moved, the more clock cycles, since most MPUs move those 8 bit chunks (bytes) around in parallel format.

Other examples

Let's look at our other example, "Clear Accumulator A," which means we want to empty accumulator A, in preparation for using it. The Boolean/Arithmetic Operation column symbology for this is 00 → A which means "put all zeros into accumulator A"...and of course, if you put nothing into A you have emptied its contents by reducing them to zero. Again, the symbols are self explanatory. Now let's look at the possible addressing modes...and lo! We have no choice because there is only one addressing mode, inherent. Note also that it takes only 2 clock cycles to perform this operation. To understand this remember that the inherent mode is so named because the operand is inherent in the op code. When we use the mnemonic "CLRA" we are not only saying "CLEAR," we are also saying what we want cleared, A. Thus the location (address), in this case accumulator A, is inherent in the op code, and no further address is needed. Since we aren't moving information *out* of one register (or memory), *into* another, we need only one short operation requiring only two clock cycles.

Now that you know why we need to use different addressing modes, you understand that we must specify the addressing mode when assembly language programming. If you examine Figure 2, under each addressing mode there is a hexadecimal symbol, and thus, in the case for the instruction for "Clear Accumulator A" we need only use the hex symbol 4F and the job is done. It was simple in this case because there was only one choice of address mode, and we used it. Of course it would have been more difficult in other cases with several choices of addressing mode, and that is where you would have to do some thinking. As you can see, it would become a slow process.

What we have been doing is known as "hand assembling," used by many computer hobbyists. Each mnemonic must be located in the manufacturers literature for the machine language code (in this case, hexadecimal, which is converted to binary inside the MPU). This is a slow and boring process (similar to looking up telephone numbers), and is by nature, error prone. Programmers who make a business out of programming use a more efficient method, based on an "assembler" (refer to the material earlier in this series about computer languages). An assembler is a program which converts the mnemonics into machine language, and does away with the need for "Look up tables."

Because different makes and models of MPUs use different instruction sets and architecture, you must use an assembler made for the particular MPU type you are programming, but, as you can readily appreciate, this takes some of the pain out of using assembly language.

Since there are different assemblers, for different computers, there are also slightly different rules for programming, using these various assemblers. The underlying principles are the same however, and once these principles are understood, it is not difficult for a programmer to quickly learn the procedure involved.

Even with an assembler, the programmer sometimes specifies the addressing mode he wants (or must) use. But, instead of the programmer looking up a hex machine code for the operation desired, and the mode of addressing to be used, he merely writes the mnemonic for the desired operation (remember, mnemonics are easily memorized!), and uses a symbol for the addressing mode desired. In the M6800 assembler program, the *symbol #*

indicates that the immediate mode is being used, which tells the MPU that the data is in the second byte of the instruction. If the symbol # is ommitted, *the assembler reads the entire instruction statement, and determines the mode of addressing!* Isn't that a trememdous help?

It is impossible to cover assembly programming in this article, but it is possible to convey the ideas of what is being done, and why...and that is what we are trying to accomplish. At this point we will go on to look at BASIC, so that the reader may understand the significant differences between these two different programming languages, and the way that they are used.

Some definitions

Since we are talking about programming, it may be helpful to emphasize a few basic definitions, even though some of them have been covered earlier, and others may now be familiar through use in this series.

An "operation" is an action performed by the computer in accordance with instructions.

A "program instruction" is a group of letters, symbols, or numbers, which direct the computer to perform an operation. (The instruction may also include one or more addresses.)

A "computer program" is a group of instructions, written in a form the computer can use, in order to accomplish a desired result.

An "addressing mode" means an addressing *method.* There are usually several different addressing methods possible in MPUs.

We can break "operations" down into several main categories. Some common operations are listed below.

Input/Output. Transferring information from an input to an accumulator, or from an accumulator to an output.

Transfer operations. Transferring information from an accumulator to memory, or from memory to an accumulator. Transferring information between an accumulator and a register, or vice versa. "Pushing" into, or "popping" out of the stack. Moving information to the program counter, stack pointer, etc. There are others but these examples should suffice.

Increment/Decrement operations. These are used to increment a register, memory, or accumulator, or to decrement same.

There are also other miscellaneous operations, such as "Enable interrupt," "Disable interrupt," "Stop"...etc. There is even an operation for doing nothing! Sometimes we wish the MPU to skip to the next operation, using up 2 cycles (a form of time delay)...so the instruction "No operation" (mnemonic NOP) exists, for just such use.

On to BASIC

We said BASIC is a more efficient way to communicate with the MPU, and the following example is a good way to illustrate this. We will assume that the program is being entered on a terminal keyboard. Each statement has a number preceding it (the reason for the number will be explained shortly). When the program is completed, the command RUN is typed. The computer then solves the problem, and types out the answer (in this case, the number 15), followed by the word DONE (signifying task completion).

Here's the problem, as written by the programmer, and the result.

```
10 LET A= 4
20 LET B=5
30 LET C=6
40 PRINT A+ B+ C
50 END
RUN
15
DONE
```

Note that all the letters are capitals. *The form is very important,* even the spacing between letter, numbers, and symbols is *according to form.*

What the programmer did was to enter the numbers 4, 5, and 6 as data. He then gave the algebraic formula for adding the three numbers. (Each number was assigned a letter. Thereafter only the letter was used, in place of the number. The letter was used exactly as it would be in algebra.)

Remember, we said earlier that BASIC is a computer language that permits stating a problem in short English statements, and mathematical equations. Notice that we did not have to use machine coded hexadecimal and we did not have to use addressing modes...(by the time you have read this far you should have an appreciation of the superiority of BASIC in reducing time, effort, and errors in programming!).

The end of this little program was indicated by END. The comment RUN told the computer to execute the program...but notice that RUN does not have a number preceding it. (More rules.) The computer runs the program, and outputs the answer desired, in accordance with the PRINT command preceding the formula.

(This short sample program was given only for the purpose of demonstrating the simplicity of BASIC, and encouraging the reader to continue the study of programming.)

Let us now look at a few of the simpler rules of BASIC programming...

The numbers at the start of each line in the program are spaced in "tens" in the example we just examined. It isn't required to space exactly in tens, but ten is a convenient number to deal with. We could have spaced in 20s for example, or even 1s, but the latter is not desirable. The idea is to allow an adequate number of spaces, which can be used later in order to modify, or add to the program. Remember, a program usually has errors in it, and may need considerable debugging, which could be accomplished by inserting statements between those already existing.

The print command

Another rule of BASIC...if a programmer wants the computer to print out part of a program *exactly as written in the program,* the word PRINT is typed ahead of the material to be printed out, *and the material to be reproduced is placed within quotation marks.* For example: If you wish to have a title describing the program to follow, you would enter the following...

```
10 PRINT "THIS IS PROGRAM ZEBRA"
```

After the END and RUN statements, the computer will print out,

```
THIS IS PROGRAM ZEBRA
```

as its first output, *without the quotation marks.*

To give an example of what quotation marks mean to a BASIC program, let's go back to the program in which we had the computer print the results of adding "4 +5 +6=15."

If we had wanted the computer to print: "A+B+C=15" we would have modified our program, in line 40 only to read:

```
40 PRINT "A+B+C="; A+B+C
```

The computer, after having been commanded to "run" the program, would have responded with:

```
A+B+C=15
END
```

The semi colon in the above statement tells the computer to allow no space between the characters between the quotation marks and the numerical value.

There are many other procedures, a few of which follow...

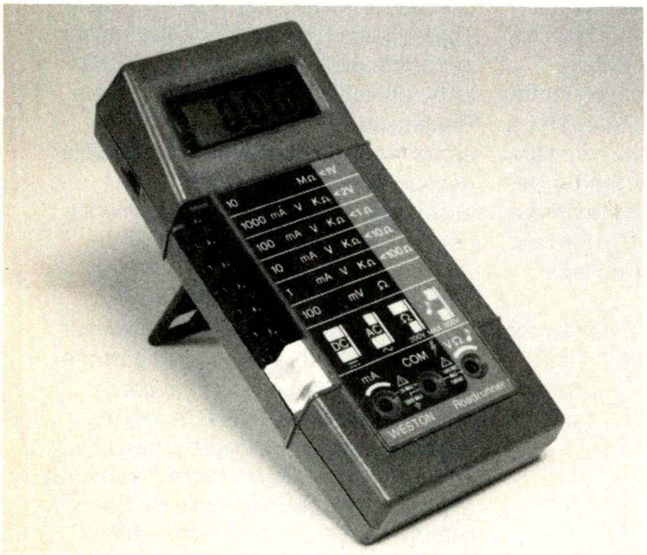
The asterisk, *, is used instead of the x as a multiplication symbol, because x is
continued on page 45

TEST INSTRUMENT REPORT

Weston's latest addition to its line of general purpose multimeters is a compact little pushbutton operated digital multimeter known as the "Roadrunner."

About 7½ by 3 inches, the Roadrunner (Model 6100) is called that because of the constant audio "beep" emitted when used as a continuity tester or for checks of diodes, transistors, or LEDs.

Of course the really unique feature of the Roadrunner is the audio response function. This function provides an audible response to the user within milliseconds after the test is performed provided the measurement value is below the level marked on the front panel. The ranges available are: less than 1 ohm, less than 10 ohms, less than 1000 ohms, less than 1 volt, and less than 2 volts.



For more information Circle Number 150 on the Reader Service Card.

The symbol ⚠ on the front panel of the instrument is an international symbol meaning "REFER TO OPERATING INSTRUCTIONS." Warnings and precautions to avoid personal injury and instrument damage are listed throughout this manual

SELECTED FUNCTION (PUSH-PUSH SWITCHES) *		INPUT JACKS	⚠ OVERLOAD PROTECTION
DC VOLTS	OUT OUT	COM, V-Ω-♪	1000VDC 750VAC
AC VOLTS	IN OUT	COM, V-Ω-♪	1000VDC 750VAC (100mV: 300VAC for 15s)
DC CURRENT	OUT OUT	mA, COM	2A FUSED (250V max)
AC CURRENT	IN OUT	mA, COM	2A FUSED (250V max)
RESISTANCE	OUT IN	COM, V-Ω-♪	300V AC/DC
AUDIO	IN IN	COM, V-Ω-♪	300V AC/DC

*Push to release a depressed Function Switch.

CAUTION
Exceeding the maximum input overload limits can damage the Model 6100.

Pushbutton settings for function selection

Weston's Model 6100 "Roadrunner"

Beep, Beep, Beep

By Richard W. Lay

As with all portable, battery operated test gear, power consumption is one of the primary considerations and, with this in mind, Weston's new unit features a ½ inch, 3½ digit liquid crystal readout which is capable of being used in all but the darkest environments. The unit is powered by one 9V transistor battery with a battery life of up to 200 hours under normal usage conditions if alkalines are used. (A battery eliminator is available as an accessory).

Eight pushbutton switches control the operation of the unit, two for mode selection, i.e., AC, DC, ohms or audio tone modes, and the other six determine the various range settings. There are three connectors to the unit, the com, mA, and the volts/ohms, audio jacks. In the mA position the Roadrunner is limited to two amps maximum and it is rated for 1,000VDC or 750AC. Protection for the unit is a two amp, 250V fuse.

In all there are 29 various range settings available. It is ideally suited for its role as a portable, general purpose meter for either consumer or industrial service work. It's size and ruggedness make it compatible for either bench or field work and one of the accessories is a leather carrying case which is easily attached to the user's belt for greater accessibility in the field.

The unit will provide the audible response providing the measurement is lower than the selected range value. Weston says the response is 2,500 hertz squarewave with a 2.5Hz beat signal.

The LCD contains a LO BAT display which is activated when the continuously monitored battery has about 10 per cent of its life remaining. Three back panel screws are all that need be removed to gain access to the battery compartment or to change the fuse.

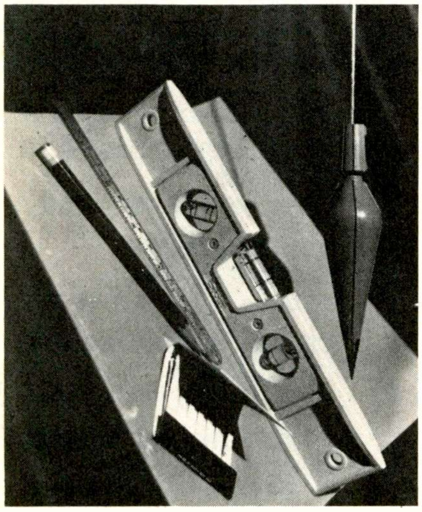
Other accessories available with the Roadrunner are a Light meter attachment, a VHF RF probe, an RF voltage probe, a high voltage probe, and an AC clamp on probe.

The basic unit itself retails for $149.95. **ET/D**

General Specifications

Display 3½ digits .5 inch high
Polarity: Automatic
Read Rate: 2.5/Sec
Power: one 9V NEDA 1604
Weight: one pound

NEW PRODUCTS



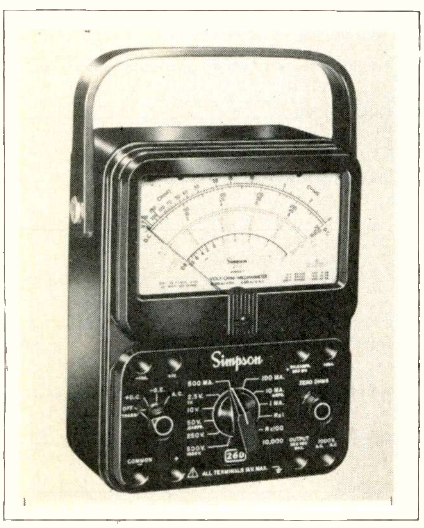
Anti-Slip Material

Circle No. 130 on Reader Inquiry Card

A reportedly very useful aid when working on small components or devices which tend to move around under the pressure of test prods, etc., is "Stop Slip" by *Spirig,* a high friction elastomer available in flexible mats. Available in one or two mm thickness and in blue, green, red and yellow colors its extremely high coefficient of friction allows it to act like a third hand. Stop Slip reportedly does not loose effectiveness with age or cleaning.

Volt-Ohm-Milliameter

Circle No. 131 on Reader Inquiry Card



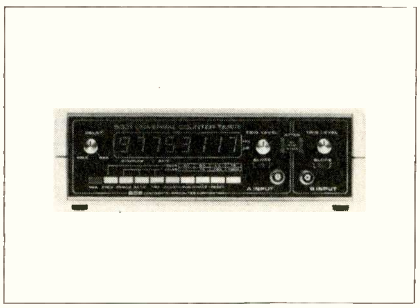
Simpson Electric Company has recently introduced the latest in its ubiquitous 260™ series of multimeters. The 260™ Series 7 features new safety engineered panel connnectors and test leads, a double fused protection network, an Off/Transit switch position, and offers 27 ranges of ac/dc voltage, dc current, resistance dB and output voltage. The taut-band meter movement is varistor protected. The basic price is $103. Options include mirror scale, relay overload protection, and a roll-top case. Accessories include probes for temperature, low power ohms and high voltage.

Multi-Mode Universal Counter-Timer

Circle No. 132 on Reader Inquiry Card

Continental Specialities Corporation has announced a new Universal Counter-Timer, Model 5001, with an introductory suggested price of $360.00. The 5001 is versatile time and frequency measuring instrument. It performs five functions: frequency counting, period and multiple-period averaging, time interval and multiple time interval averaging, frequency ratio and unit counting.

As a frequency counter, the 5001 UCT provides a selection of four gate times



—0.01, 0.1, 1.0 and 10 seconds—and an eight-digit display for a selectable resolution of 100 Hz, 10 Hz, 1 Hz or 0.1 Hz, respectively. In each range, the decimal point is automatically positioned for a direct readout in kiloHertz units.The selected edge of the UCT's "A" input is counted during the gate time, providing accurate, non-redundant frequency measurement of digital pulses. Maximum input frequency is 10 MHz.

In the period measurement mode, the 5001 measures the time between successive selected edges at the "A" input. This measurement is taken over a range of 1, 10, 100, or 1000 cycles, and the average period-per-cycle within the sample is displayed. This results in a resolution of 100 nsec, 10 nsec, 1 nsec, or 100 psec, respectively, in the four ranges. Maximum input frequency is 5 MHz.

Time interval measurements are taken between the selected edge of the signal at the "A" Input and the next selected edge occuring at the "B" Input. This reading may be displayed directly for a single cycle, or averaged over 10, 100, or 1000 cycles; the resultant resolution is 100 nsec, 10 nsec, 1 nsec or 100 psec, respectively. The minimum measurable interval is 200 nanoseconds.

The frequency ratio mode displays the number of cycles appearing at the "A" Input during 1, 10, 100 or 1000 cycles at the "B" Input. This information is displayed as a ratio of cycles of A per cycle of B, with respective resolutions of 1, 0.1, 0.01 and 0.001 cycle-per-cycle.

The unit counter (or event counter) displays the total number of rising edges appearing at the "A" Input, incrementing continually until manually reset.

Both "A" and "B" Inputs feature 1 MegOhm 20 pF input impedance, 25 mV RMS sensitivity, and BNC connectors. Each has a 3-position attenuator (x1, x10 and x100), a positive, negative-going slope selector and a ± Volt DC Offset control. Maximum frequency at the "A" Input is specified as 10MHz; the "B" Input as 2MHz.

Test Lead Package

Circle No. 133 on Reader Inquiry Card

Herman H. Smith, Inc. is now producing a universal modular "Safety Test Lead" package. The 9300 Series has an insulation piercing tip with a threaded base to accept a screw-on alligator clip; the 9700 Series has a ⅜ inch nose to accept any of several input adapters. The test leads are rated at 1000v.

Sweep/FunctionGenerator

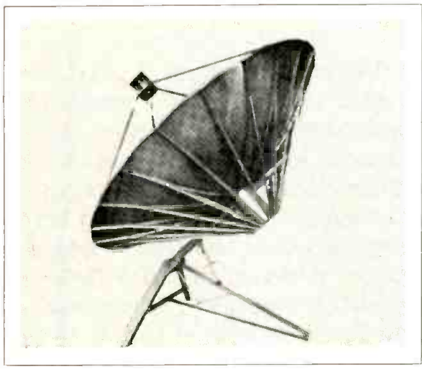
Circle No. 134 on Reader Inquiry Card

The Model 501 Function Generator by *Exact Electronics* is a sine, square and triangle wave generator with variable symmetry, dc offset, internal ramp, gate and trigger, and start/stop frequency controls. It has a 30v p-p maximum output with 60dB of attenuation in 10dB steps plus 20dB of variable attenuation. It also offers external VCF input, main generator sync output and ramp generator sync output. The price is $595.

Satellite Antenna

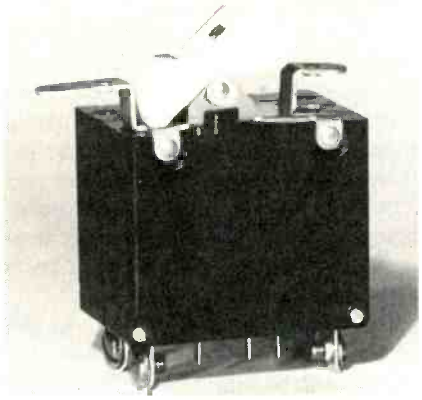
Circle No. 135 on Reader Inquiry Card

A new eleven foot diameter parabolic antenna for satellite TV reception is now available from *Antenna Development and Manufacturing, Inc*. Also available are a polar mount and a rotable feed. The basic dish cost is $2100. The polar mount is $490 and the rotable feed is $175. Equipment is shipped knocked down and is reportedly easily assembled.



Audio Circuit Breakers

Circle No. 136 on Reader Inquiry Card

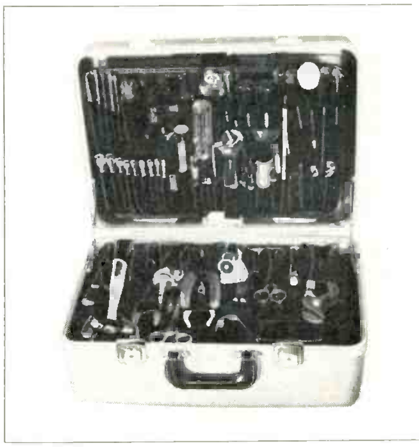


AIRPAX has recently introduced a series of magnetic circuit breakers designed to protect audio power amplifiers against overload while discriminating between overloads and legitimate power peaks. Breakers are available in current ratings of from 2.5 to 15 amps, as single or dual pole units and with medium or long delay.

Tool Kit

Circle No. 137 on Reader Inquiry Card

A new tool case of molded polyethylene has recently been introduced by *Techni-Tool*. Dynasty Tool Kit No. 9600 includes two removable pallets containing 120 tools in a reinforced case with full length piano hinge, anodized aluminum valence, self-closing drawbolts, and a padded steel core handle. The silver colored polyethylene reportedly can't chip or fade and will not show scrapes and bumps.



Locking Long-Nose Pliers

Circle No. 138 on Reader Inquiry Card

Now you can buy a locking long-nose. *Petersen Manufacturing* has just introduced Model 6LN, a 6-¼ inch long Vise-Grip™ with long thin jaws and a wire cutter. With a standard Vise-Grip™ warranty it reportedly costs the same as standard long-nose pliers. ET/D

DEALER'S SHOWCASE

Omni-Sound Speaker

Circle No. 140 on Reader Inquiry Card

The Omni-Sound Home and Auto Mini Speaker System from *Audiotex division of GC Electronics* is compact in design (just 7-½ inches high), but is rated at 25 watts rms, with a 2 inch diameter, wide-dispersion tweeter,and 4 inch woofer. A high-temperature voice coil in the tweeter and woofer dissipates heat, allowing the drivers to handle high levels of power. Frequency response is rated at 55-20,000 Hz.

The Omni-Sound includes a "multi-use" mounting bracket for positioning the speaker in virtually any direction. This mini speaker is intended for use in autos, vans, trucks, campers, and boats, as well as in homes, apartments and condominiums, or A-V and P A installations where a small music speaker system is desirable. It's also useful as a second speaker pair.

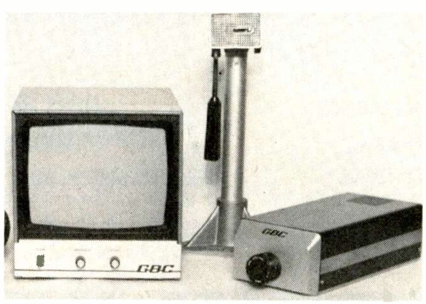
The speaker is housed in a black die cast aluminum cabinet and features convenient pushbutton terminals for quick and easy connection.

Suggested retail price of the Omni-Sound Speaker is $99.95 per pair.

Closed Circuit TV System

Circle No. 141 on Reader Inquiry Card

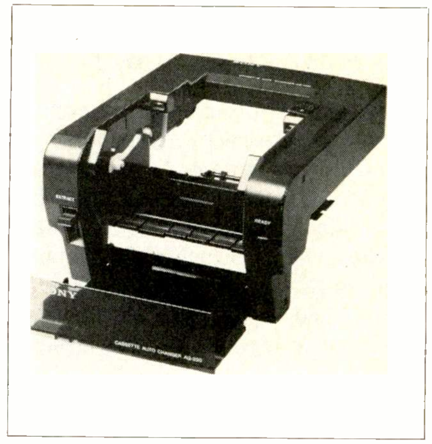
A new series of CCTV equipment and accessories has recently been introduced by *Columbia Video Systems.* These all American made units are for general security monitoring and surveillance for schools, industry, home, and any business operation. The VICOM 100 system can be expanded to add as many cameras and monitors as necessary. Basic system consists of CTC-3000 camera, wall mount, lens, 16mm @ F1.9, MV-10A high performance 10" monitor, and 50' coax cable with connectors. Dealer net price, $489.00. Same system but with 2 way intercom for total audio-visual communication is $549.00 net.



Videocassette Auto Changer

Circle No. 142 on Reader Inquiry Card

Sony Consumer Products Company introduced an automatic videocassette tape changer that permits continuous recording and playback of up to three cassettes on Sony Betamax Models LV-1901/D,SL-7200/A,SL-8200 and SL-8600. The Sony Videocassette Auto Changer Model AG-200, is an easily installed accessory which offers a maximum recording capacity of 4.5 hours (Beta-I Mode) or 9 hours (Beta-II Mode) using three L-750 tapes. Manual operation (record, playback, stop, etc.) is also possible with the changer installed on the recorder. This auto changer is stated to provide earlier Betatax owners with the opportunity to upgrade their systems to match the longer recording times being offered with the newer models. A changer designed for Sony Betamax Models SL-5400 and SL-5600 will reportedly be introduced by the end of 1980. The Sony Videocassette Auto Changer Model AG-200 is currently available for a suggested retail price of $125.



Power Factor Corrector

Circle No. 143 on Reader Inquiry Card

Electronic Relays Inc. has introduced a power factor controller, which is stated to cut power consumption of induction motors by from 10 to 60%. Built for motors of ½ horsepower or less it is reportedly effective on washers, refrigerators, furnaces, fans, power tools, etc. The unit senses the power required and automatically corrects the power factor. The cost is under $30.

P.A. Amplifier Line

Circle No. 144 on Reader Inquiry Card

A new line of all-solid-state public address amplifiers is being manufactured by *Newcomb Audio Products Co.* Bearing the "Pathfinder" brand name, the equipment is designed to meet the requirements of commercial sound installers. There are six models in the line ranging in power from 25 to 100 watts. One of the two 100-watt booster amplifiers is especially suited to telephone line use. Most of the p.a. amplifiers have such features as mike-precedence music muting, a separate and independent response control for each mike channel, bridging jacks for joining two amplifiers together to sum the inputs and outputs so that all inputs feed both outputs with an independent master control

for each output. On most, a circuit break-in feature is provided for connection of external frequency control equipment or a reverb unit. In most of the Pathfinder p.a. amplifiers, inputs give a choice of low or high impedance mikes without the need of transformers. However, there are special sockets for plug-in transformers for each mike where balanced line low impedance is necessary. There's an output-to- tape jack and an output-to-booster jack unaffected by the p.a. amplifier's volume control. There are wall mountings for all models as well as conventional rack mountings. A stacking module permits ventilation and deflects heat when a pair of amplifiers is used for stereo, or interconnected, or when a booster amp is added to a p.a. amp. The Pathfinder line includes two column loudspeakers and a four-speed phono top. All units are U.L. approved.

Mini Indoor Antenna

Circle No. 145 on Reader Inquiry Card

Winegard Company has introduced a new mini-sized VHF-UHF-FM antenna designed to replace and outperform "tv rabbit ears" in apartments and homes where an outdoor antenna is not feasible. The AT-5001 mounts overhead on a gold color floor-to-ceiling pole which adjusts from 7 feet 6 inches to 8 feet 3 inches. It receives television channels 2-69 plus FM and is recommended for city and suburban locations. The package includes antenna, wire, VHF-UHF-FM band separator and two plant hanger hooks and can be installed with a small screwdriver. Suggested retail is $44.75.

Auto-Stereo Speakers

Circle No. 146 on Reader Inquiry Card

Electronic Industries, Inc., has announced its new domestically produced Model 94Z auto sound speaker system. This new model boasts a power rating of 125 watts RMS each and reportedly has a frequency response of 25 Hz to beyond 40kHz. This speaker is stated to

represent the first 6 × 9 3-way configuration capable of handling the power produced by today's more sophisticated amplifiers. Some of the features found in this new speaker are: reflective radiator array, 40 oz magnet, piezo electric midrange and acoustic lens tweeter, bi-amp or conventional hook up capability and a 10 year warranty.

Phone Tap Detector

Circle No. 147 on Reader Inquiry Card

Phone-Guard, a device which indicates that someone is listening to your phone conversation, has been developed by *Cose Technology Corporation.* Unscrew the mouthpiece of your telephone and replace it with Phone-Guard. If you phone is taped or an evesdropper is listening on another extension, Phone-Guard will, according to the manufacturer, indicate an open line. The retail price is $49.95.

Vehicle Alarm

Circle No. 148 on Reader Inquiry Card

Page Alert Systems has introduced its new Theft Alert 500A. A small transmitter installed in the vehicle and transmitting via the existing auto antenna alerts a pocket pager which "beeps" a warning of vehicle tampering. The system range is reportedly over one mile depending

upon terrain, etc. The retail price is about $100. A higher power Page Alert 4000 reportedly has a range of over eight miles.

AUDIO EQUIPMENT

continued from page 33

cost by nearly ten to one. Very adequate service upon compacts and mid-fi equipment could probably be done with the Sencor SG-165 ($795) or a few separate instruments totaling no more than $1000 in cost. Authorized warranty work for most of the audiophile brands could require equipment costing up to five or six times this much (in both instances excluding such usual instruments as DMM's, scopes, etc.

DIGITAL EQUIPMENT

continued from page 28

and all that TTL logic would simply evaporate... vaporized in a silicon cloud! The solution is to supply an overvoltage protector... or SCR Crowbar as it is sometimes called. In my power supply of Fig. 7 the OVP was in the form of a Lambda Electronics module, an L35-OV5. This device will carry 35 amperes and is designed to protect +5 volt supplies (other models are available). The typical circuit, however, is made from discrete components, as in Fig. 13. Diode D2 is a high current SCR, and is connected across the power supply output; i.e. it is between +5 volts and ground. The gate is controlled by Zener diode D1. If the voltage on the output line exceeds +5.6 volts, then the Zener breaks over, and turns on the gate of the SCR. This, in turn, causes the SCR to conduct a high current, blowing the fuse. In some circuits the fuse is prior to the regulator, or they depend upon the primary transformer fuse. In still other cases, the SCR merely absorbs the total current of the supply until help comes.

Whenever the fuse is found to be blown, special troubleshooting is in order. Remember the old adage: "A fuse doesn't cause trouble, it *indicates* trouble." Disconnect the power supply from its load before replacing the fuse. This will protect the computer while you troubleshoot the power supply. If the supply must see a load in order to work, then use a high power resistor. I use three 1-ohm, 100 watt resistors in parallel for this purpose. It will draw 15 amperes (i.e. 5 V/0.33 ohms) from the supply, and the 100-watt size will dissipate the power. Even much higher rated supplies will usually operate properly at a load current of 15 amperes.

MICROPROCESSORS

continued from page 37

commonly used to denote a mathematical variable.

When the answer to a problem has more digits (numbers) in it than the computer can print out, the answer if given in "scientific notation" (powers of ten). Thus 180 micromicrofarads, which is 0.000,000,000,180 in decimal notation would become 18×10^{-11} in scientific notation...but we just said that the computer does not use the x for multiplication, so instead, the print out would read 18E-11 which is read as "eighteen times ten to the eleventh power." (The E indicates we are dealing with an *exponent* of ten.)

It should be apparent by now that using BASIC does not require knowledge of the different MPUs instruction sets. It does require a knowledge of the rules for using BASIC, *which do not change*. (It is true that there are some variants, other types of BASIC, but they bear other names. If you are using plain old BASIC, you have programming by the tail, if the MPU you are working with has a BASIC interpreter.) Programming with BASIC is almost as simple as using one of the advanced pocket calculators, except that instead of pushing certain buttons with labels on them, in accordance with instructions, we typed the labels in accordance with instructions...but we have more combinations in BASIC, and more flexibility in their use.

Summary

In this article we looked at the essential steps in programming, including flowcharting. Addressing modes, instruction sets, and their application in programming was covered. Hand assembling, and the use of an assembler was discussed. Some of the different operations were defined. The advantages of using BASIC were demonstrated, and BASIC itself was explained, and compared with machine code and assembly language. **ET/D**

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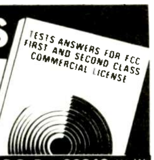

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Picture Tube Rebuilding Equipment. Produce 48 Quality Color, B/W Tubes Per Week. Sell To Distributors, TV Shops And Retail. Everything Needed For A Profitable Business. $7500.00. John Culver, 30E Dory Drive, Mystic Islands, N.J. 08087. 6/80

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TUNER SERVICE serving over 400 dealers in the Chicago area wants additional lines. Write or call: Economy Tuner Service., 4901 N. Elston, Chicago, IL 60630. Phone 312-282-3939. 4/80

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EXTRA INCOME! NO SELLING! Distribute **VIDEO GAMES** ad cards from your shop or on service calls and earn easy commissions! Write: **VIDEO,** Box 27348, Dept. ET1, Mpls., MN 55427. 5/80

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Miami, Fla., Drive-in TV-Auto radio business. 20 years same location. Service gross $70,000. Lots of business. Partnership considered. $20,000 total. Contact D. Greenwood, 7451 S.W. 8th St., Miami, Fla. Tel. 1-305-261-5223. 6/80

ARIZONA. Television sales/service for sale by non-technician owner. Good technician, salesman on payroll. Grosses $100,000 plus. Number one shop in resort community. Make offer. Write Box 1075, Wickenburg, Arizona, 85358. 5/80

MECHANICALLY INCLINED INDIVIDUALS Assemble electronic devices in your home. Knowledge or experience not necessary. Get started in spare time. Above average profits. $300-$600/wk. possible. Sales handled by others. No investment-Write for free details. ELECTRONIC DEVELOPMENT LAB, Box 1560B, Pinellas Park, FL 33565. TF

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AD INDEX

TEST INSTR. RPT.

NEW PRODUCTS

FEATURES *AUDIO BENCH*

DEALER'S SHOWCASE

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

ET/D TEKFAX

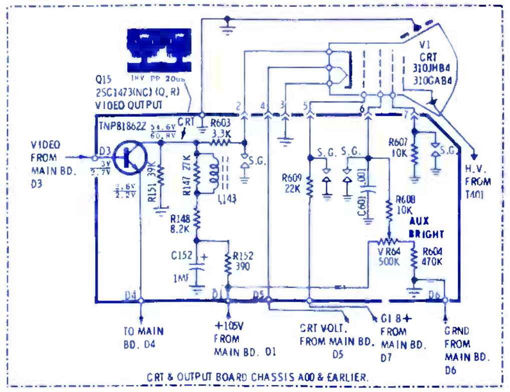
COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS

SCHEMATIC NO.		SCHEMATIC NO.	
QUASAR B&W TV Chassis 12TS-625 A00, 800	1841	ZENITH Color TV Chassis 25GC45, 45Z	1844
MIDLAND Color TV Model 15-247	1842	PANASONIC B&W TV Chassis 12B01-A	1845
ZENITH Color TV Chassis 19GC45, 48, 48Z1	1843		

1841

QUASAR
B&W TV Chassis
12TS625 A00, 800

MAY . 1980

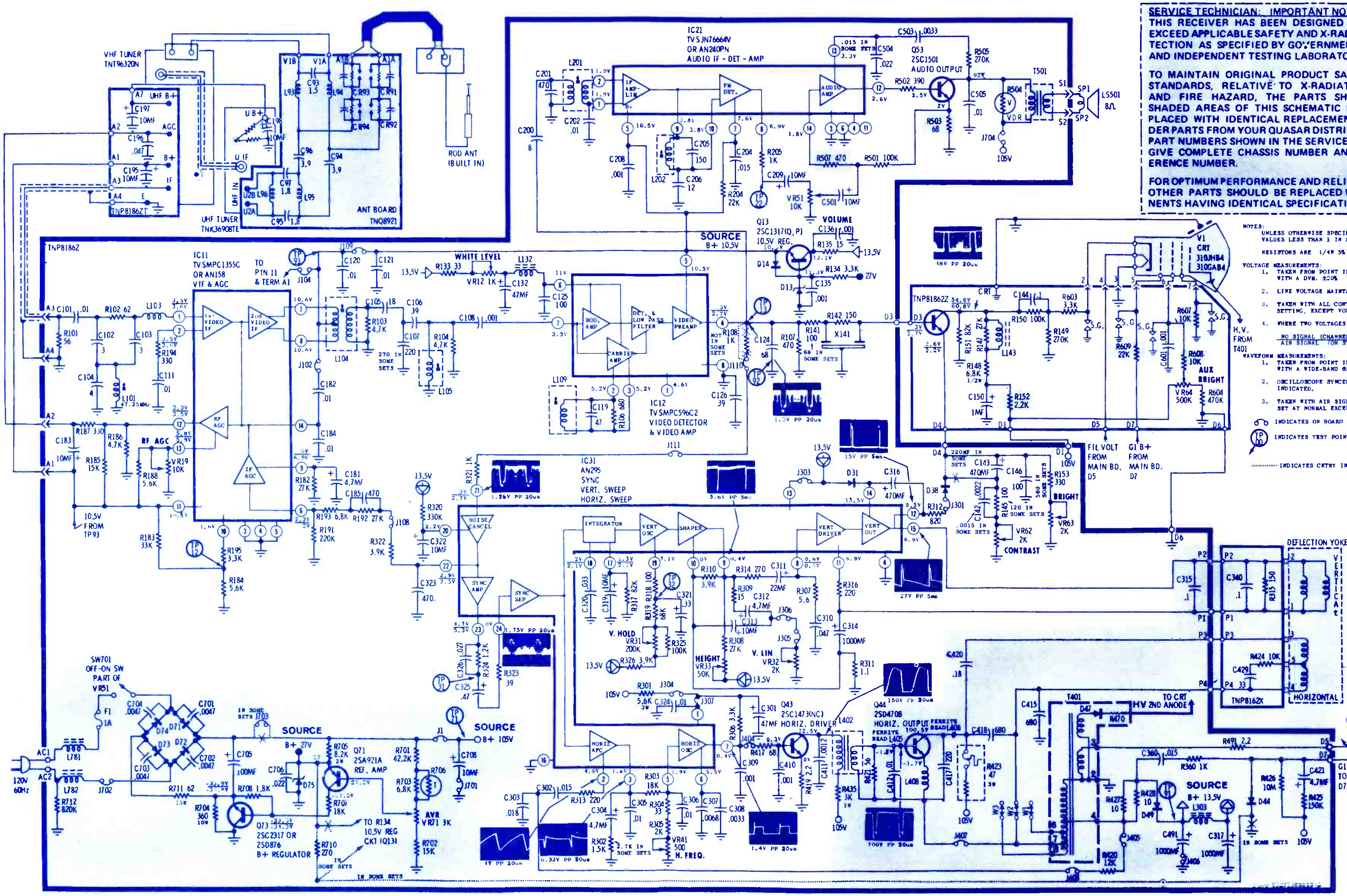


Partial Schematic–CRT & Output Board
Chassis A00 and Earlier

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

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

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



NOTES:
UNLESS OTHERWISE SPECIFIED; CAPACITOR VALUES LESS THAN 1 IN MF, ALL OTHERS IN PF.

RESISTORS ARE 1/4W 5% UNLESS SPECIFIED.

VOLTAGE MEASUREMENTS:
1. TAKEN FROM POINT INDICATED TO CHASSIS WITH A DVM. ±20%
2. LINE VOLTAGE MAINTAINED AT 120V AC.
3. TAKEN WITH ALL CONTROLS AT NORMAL SETTING, EXCEPT VOLUME; AT MIN.
4. WHERE TWO VOLTAGES ARE SHOWN

$\frac{\text{NO SIGNAL (CHANNEL BETWEEN 2 AND UHF)}}{\text{AIR SIGNAL (ON STRONG CHANNEL)}}$

WAVEFORM MEASUREMENTS:
1. TAKEN FROM POINT INDICATED TO CHASSIS WITH A WIDE-BAND OSCILLOSCOPE.
2. OSCILLOSCOPE SYNCED NEAR SWEEP RATE INDICATED.
3. TAKEN WITH AIR SIGNAL WITH ALL CONTROLS SET AT NORMAL EXCEPT VOLUME AT MIN.

INDICATES ON BOARD JUMPER

TP 00 INDICATES TEST POINT ON BOARD

.... INDICATES CKTRY IN SOME SETS

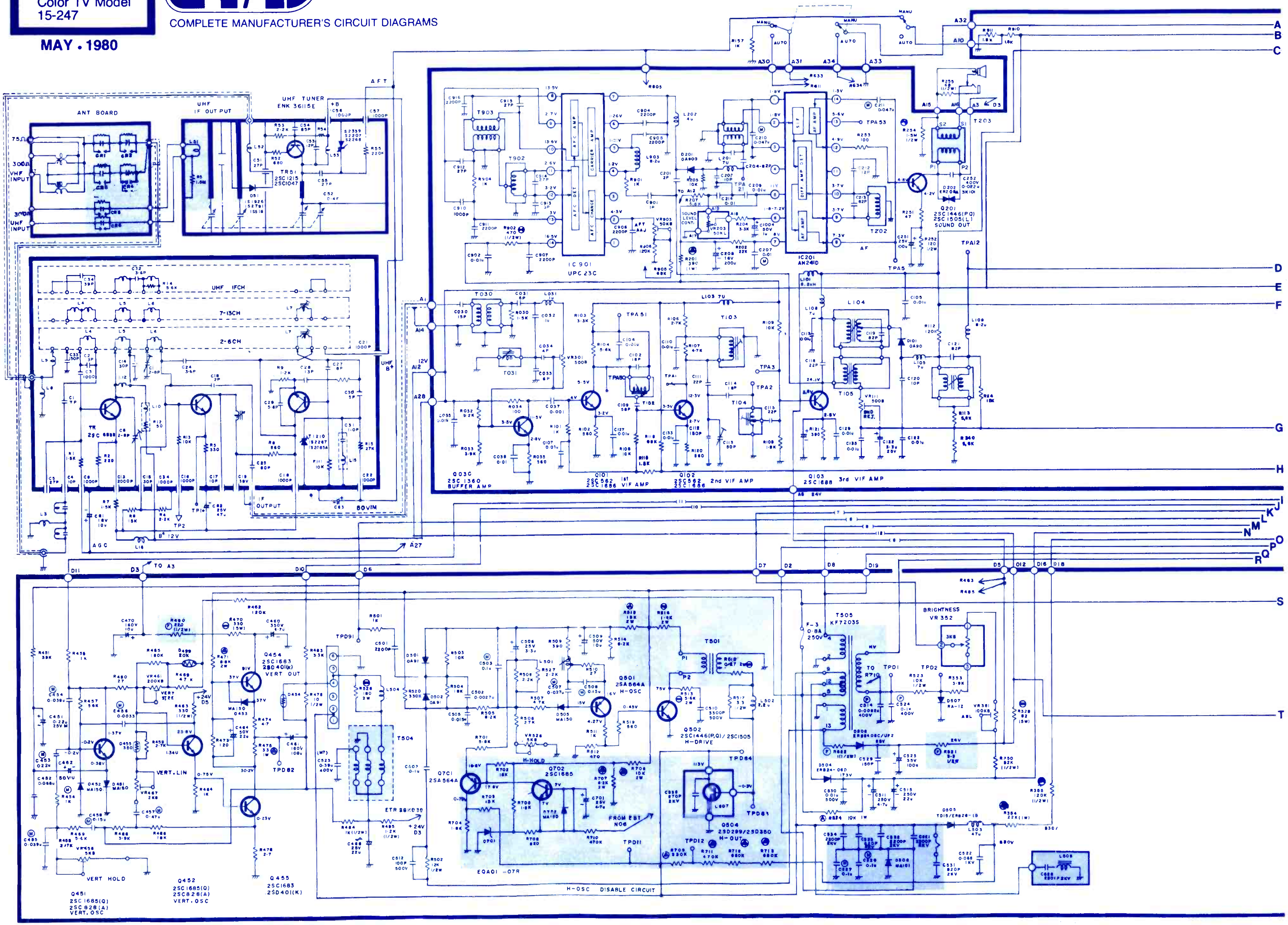
1842

MIDLAND
Color TV Model
15-247

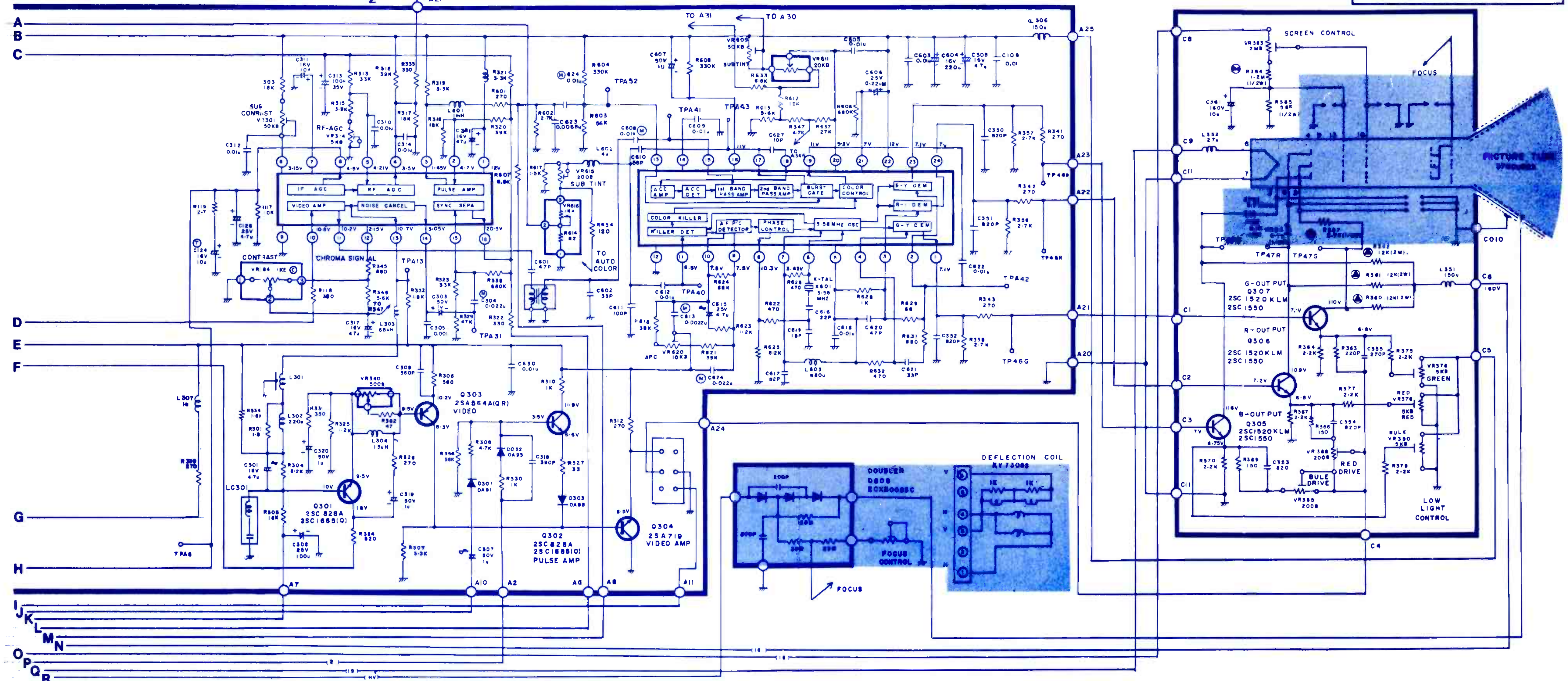
MAY • 1980

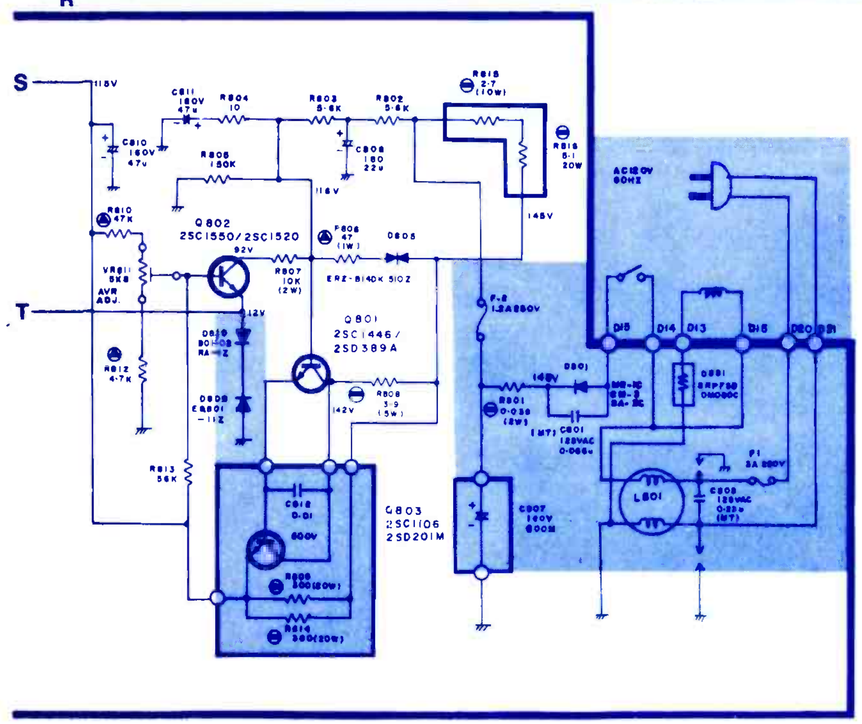
ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS

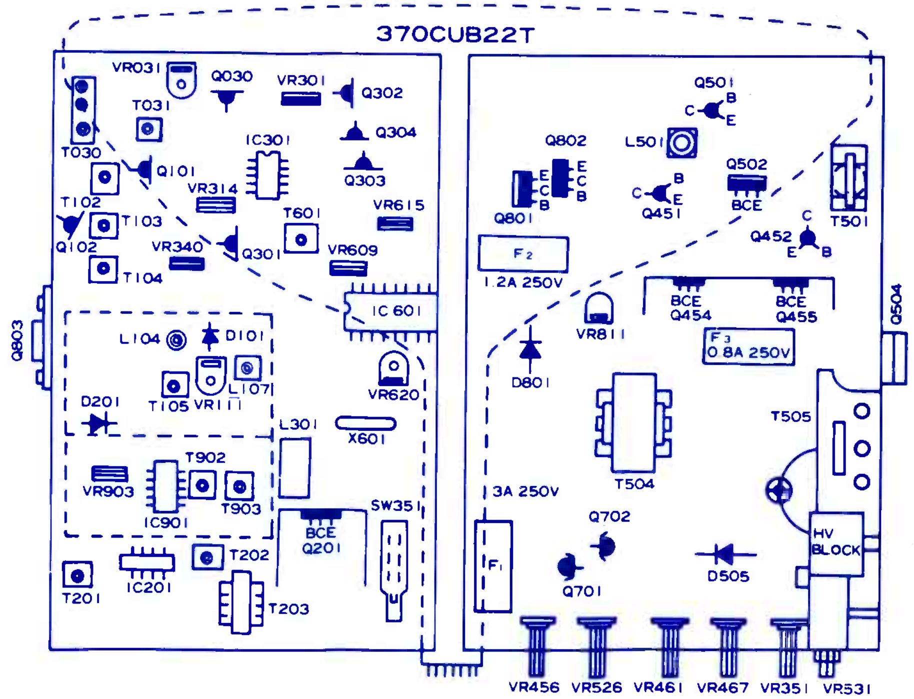


MIDLAND
Color TV Model
15-247





PARTS LOCATION DIAGRAM



CAUTION

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

NOTE

1. RESISTORS : ALL resistors are carbon1/4 WATT resistors, Resistance in ohm K(KIL OHMS) or M(MEGAOHMS), UNLESS other wise noted the following marks.
   - SOLD RESISTORS
   - WIRE WOUND RESISTORS
   - METAL OXIDE RESISTORS
   - THEMISTORS
   - CEMENT RESISTORS
   - FUSE RESISTORS
2. INDUCTORS : Inductance in u(Micro Henries) or MH(MILLIHENRIES)
3. CAPACITORS : ALL CAPACITORS are ceramic 50V capacitor capacity in P(Picofards), u(Microfards) unless other noted the following marks.

(M) : POLYESTOR CAPACITORS
(P) : POLYPROPYLENE CAPACITORS
(MT):METALZED POLYESTOR CAPACITORS
(OP) : OIL POLYESTOR CAPACITORS
(T) : TANTALIUM
:ELECTROLYTIC CAPACITORS
:ELECTROLYTIC NONE POLARITY CAPACITORS.

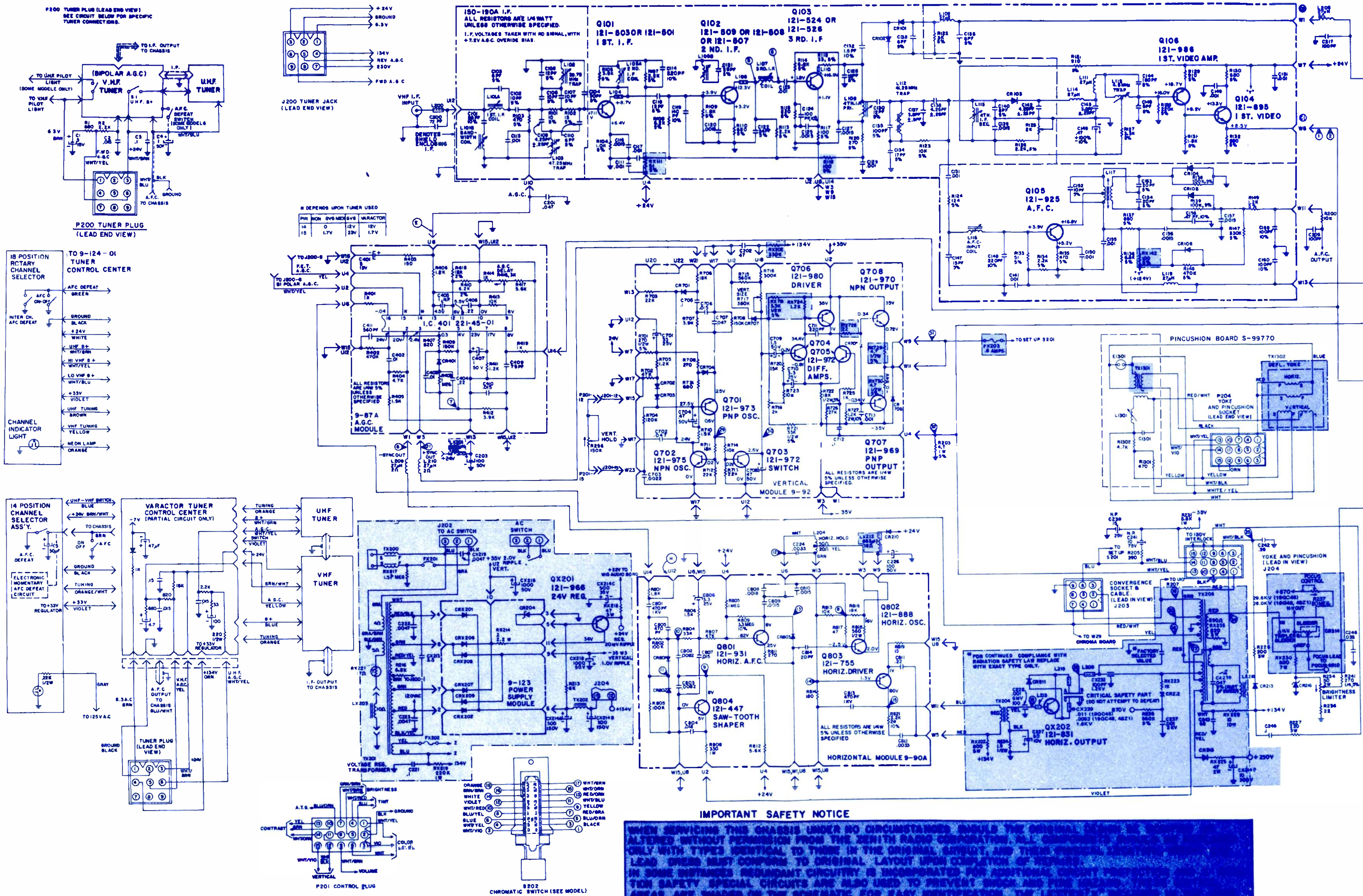
1843

ZENITH
Color TV Chassis
19GC45, 48, 48Z1

MAY • 1980

ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS



IMPORTANT SAFETY NOTICE

WHEN SERVICING THIS CHASSIS UNDER NO CIRCUMSTANCES SHOULD THE ORIGINAL [illegible] ALTERED WITHOUT PERMISSION FROM THE ZENITH RADIO CORPORATION. ALL COMPONENTS [illegible] ONLY WITH TYPES IDENTICAL TO THOSE IN THE ORIGINAL CIRCUIT, AND [illegible] LEAD DRESS MUST CONFORM TO ORIGINAL LAYOUT UPON COMPLETION OF REPAIRS. IN SOME INSTANCES REDUNDANT CIRCUITRY IS INCORPORATED FOR ADDITIONAL [illegible] TION SAFETY. SPECIAL CIRCUITS ARE ALSO USED TO PREVENT SHOCK AND FIRE HAZARDS. [illegible] AREAS ARE SHADED ON THE SCHEMATIC FOR EASY IDENTIFICATION. THE LETTER "X" [illegible] NUMBER DESIGNATES SPECIAL FAIL SAFE COMPONENTS IN THESE AREAS [illegible] REQUIRED TO MAINTAIN SAFE PERFORMANCE. NO DEVIATIONS ARE ALLOWED WITHOUT [illegible] BY THE PRODUCT SAFETY ENGINEERING DEPARTMENT.

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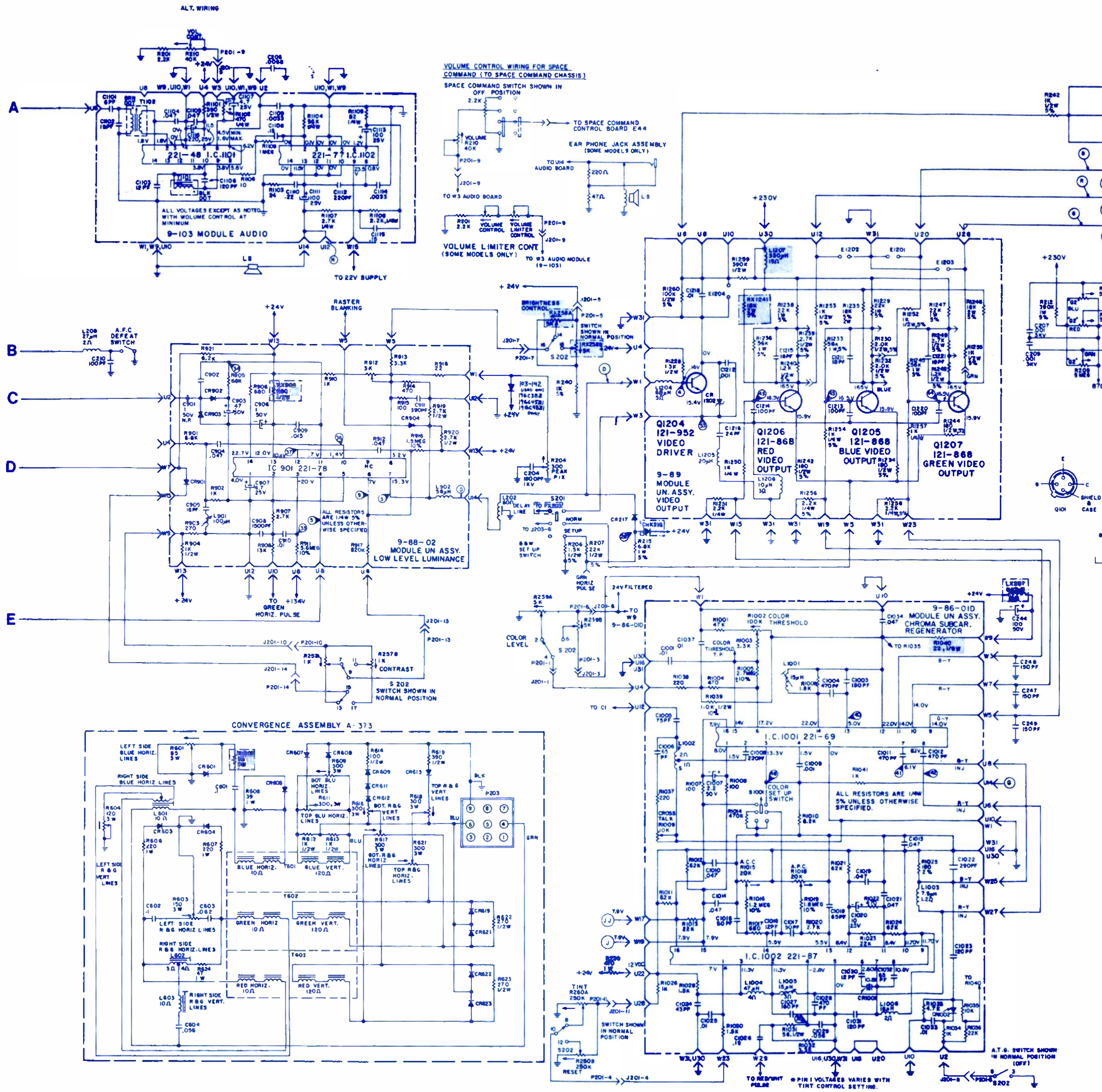
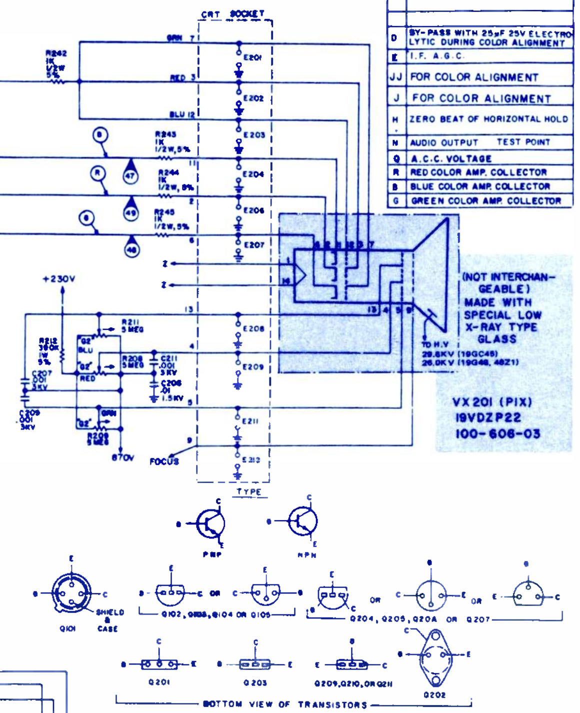
ZENITH
Color TV Chassis
19GC45, 48, 48Z1





TEST POINTS	
C1	PICTURE DETECTOR OUTPUT
C2	SOUND DETECTOR OUTPUT
D	BY-PASS WITH 25μF 25V ELECTROLYTIC DURING COLOR ALIGNMENT
E	I.F. A.G.C.
JJ	FOR COLOR ALIGNMENT
J	FOR COLOR ALIGNMENT
H	ZERO BEAT OF HORIZONTAL HOLD
N	AUDIO OUTPUT TEST POINT
Q	A.C.C. VOLTAGE
R	RED COLOR AMP. COLLECTOR
B	BLUE COLOR AMP. COLLECTOR
G	GREEN COLOR AMP. COLLECTOR

NOTES

TURN POWER OFF BEFORE REPLACING SEMICONDUCTORS

PHOTOGRAPHS TAKEN ON A STANDARD GATED RAINBOW COLOR BAR SIGNAL THE HUE SETTING ADJUSTED FOR PROPER COLOR. THE WAVE SHAPES AT THE RED, GREEN AND BLUE CATHODE GRIDS OF THE PICTURE TUBE DEPEND ON THE HUE, COLOR LEVEL, CONTRAST AND PICTURE PEAKING CONTROLS

FOR WAVEFORMS 43 THRU 49, TEST POINT "D" MUST BE BY-PASSED WITH A 0.1 μF CAPACITOR.

ALL VOLTAGES MEASURED FROM CHASSIS TO POINTS INDICATED.

ALL VOLTAGES ARE D.C. UNLESS OTHERWISE SPECIFIED.

ALL D.C. VOLTAGES TO BE MEASURED WITH A VACUUM TUBE VOLTMETER HAVING 11 MEGOHM INPUT RESISTANCE.

ALL VOLTAGE MEASUREMENTS TO BE MADE WITH NO SIGNAL PRESENT AND NORMAL SETTING OF CONTROLS AND CHANNEL SELECTOR SET TO CHANNEL 2 UNLESS OTHERWISE SPECIFIED.

RESISTANCE MEASUREMENTS SHOWN WITH COILS DISCONNECTED FROM CIRCUIT.

ALL RESISTORS ARE ± 10% TOLERANCE, CARBON, 1/2 WATT UNLESS OTHERWISE SPECIFIED.

COIL RESISTANCE NOT GIVEN UNDER ONE OHM.

ALL CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED

FOR CAPACITOR TOLERANCE, SEE LEGEND.

CATHODE RAY TUBE 2ND. ANODE VOLTAGE TO BE MEASURED WITH ELECTROSTATIC OR 20K OHMS PER VOLT MIN. HIGH VOLTAGE METER.

ARROWS ON POTENTIOMETER INDICATE CLOCKWISE ROTATION.

○— INDICATES ALIGNMENT AND TEST POINT.

PF = PICOFARAD MHz = MEGAHERTZ μH = MICROHENRY

INDICATES ± 20% MAY BE USED. ○— INDICATES VOLTAGE SOURCE.

(2)▶ INDICATES WAVEFORMS CHECK POINTS (SEE CHART WAVEFORM MEASURED FROM POINT INDICATED TO CHASSIS GROUND.)

INDICATES WAVEFORM (SEE CHART) WAVEFORM MEASURED ACROSS POINTS INDICATED (NOT TO CHASSIS GROUND) OSCILLOSCOPE SHOULD NOT BE GROUNDED TO CHASSIS. REVERSING LEADS REVERSES WAVEFORM.

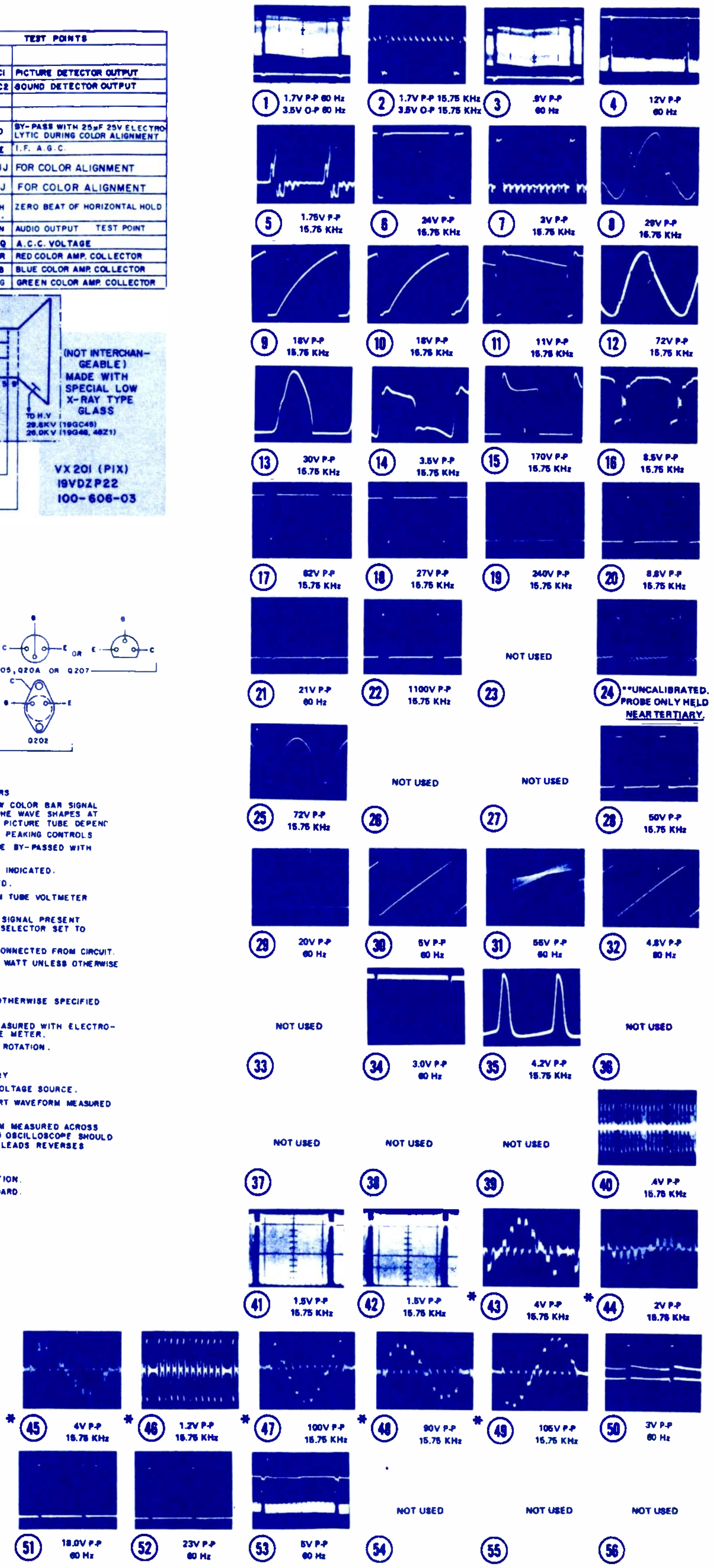
INDICATES CHASSIS GROUND.

(S)— INDICATES CHROMATIC SWITCH WIRING POSITION.

AJ INDICATES PIN NUMBERS ON MODULE BOARD.

IMPORTANT SAFETY NOTICE

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



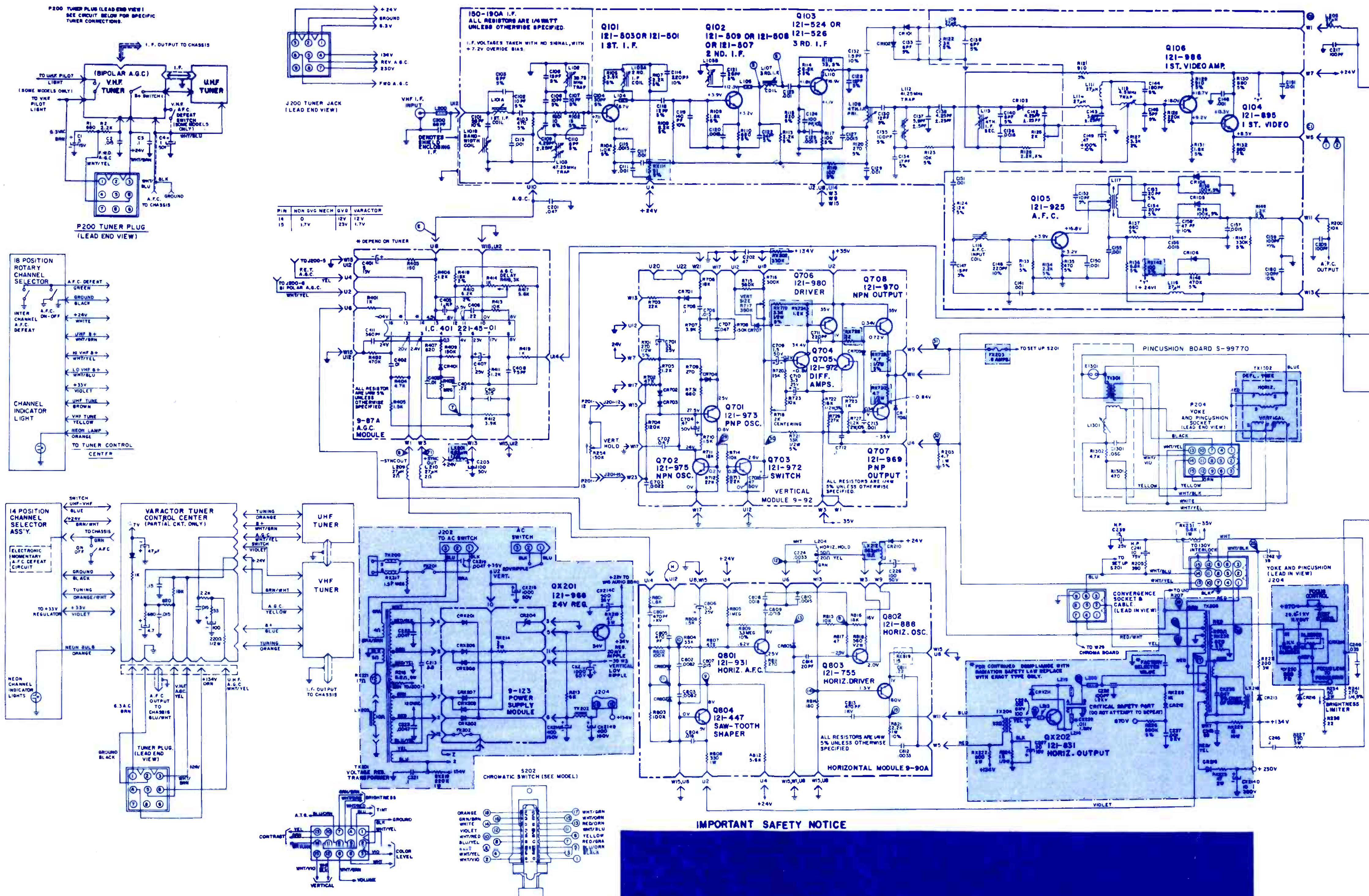
1844

ZENITH
Color TV Chassis
25GC45, 45Z

MAY • 1980

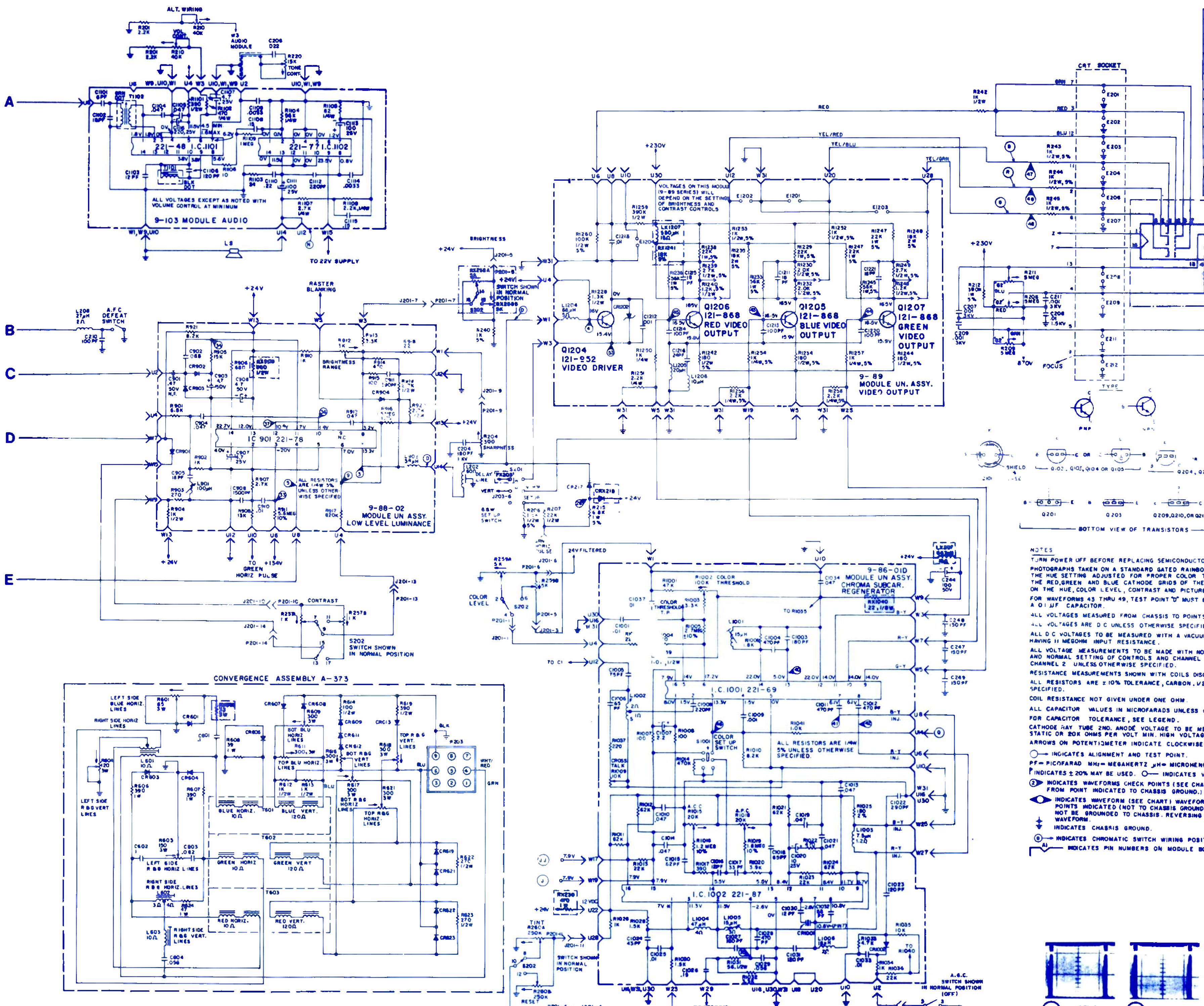
ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS



IMPORTANT SAFETY NOTICE

ZENITH
Color TV Chassis
25GC45, 45Z



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E	I.F. A.G.C
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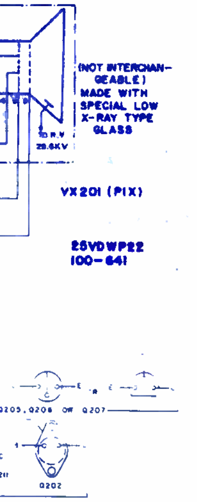
J	FOR COLOR ALIGNMENT
H	ZERO BEAT OF HORIZONTAL HOLD
M	AUDIO OUTPUT TO SPEAKER
Q	A.C.C. VOLTAGE
R	RED COLOR AMP. COLLECTOR
B	BLUE COLOR AMP. COLLECTOR
G	GREEN COLOR AMP. COLLECTOR



NOTES

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PHOTOGRAPHS TAKEN ON A STANDARD GATED RAINBOW COLOR BAR SIGNAL THE HUE SETTING ADJUSTED FOR PROPER COLOR. THE WAVE SHAPES AT THE RED,GREEN AND BLUE CATHODE GRIDS OF THE PICTURE TUBE DEPEND ON THE HUE, COLOR LEVEL, CONTRAST AND PICTURE PEAKING CONTROLS

FOR WAVEFORMS 43 THRU 49, TEST POINT "D" MUST BE BY-PASSED WITH A 0.1 µF CAPACITOR.

ALL VOLTAGES MEASURED FROM CHASSIS TO POINTS INDICATED.

ALL VOLTAGES ARE D.C UNLESS OTHERWISE SPECIFIED.

ALL D.C VOLTAGES TO BE MEASURED WITH A VACUUM TUBE VOLTMETER HAVING 11 MEGOHM INPUT RESISTANCE.

ALL VOLTAGE MEASUREMENTS TO BE MADE WITH NO SIGNAL PRESENT AND NORMAL SETTING OF CONTROLS AND CHANNEL SELECTOR SET TO CHANNEL 2 UNLESS OTHERWISE SPECIFIED.

RESISTANCE MEASUREMENTS SHOWN WITH COILS DISCONNECTED FROM CIRCUIT

ALL RESISTORS ARE ± 10% TOLERANCE, CARBON, 1/2 WATT UNLESS OTHERWISE SPECIFIED.

COIL RESISTANCE NOT GIVEN UNDER ONE OHM.

ALL CAPACITOR VALUES IN MICROFARADS UNLESS OTHERWISE SPECIFIED

FOR CAPACITOR TOLERANCE, SEE LEGEND.

CATHODE RAY TUBE 2ND. ANODE VOLTAGE TO BE MEASURED WITH ELECTROSTATIC OR 20K OHMS PER VOLT MIN. HIGH VOLTAGE METER.

ARROWS ON POTENTIOMETER INDICATE CLOCKWISE ROTATION.

INDICATES ALIGNMENT AND TEST POINT.

PF= PICOFARAD MHz= MEGAHERTZ µH= MICROHENRY

INDICATES ± 20% MAY BE USED. INDICATES VOLTAGE SOURCE.

INDICATES WAVEFORMS CHECK POINTS (SEE CHART WAVEFORM MEASURED FROM POINT INDICATED TO CHASSIS GROUND.)

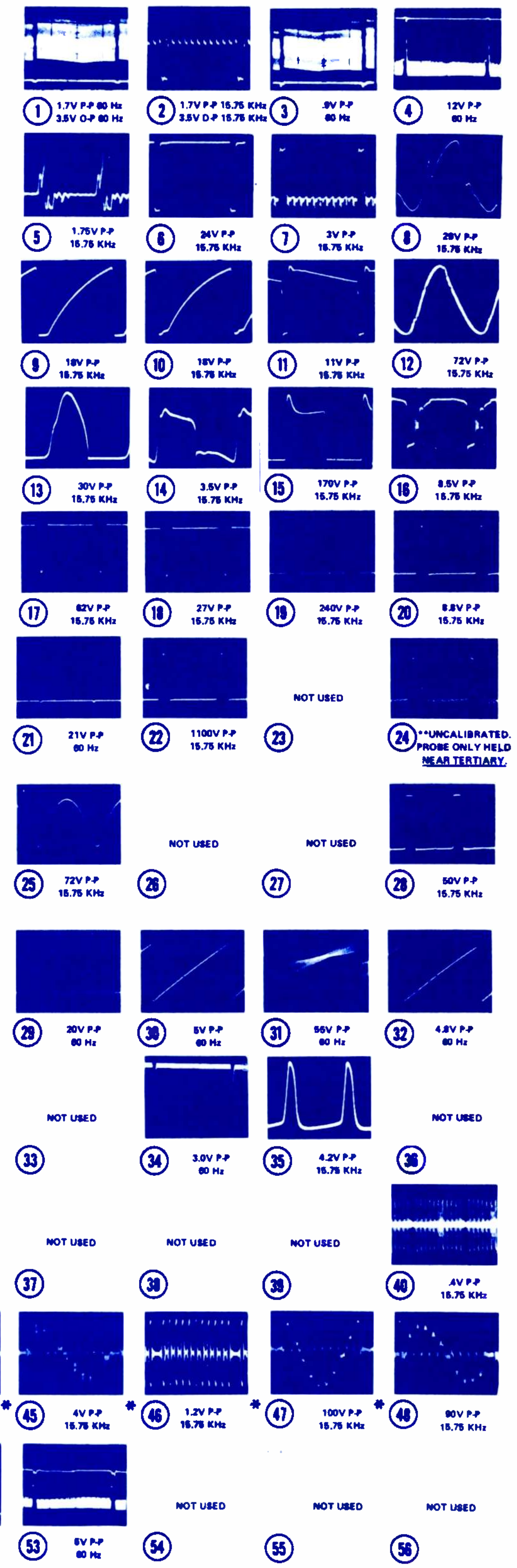
INDICATES WAVEFORM (SEE CHART) WAVEFORM MEASURED ACROSS POINTS INDICATED (NOT TO CHASSIS GROUND) OSCILLOSCOPE SHOULD NOT BE GROUNDED TO CHASSIS. REVERSING LEADS REVERSES WAVEFORM.

INDICATES CHASSIS GROUND.

INDICATES CHROMATIC SWITCH WIRING POSITION

INDICATES PIN NUMBERS ON MODULE BOARD.

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



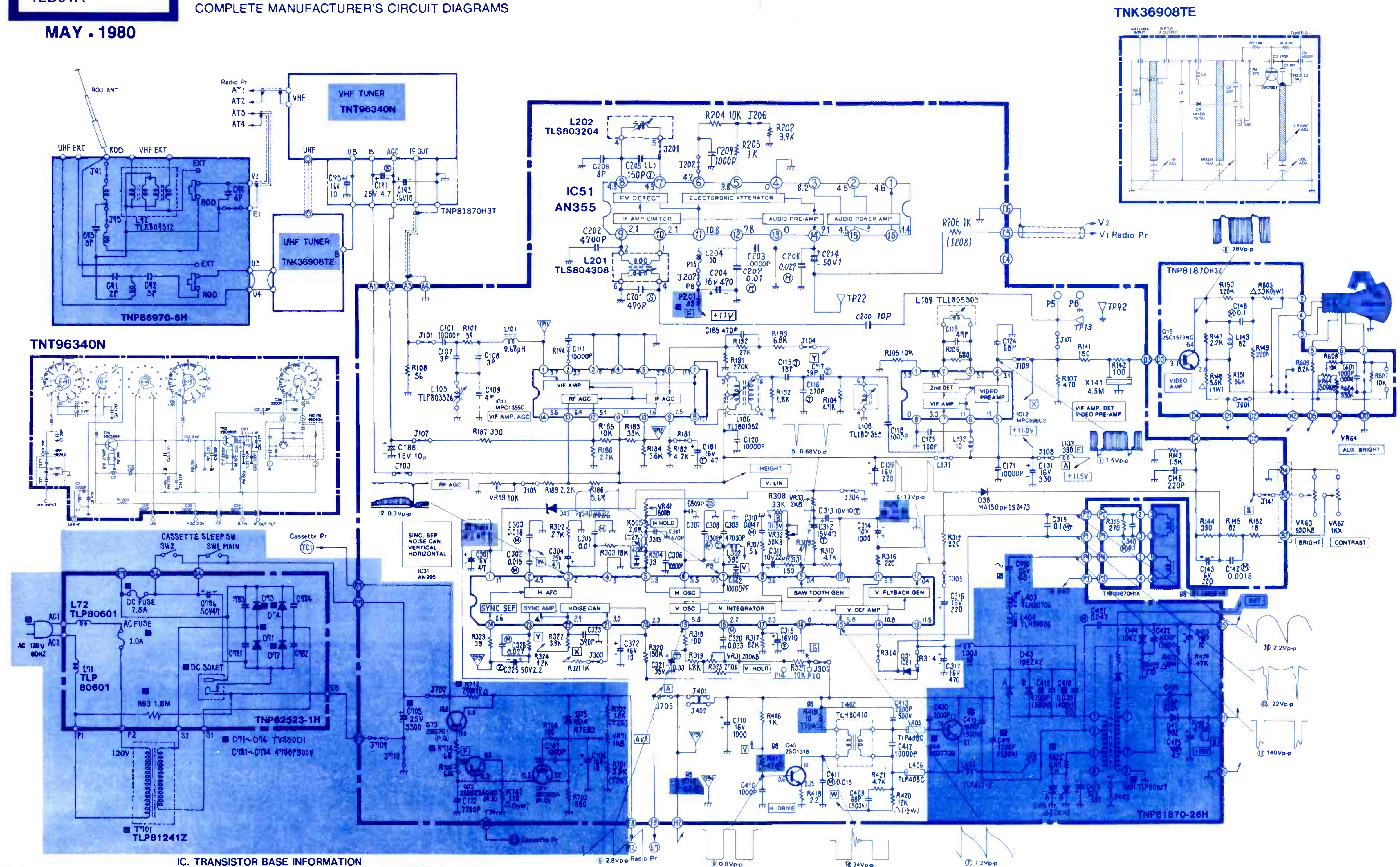
1845

PANASONIC
B&W TV Chassis
12B01A

MAY • 1980

ET/D TEKFAX

COMPLETE MANUFACTURER'S CIRCUIT DIAGRAMS

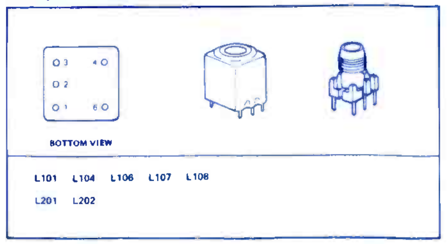


NOTE: The volume control does not function in the record mode.
To monitor the sound being recorded. Use the monitor switch (Located on the side of the cabinet) to turn the sound on and to a high or low level.
The monitor switch does not affect the recording level.

IC. TRANSISTOR BASE INFORMATION

	TVSMPC1355C		2SC1573
	TVSMPC596C2		2SC828A 2SC1359
	AN295		2SC1686
	AN7218 AN355		2SD389BLB

TRANSFORMER TERMINAL INFORMATION



NOTE

1. RESISTOR
All resistors are carbon 1/4W resistor, unless otherwise noted the following marks.
Unit of resistance is OHM (Ω), (K= 1,000, M= 1,000,000)
Δ : Solid resistor ● : Metal oxide resistor
□ : Wire wound resistor : Thermistor
: Fuse resistor
2. CAPACITOR
All capacitors are ceramic 50V capacitor, unless otherwise noted the following marks.
Unit of capacitance is μF, unless otherwise noted.
Ⓜ : Polyester capacitor S : Polystylene capacitor
: Electrolytic capacitor
3. COIL
Unit of inductance is μH.
4. TEST POINT
▽ : Test point position
5. VOLTAGE MEASUREMENT
Voltage is measured by a volt ohm meter with DC 20K OHM/V receiving normal signal, when all controls are set to the maximum position.
6. Number in red circle indicates waveform number.
7. When arrow mark (↗) is found, connection is easily found along with the direction of an arrow.
8. When schematic diagram of a board is described in more than two places, they are encircled with dotted line (— · —).
9. This schematic diagram is the latest at the time of printing and subject to change without notice.

IMPORTANT SAFETY NOTICE

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

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JAPANESE TRANSISTOR SUBSTITUTION MANUAL

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

PARTS PROCUREMENT PROBLEMS

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

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

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

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

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

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

TYPE	25-UP	10-24	1-9
2SD 234	.60	.70	.80
2SD 235	.60	.70	.80
2SD 261	.35	.40	.45
2SD 287	2.50	2.70	2.90
2SD 300	4.50	5.00	5.60
2SD 313	.60	.70	.80
2SD 315	.60	.70	.80
2SD 325	.60	.70	.80
2SD 330	.60	.70	.80
2SD 350	3.80	4.00	4.40
2SD 380	5.20	5.40	5.95
2SD 381	.85	1.00	1.10
2SD 424	3.80	4.00	4.40
2SD 425	2.90	3.20	3.40
2SD 426	3.10	3.30	3.60
2SD 427	1.80	2.00	2.25
2SD 525	.90	1.10	1.20
2SD 526	.60	.70	.80
2SK 19BL	.50	.55	.60
3SK 22Y	1.40	1.60	1.80
3SK 39	.90	1.10	1.20
3SK 40	.90	1.10	1.20
3SK 41	1.30	1.45	1.60
3SK 45	1.30	1.45	1.60
AN 203	1.40	1.60	1.80
AN 214Q	1.50	1.70	1.90
AN 239	4.20	4.40	4.90
AN 247	2.50	2.70	3.00
AN 274	1.50	1.75	1.95
AN 313	3.00	3.20	3.40
AN 315	1.80	2.00	2.25
BA 511A	1.80	2.00	2.25
BA 521	1.90	2.10	2.40
HA 1151	1.50	1.75	1.95
HA 1156W	1.60	1.80	2.00
HA 1306W	2.00	2.20	2.50
HA 1339	2.50	2.70	3.00
HA 1339A	2.50	2.70	3.00
HA 1342A	2.50	2.70	3.00
HA 1366W	2.50	2.70	3.00
HA 1366WR	2.50	2.70	3.00
LA 4031P	1.80	2.00	2.25
LA 4032P	1.80	2.00	2.25
LA 4051P	1.80	2.00	2.25
LA 4400	1.90	2.10	2.40
LA 4400Y	2.00	2.20	2.50
LA 4420	2.00	2.20	2.50
LD 3001	2.00	2.20	2.50
M5 1513L	2.00	2.20	2.50
STK 011	3.80	4.00	4.40
STK 013	7.60	8.00	8.80
STK 015	4.20	4.40	4.90
STK 435	4.50	5.00	5.60
STK 439	7.90	8.00	8.80
TA 7045M	2.00	2.20	2.50
TA 7055P	2.00	2.20	2.50
TA 7061AP	.90	1.10	1.20
TA 7062P	1.10	1.25	1.40
TA 7203P	2.50	2.70	2.90
TA 7204P	2.00	2.20	2.50
TA 7205P	1.60	1.80	2.00
TA 7222P	3.40	3.55	3.90
TA 7310P	1.30	1.45	1.60
TBA 810SH	1.90	2.10	2.40
TC 5080P	5.00	5.20	5.80
TC 5081P	3.00	3.20	3.40
TC 5082P	3.40	3.55	3.90
UHIC 001	4.20	4.40	4.90
UHIC 002	4.20	4.40	4.90
UHIC 003	4.20	4.40	4.90
UHIC 004	4.20	4.40	4.90
UHIC 005	4.20	4.40	4.90
uPC 20C	2.10	2.50	2.80
uPC 563	1.90	2.10	2.40
uPC 575C2	1.30	1.45	1.60
uPC 576	1.90	2.10	2.40
uPC 592H	.70	.80	.90
uPC 1001H	1.90	2.10	2.40
uPC 1008C	4.20	4.40	4.90
uPC 1020H	1.90	2.10	2.40
uPC 1025	1.90	2.10	2.40
uPC 1154	2.00	2.20	2.50
uPC 1155	2.00	2.20	2.50
uPC 1156	1.90	2.10	2.40
uPD 861	8.00	8.40	9.50
uPD 857	8.00	8.40	9.50
uPD 858	6.00	6.30	7.00
PLL 0IA	3.00	4.20	4.60
PLL 02A	5.00	5.20	5.90
PLL 03A	7.60	8.00	8.80
C-3001	1.30	1.45	1.60
2SC F8	2.20	2.70	2.90
4004	1.90	2.10	2.40
4005	2.00	2.20	2.50
SG 613	5.20	5.40	5.95
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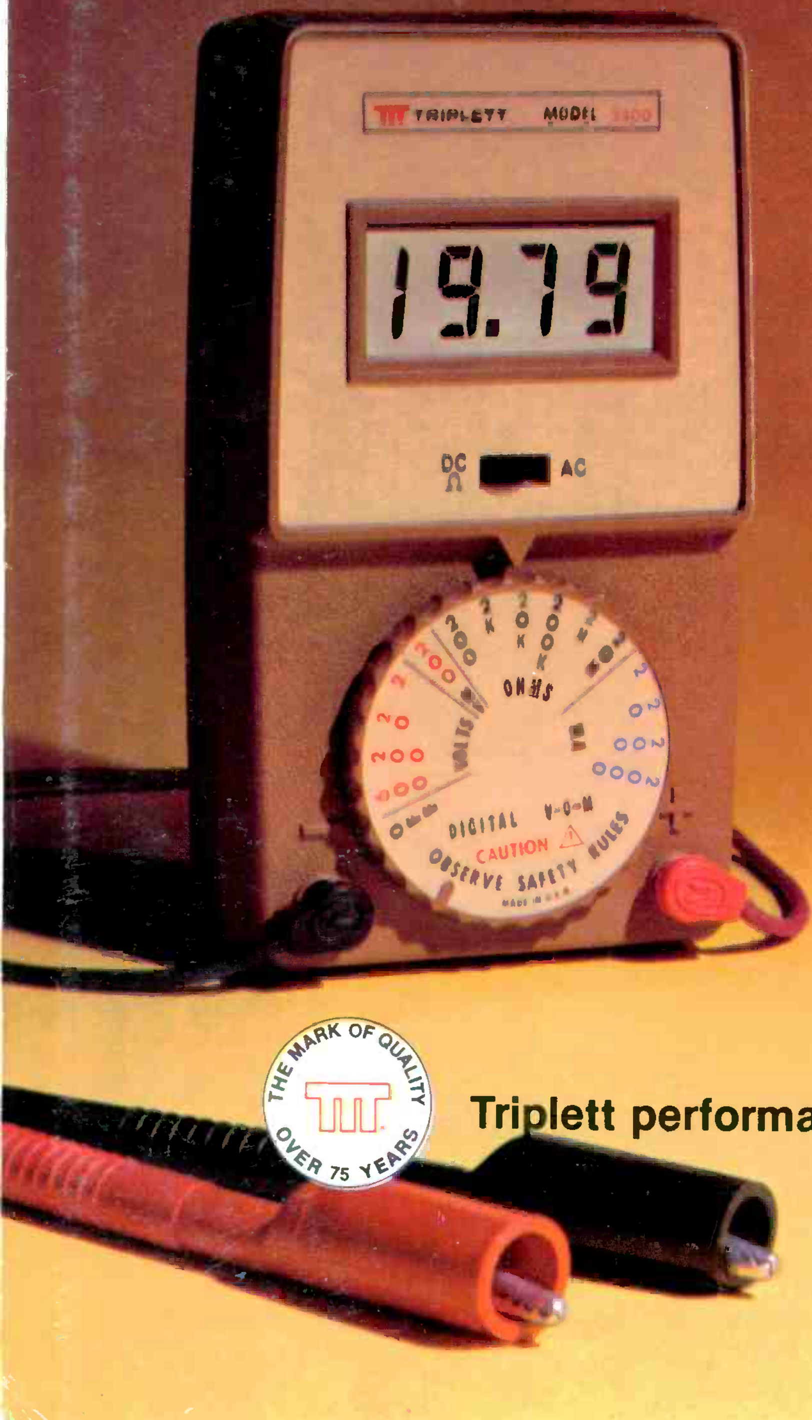

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