TECHNICAL MANUAL

for

SPECTRUM ANALYZER GROUP MODEL FSA-3

WORLD WIDE SUPPLIERS OF ELECTRONIC COMMUNICATIONS EQUIPMENT

THE TECHNICAL MATERIEL CORPORATION

MAMARONECK, N.Y. OTTAWA, CANADA

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IN-0297 Issue Date: 1 AUG 1964

NOTICE

WORLD WIDE SUPPLIERS OF ELECTRONIC COMMUNICATIONS EQUIPMENT

THE TECHNICAL MATERIEL CORPORATION

COMMUNICATIONS ENGINEERS

700 FENIMORE ROAD MAMARONECK, N. Y.

Warranty

The Technical Materiel Corporation, hereinafter referred to as TMC, warrants the equipment (except electron tubes*, fuses, lamps, batteries and articles made of glass or other fragile or other expendable materials) purchased hereunder to be free from defect in materials and workmanship under normal use and service, when used for the purposes for which the same is designed, for a period of one year from the date of delivery F.O.B. factory. TMC further warrants that the equipment will perform in a manner equal to or better than published technical specifications as amended by any additions or corrections thereto accompanying the formal equipment offer.

TMC will replace or repair any such defective items, F.O.B. factory, which may fail within the stated warranty period, PROVIDED:

1. That any claim of defect under this warranty is made within sixty (60) days after discovery thereof and that inspection by TMC, if required, indicates the validity of such claim to TMC's satisfaction.
2. That the defect is not the result of damage incurred in shipment from or to the factory.
3. That the equipment has not been altered in any way either as to design or use whether by replacement parts not supplied or approved by TMC, or otherwise.
4. That any equipment or accessories furnished but not manufactured by TMC, or not of TMC design shall be subject only to such adjustments as TMC may obtain from the supplier thereof.

Electron tubes* furnished by TMC, but manufactured by others, bear only the warranty given by such other manufacturers. Electron tube warranty claims should be made directly to the manufacturer of such tubes.

TMC's obligation under this warranty is limited to the repair or replacement of defective parts with the exceptions noted above.

At TMC's option any defective part or equipment which fails within the warranty period shall be returned to TMC's factory for inspection, properly packed with shipping charges prepaid. No parts or equipment shall be returned to TMC, unless a return authorization is issued by TMC.

No warranties, express or implied, other than those specifically set forth herein shall be applicable to any equipment manufactured or furnished by TMC and the foregoing warranty shall constitute the Buyers sole right and remedy. In no event does TMC assume any liability for consequential damages, or for loss, damage or expense directly or indirectly arising from the use of TMC Products, or any inability to use them either separately or in combination with other equipment or materials or from any other cause.

*Electron tubes also include semi-conductor devices.

PROCEDURE FOR RETURN OF MATERIAL OR EQUIPMENT

Should it be necessary to return equipment or material for repair or replacement, whether within warranty or otherwise, a return authorization must be obtained from TMC prior to shipment. The request for return authorization should include the following information:

1. Model Number of Equipment.
2. Serial Number of Equipment.
3. TMC Part Number.
4. Nature of defect or cause of failure.
5. The contract or purchase order under which equipment was delivered.

PROCEDURE FOR ORDERING REPLACEMENT PARTS

When ordering replacement parts, the following information must be included in the order as applicable:

1. Quantity Required.
2. TMC Part Number.
3. Equipment in which used by TMC or Military Model Number.
4. Brief Description of the Item.
5. The *Crystal Frequency* if the order includes crystals.

PROCEDURE IN THE EVENT OF DAMAGE INCURRED IN SHIPMENT

TMC's Warranty specifically excludes damage incurred in shipment to or from the factory. In the event equipment is received in damaged condition, the carrier should be notified immediately. Claims for such damage should be filed with the carrier involved and not with TMC.

All correspondence pertaining to Warranty Claims, return, repair, or replacement and all material or equipment returned for repair or replacement, within Warranty or otherwise, should be addressed as follows:

THE TECHNICAL MATERIEL CORPORATION
Engineering Services Department
700 Fenimore Road
Mamaroneck, New York

RECORD OF CORRECTIONS MADE

Change No.	Date of Change	Date Entered	Entered By

CHANGE NO. 1 FSA-3

INSTRUCTION BOOK CHANGE NOTICE

Date 6/22/65

Manual affected: Spectrum Analyzer Group, Model FSA-3 IN -0297
(Issue Date: 1 August 1964)

Section 7. Parts List.

Remove page 7-1 from the manual, and insert pages 7-1 through 7-18 provided with this change notice.

SHOULD ADDITIONAL COPIES OF THIS CHANGE NOTICE BE REQUIRED, PLEASE CONTACT:
THE TECHNICAL MATERIEL CORP., 700 Fenimore Road, Mamar neck, New York
Attn.: Director of Eng. Services.

SECTION 7

PARTS LIST

7-1. INTRODUCTION.

Reference designations have been assigned to identify all electrical parts of the equipment. These designations are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams and the parts list. The letters of a reference designation indicate the kind of part (generic group), such as resistor, capacitor, transistor, etc. The number differentiates between parts of the same generic group. Sockets associated with a particular plug-in device, such as transistor or fuse, are identified by a reference designation which includes the reference designation of the plug-in device. For example, the socket for fuse F601 is designated XF601. To expedite delivery, when ordering replacement parts, specify the TMC part number and the model number of the equipment.

NOTE

For all symbol numbers denoted by an asterisk see Manufacturers Code for list of Replaceable Parts, located at the end of the parts list, to determine manufacturer and manufacturers part number.

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C601	CAPACITOR, FIXED, ELECTROLYTIC: 20 uf, 500 V.	CE31X200S-1
C602	CAPACITOR, FIXED, ELECTROLYTIC: 30 uf, 500 V.	CE31X300S-1
*C603	CAPACITOR, FIXED, PAPER DIELECTRIC: 0.25 uf, 3,000 WVDC.	
C604	Same as C603.	
C605	Same as C603.	
C606	Same as C603.	
C607	CAPACITOR, FIXED, CERAMIC DIELECTRIC: .01 uf, 500 WVDC.	CC2003-2
C608	CAPACITOR, FIXED, PLASTIC DIELECTRIC: 0.1 uf, 400 WVDC.	CT2011-10
C609	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, 25 V.	CE105-25-25
*C610	CAPACITOR, FIXED: 0.01 uf, 1000 WVDC.	
C611	Same as C610.	
CR601	RECRIFIER: selenium; half wave; cartridge type; 5 ma; 2,000 V.	CR2005
CR602	Same as CR601.	
EV103	SHIELD, ELECTRON TUBE	TS102U02
EV104	SHIELD, ELECTRON TUBE	TSF0T102
F601	FUSE: instantaneous; glass cartridge; 2 amps, 250 V.	F1003
F602	Same as F601.	
J601	CONNECTOR, RECEPTACLE, ELECTRICAL: 14 female contacts; solid shell, box mounting.	MS3102A28-2S
J602	JACK: tip; black.	J2001
J603	CONNECTOR, RECEPTACLE, ELECTRICAL: male; 3 wire, AC power; polarized; twist lock; flush mount.	J1002
L601	FILTER: reactor; 8 hy; 110 ma.	L210789
R601	RESISTOR, FIXED, COMPOSITION: 820,000 ohms, ±5%; 1/2 watt.	RC20GF824J
R602	RESISTOR, FIXED, COMPOSITION: 680,000 ohms, ±5%; 1/2 watt.	RC20GF684J
R603	RESISTOR, FIXED, COMPOSITION: 510,000 ohms, ±5%; 1 watt.	RC32GF514J
R604	Same as R603.	
R605	RESISTOR, FIXED, WIREWOUND: 20,000 ohms, ±5%; 10 watts.	RW109-37
R606	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; 1/2 watt.	RC20GF103J
R607	RESISTOR, FIXED, COMPOSITION: 68,000 ohms, ±5%; 1/2 watt.	RC20GF683J
R608	RESISTOR, FIXED, COMPOSITION: 47,000 ohms, ±5%; 1 watt.	RC32GF473J

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R609	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, ±10%; 2 watts; linear taper A.	RV4LAYSA103A
R610	RESISTOR, FIXED, WIREWOUND: 6,000 ohms, ±5%; current rating 28 ma; 5 watts.	RW107-48
R611	RESISTOR, FIXED, COMPOSITION: 1 meg. ohms, ±5%; 1/2 watt.	RC20GF105J
R612	RESISTOR, FIXED, COMPOSITION: 75,000 ohms, ±5%; 1 watt.	RC32GF753J
R613	RESISTOR, FIXED, COMPOSITION: 51 ohms, ±5%; 1 watt.	RC32GF510J
R614	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, ±5%; 1 watt.	RC32GF104J
R615	Same as R614.	
R616	RESISTOR, FIXED, COMPOSITION: 10 megohms, ±5%; 2 watts.	RC42GF106J
R617	Same as R616.	
R618	RESISTOR, FIXED, COMPOSITION: 5.1 megohms, ±5%; 2 watts.	RC42GF515J
R619	Same as R618.	
R620	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, ±5%; 1/2 watt.	RC20GF104J
T601	TRANSFORMER, POWER: low voltage; primary-115/230 V, 50-60 cycles; secondary- 750 VCT, 150 ma DC; 6.5 V, 4 amps; 5 V, 2 amps.	T39877B
T602	TRANSFORMER, POWER: high voltage; pri- 115/230 V, 50-60 cps; sec- 6.4 V, 0.6 amps; 2.5 V, 1.75 amps; 1200 V, 4 ma; 6.3 V, 6 amps	T39875D
V101	TUBE, ELECTRON: full wave rectifier; 8 pin, octal.	5V4G
V102	TUBE, ELECTRON: low-mu twin triode, power type; 8 pin, octal.	6AS7G
V103	TUBE, ELECTRON: high-mu twin triode; 9 pin miniature.	12AX7
V104	TUBE, ELECTRON: voltage reference; 7 pin miniature.	5651
*XF601	FUSEHOLDER: 3 ACG	
XF602	Same as XF601.	
XV101 thru XV104	SOCKET, ELECTRON TUBE Part number to be supplied at a later date.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C101	CAPACITOR, FIXED, CERAMIC DIELECTRIC: .02 uf, 500 WVDC.	CC100-24
C102	CAPACITOR, FIXED, PLASTIC DIELECTRIC: .1 uuf, ±5%; 400 WVDC.	CN112A104M4
C103	CAPACITOR, FIXED, MICA DIELECTRIC: 910 uuf.	CM20C911J
C104	CAPACITOR, FIXED, MICA DIELECTRIC: 470 uuf.	CM15C471K
C105	CAPACITOR, FIXED, MICA DIELECTRIC: 560 uuf.	CM20C561K
C106	Same as C101.	
*C107	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 1-8 uuf	
C108	CAPACITOR, FIXED, PLASTIC DIELECTRIC: .47 uuf, 400 WVDC.	CN112A474K4
C109	Same as C102.	
C110	CAPACITOR, FIXED, CERAMIC DIELECTRIC: .01 uf, 500 WVDC.	CC100-16
C111	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf	CM20A101K
C112 thru C115	Same as C102.	
C116	Same as C111.	
C117	Same as C110.	
C118	Same as C108.	
C119 thru C121	Same as C102.	
C122	Same as C108.	
C123	Same as C111.	
C124	Same as C110.	
C125	Same as C102.	
C126	CAPACITOR, FIXED, MICA DIELECTRIC: 100 uuf	CM15A101K
C127	CAPACITOR, FIXED, MICA DIELECTRIC: 270 uuf	CM15A271K
C128	Same as C102.	
C129	CAPACITOR, FIXED, MICA DIELECTRIC: 470 uuf	CM15A471K
C130	Same as C102.	
C131	CAPACITOR, FIXED, MICA DIELECTRIC: 1,000 uuf	CM20A102K
C132	CAPACITOR, FIXED, MICA DIELECTRIC: 10 uuf	CM15A100K
C133	Same as C126.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C134	Same as C102.	
C135	Same as C102.	
C136	Same as C110.	
C137	Same as C102.	
C138	Same as C102.	
C139	Same as C110.	
C140	Same as C102.	
C141 thru C143	Same as C110.	
C144	Same as C102.	
C145	Same as C102.	
C146	CAPACITOR, FIXED, ELECTROLYTIC: 25 uf, 25 WVDC.	CE105-25-25
C147	CAPACITOR, FIXED, MICA DIELECTRIC: .01 uf	CM30D102G
C148	Same as C147.	
C149	CAPACITOR, FIXED, MICA DIELECTRIC: 6,800 uuf	CM35D682G
C150	Same as C146.	
C151	CAPACITOR, FIXED, MICA DIELECTRIC: 820 uuf	CM20A821K
C152	Same as C102.	
C153	Same as C110.	
C154	CAPACITOR, FIXED, MICA DIELECTRIC: 5,100 uuf	CM35A512J
C155	Same as C102.	
C156	Same as C127.	
C157	Same as C108.	
C158	Same as C102.	
C159	Same as C102.	
C160	Same as C108.	
C161	Same as C102.	
C162	CAPACITOR, FIXED, MICA DIELECTRIC: 51 uuf	CM15A510J
C163	CAPACITOR, FIXED, PLASTIC DIELECTRIC: .047 uf, 400 WVDC.	CN112A473K4
C164	Same as C102.	
C165	Same as C162.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
C166	Same as C102.	
*C206	CAPACITOR, FIXED, ELECTROLYTIC: 4,000 uuf, 15 V.	
*C303	CAPACITOR, VARIABLE, CERAMIC DIELECTRIC: 3-12 uuf.	
C306	Same as C303.	
C315	Same as C303.	
C402	CAPACITOR, FIXED, PAPER DIELECTRIC: 4 uuf, 600 V	CP41B1FF405K-10
C501A, B, C, D	CAPACITOR, FIXED, ELECTROLYTIC: 4 x 20 uf, 350 V, twist lock	CE34X200P-1
CR101	RECTIFIER: silicon, 400 piv, 500 ma	1N2070
CR102 thru CR104	Same as CR101.	
EV1	SHIELD, ELECTRON TUBE	TS102U02
EV2	SHIELD, ELECTRON TUBE	TSFOT105
EV3	SHIELD, ELECTRON TUBE	TSFOT102
EV4	Same as EV3.	
EV5	Same as EV3.	
EV6	SHIELD, ELECTRON TUBE	TS102U01
EV7	Same as EV2.	
EV8	Same as EV2.	
EV9	Same as EV3.	
EV10	Same as EV2.	
EV11	Same as EV2.	
*EV12	SHIELD, CATHODE RAY TUBE	
EV13	Same as EV3.	
EV14	Same as EV2.	
EV15	Same as EV3.	
EV16	Same as EV2.	
EV17	Same as EV3.	
EV18	SHIELD, ELECTRON TUBE	TSFOT103
EV20	Same as EV2.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
*I101	LAMP	
I102 thru I105	Same as I101.	
J101	CONNECTOR, RECEPTACLE, ELECTRICAL: N type	UG58/U
J102	Same as J101.	
J103	CONNECTOR, RECEPTACLE, ELECTRICAL: BNC type	UG909A/U
J104	Same as J103.	
J105	CONNECTOR, RECEPTACLE, BULKHEAD ELECTRICAL; pressurized; 1-5/16" long; series BNC.	UG657/U
J106	CONNECTOR, RECEPTACLE, ELECTRICAL	UG1094A/U
J107	Same as J106.	
J108	JACK: tip; black.	J2001
J402	CONNECTOR, RECEPTACLE, ELECTRICAL: 10 female contacts; straight type; solid shell; box mounting.	MS3102A18-1S
J501	CONNECTOR, RECEPTACLE, ELECTRICAL: 14 male contacts; straight type; solid shell; box mounting.	MS3102A28-2P
L101	COIL, RADIO FREQUENCY: fixed; 100 uh	L1112
L101A	COIL: crystal loading; 100 Kc	ZN8223
L101B	Same as L101A.	
L101C	Same as L101A.	
L102	CHOKE, RADIO FREQUENCY: 2.5 mh.	L2019
L103	CHOKE, .68 mh ±10%; insulated	L2016
P402	CONNECTOR, PLUG, ELECTRICAL: 10 male contacts; straight type; solid shell.	MS3106A18-1P
Q3	TRANSISTOR	2N404
Q4 thru Q6	Same as Q3.	
R101	RESISTOR, VARIABLE, COMPOSITION: 100,000 ohms, ±10%; 2 watts; linear taper A.	RV025
R102	RESISTOR, FIXED, COMPOSITION: 82,000 ohms, ±5%; 2 watts.	RC42GF823J
R103	RESISTOR, FIXED, COMPOSITION: 22,000 ohms, ±5%; 1/2 watt.	RC20GF223J
R104	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; 1/2 watt.	RC20GF102J
R105	RESISTOR, FIXED, COMPOSITION: 3,300 ohms, ±5%; 1/2 watt.	RC20GF332J
R106	RESISTOR, FIXED, COMPOSITION: 180,000 ohms, ±5%; 1/2 watt	RC20GF184J

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R107	Same as R106.	
R108	Same as R104.	
R109	RESISTOR, FIXED, COMPOSITION: 8,200 ohms, ±5%; 1/2 watt.	RC20GF822J
R110	Factory adjusted resistor.	
R111	RESISTOR, FIXED, COMPOSITION: 56,000 ohms, ±10%; 1/2 watt.	RC20GF563K
R112	RESISTOR, FIXED, COMPOSITION: 220 ohms, ±5%; 1/2 watt.	RC20GF221J
R113	RESISTOR, FIXED, COMPOSITION: 2 megohms, ±5%; 1/2 watt.	RC20GF205J
R114	RESISTOR, FIXED, COMPOSITION: 430 ohms, ±5%; 1/2 watt.	RC20GF431J
R115	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; 2 watts.	RC42GF103J
R116	RESISTOR, FIXED, COMPOSITION: 1,000 ohms, ±5%; 1 watt.	RC32GF102J
R117	RESISTOR, FIXED, COMPOSITION: 10,000 ohms, ±5%; 1/2 watt.	RC20GF103J
R118	RESISTOR, FIXED, COMPOSITION: 75,000 ohms, ±5%; 1 watt.	RC32GF753J
R119	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, ±5%; 1 watt.	RC32GF104J
R120	RESISTOR, FIXED, COMPOSITION: 150 ohms, ±5%; 1/2 watt.	RC20GF151J
R121	RESISTOR, FIXED, COMPOSITION: 100,000 ohms, ±5%; 1/2 watt.	RC20GF104J
R122	Same as R112.	
R123	Same as R114.	
R124	Same as R115.	
R125	Same as R118.	
R126	Same as R118.	
R127	Same as R116.	
R128	Same as R116.	
R129	Same as R115.	
R130	Same as R117.	
R131	Same as R118.	
R132	Same as R114.	
R133	Same as R119.	
R134	Same as R120.	
R135	Same as R121.	
R136	Same as R112.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R137	RESISTOR, FIXED, COMPOSITION: 390 ohms, ±5%; 1/2 watt.	RC20GF391J
R138	Same as R104.	
R139	Same as R119.	
R140	Same as R121.	
R141	Same as R114.	
R142	RESISTOR, FIXED, COMPOSITION: 910 ohms, ±5%; 1/2 watt.	RC20GF911J
R143	RESISTOR, FIXED, COMPOSITION: 6,800 ohms, ±5%; 1/2 watt.	RC20GF682J
R144	Same as R117.	
R145	RESISTOR, FIXED, COMPOSITION: 24,000 ohms, ±5%; 1/2 watt.	RC20GF243J
R146	RESISTOR, VARIABLE, COMPOSITION: dual; 2 megohms, ±20%; 2 watts; cw taper (front section), 2 megohms, ±20%; 2 watts; cw taper (rear section)	RVT507
R147	Same as R114.	
R148	Same as R142.	
R149	Same as R143.	
R150	Same as R117.	
R151	Same as R145.	
R152	See R146.	
R153	RESISTOR, VARIABLE, COMPOSITION: 5,000 ohms, ±10%; 2 watts; linear.	RV012
R154 thru R158	Same as R153.	
R159	RESISTOR, VARIABLE, COMPOSITION: 5 megohms, ±2%; 2 watts; linear.	RV003
R160	RESISTOR, FIXED, COMPOSITION: 51,000 ohms, ±5%; 1/2 watt.	RC20GF513J
R161	Same as R103.	
R162	RESISTOR, FIXED, COMPOSITION: 200 ohms, ±5%; 1/2 watt.	RC20GF201J
R163	Same as R104.	
R164	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, ±5%; 1/2 watt.	RC20GF562J
R165	Same as R143.	
R166	RESISTOR, FIXED, COMPOSITION: 5,600 ohms, ±5%; 1 watt.	RC32GF562J
R167	RESISTOR, FIXED, COMPOSITION: 47,000 ohms, ±5%; 1 watt.	RC32GF473J

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R168	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, ±5%; 1 watt.	RC32GF333J
R169	RESISTOR, FIXED, COMPOSITION: 100 ohms, ±5%; 1/2 watt.	RC20GF101J
R170	RESISTOR, VARIABLE, COMPOSITION: 50,000 ohms, 2 watts (1" S-shaft).	RV4NAYSG503A
R171	RESISTOR, VARIABLE, COMPOSITION: 50,000 ohms, ±10%; 2 watts; linear.	RV014
R172	Same as R169.	
R173	RESISTOR, FIXED, COMPOSITION: 68,000 ohms, ±5%; 1/2 watt.	RC20GF683J
R174	Same as R101.	
R175	Same as R160.	
R176	RESISTOR, FIXED, COMPOSITION: 120 ohms, ±5%; 1/2 watt.	RC20GF121J
R177	RESISTOR, FIXED, COMPOSITION: 620 ohms, ±5%; 1/2 watt.	RC20GF621J
R178	RESISTOR, FIXED, COMPOSITION: 220,000 ohms, ±5%; 1/2 watt.	RC20GF224J
R179	Same as R119.	
R180	RESISTOR, FIXED, COMPOSITION: 150,000 ohm, ±5%; 1 watt.	RC32GF154J
R181	Same as R119.	
R182	RESISTOR, FIXED, COMPOSITION: 1 megohm; ±5%; 1/2 watt.	RC20GF105J
R183	Same as R178.	
R184	Same as R164.	
R185	RESISTOR, FIXED, COMPOSITION: 5,100 ohms, ±5%; 1/2 watt.	RC20GF512J
R186	RESISTOR, VARIABLE, COMPOSITION: 500,000 ohms, ±10%; 2 watts; linear taper.	RV015
R187	Same as R118.	
R188	RESISTOR, VARIABLE, COMPOSITION: 50 ohms, 2 watts (consists of S104).	RV4NBYSC500A
R189	RESISTOR, FIXED, COMPOSITION: 18 ohms, ±10%; 2 watts.	RC42GF180K
R190	RESISTOR, VARIABLE, COMPOSITION: 50 ohms, 2 watts.	RV4LAYSA500A
R191	RESISTOR, FIXED, COMPOSITION: 15 ohms, ±5%; 1/2 watt.	RC20GF150J
R192	RESISTOR, FIXED, FILM: 253 ohms, ±1%; 1/2 watt.	RC20AZ2530F
R193	RESISTOR, FIXED, FILM: 72.8 ohms, ±1%; 1/2 watt.	RC20AZ72P8F
R194 thru R196	Same as R193.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R197	RESISTOR, FIXED, FILM: 31 ohms, ±1%; 1/2 watt.	RC20AZ310F
R198	RESISTOR, FIXED, FILM: 62.3 ohms, ±1%; 1/2 watt.	RC20AZ62P3F
R199	Same as R198.	
R200	RESISTOR, FIXED, FILM: 98 ohms, ±1%; 1/2 watt.	RC20AZ980F
R201 thru R207	Same as R200.	
R208	RESISTOR, FIXED, FILM: 182 ohms, ±1%; 1/2 watt.	RC20AZ1820F
R209	Same as R208.	
R210	RESISTOR, FIXED, COMPOSITION: 51 ohms, ±5%; 1/2 watt.	RC20GF510J
R211	Same as R104.	
R212	Same as R169.	
R213	Same as R104.	
R214	Same as R115.	
R215	Same as R210.	
R216	RESISTOR, FIXED, COMPOSITION: 4,300 ohms, ±5%; 1 watt.	RC32GF432J
R217	Same as R185.	
R218	RESISTOR, FIXED, COMPOSITION: 270 ohms, ±5%; 1/2 watt.	RC20GF271J
R219	Same as R167.	
R220	Same as R167.	
R221	RESISTOR, FIXED, COMPOSITION: 2,200 ohms, ±5%; 1/2 watt.	RC20GF222J
R222	RESISTOR, FIXED, COMPOSITION: 33,000 ohms, ±5%; 1/2 watt.	RC20GF333J
R223	Same as R160.	
R224	Same as R164.	
R225	Same as R113.	
R226	RESISTOR, FIXED, COMPOSITION: 390,000 ohms, ±5%; 1 watt.	RC32GF394J
R227	RESISTOR, FIXED, COMPOSITION: 510,000 ohms, ±5%; 1 watt.	RC32GF514J
*R228	RESISTOR, VARIABLE, COMPOSITION: 500,000 ohms, 2 watts, 1/8" S-shaft	
R229	RESISTOR, FIXED, COMPOSITION: 270,000 ohms, ±5%; 1 watt.	RC32GF274J
R230	Same as R117.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
*R231	RESISTOR, VARIABLE, COMPOSITION: 100,000 ohms, 2 watts, 1/8" S-shaft.	
R232	Same as R167.	
R233	Same as R171.	
R234	Same as R167.	
R235	RESISTOR, FIXED, COMPOSITION: 240,000 ohms, ±5%; 1/2 watt.	RC20GF244J
R236	RESISTOR, VARIABLE, COMPOSITION: 2 megohms, ±10%; 2 watts; linear taper	RV4LAYSA205A
R237	RESISTOR, VARIABLE, COMPOSITION: 25,000 ohms, ±10%; 2 watts; linear taper.	RV4LAYSA253A
R238	Same as R185.	
R239	Same as R167.	
R240	RESISTOR, VARIABLE, COMPOSITION: dual; 1 megohm, ±20%; 2 watts, linear (front section), 10,000 ohms, ±10%; 2 watts, linear (rear section)	RVT505
R241	Same as R167.	
R242	NOT USED	
R243	RESISTOR, FIXED, COMPOSITION: 15,000 ohms, ±5%; 1/2 watt.	RC20GF153J
R244	RESISTOR, FIXED, COMPOSITION: 62,000 ohms, ±5%; 1/2 watt.	RC20GF623J
R245	RESISTOR, FIXED, WIREWOUND: 3,500 ohms, 20 watts.	RW20X352R-4
*R246	RESISTOR, FIXED, FILM: 8,500 ohms, ±1%; 1/2 watt.	
R247	Same as R246.	
R248	RESISTOR, FIXED, WIREWOUND: 40,000 ohms, ±5%; 10 watts.	RW109-41
R249	NOT USED	
R250	Same as R222.	
R251	Same as R222.	
R252	Same as R210.	
R253	Same as R121.	
R254	RESISTOR, VARIABLE, COMPOSITION: 250 ohms, 2 watts.	RV4LAYSA251A
R255	RESISTOR, FIXED, COMPOSITION: 560 ohms, ±5%; 1/2 watt.	RC20GF561J
R256	Same as R162.	
R257	See R240.	
R258	Same as R210.	

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R259	Same as R178.	
R260	Same as R227.	
R261	Same as R227.	
R262	NOT USED	
R263	RESISTOR, FIXED, COMPOSITION: 15,000 ohms, ±5%; 1 watt.	RC32GF153J
R264	Same as R221.	
R265	Same as R178.	
R266	RESISTOR, FIXED, COMPOSITION: 510,000 ohms, ±5%; 1/2 watt.	RC20GF514J
R267	Same as R178.	
R268	RESISTOR, FIXED, COMPOSITION: 39,000 ohms, ±5%; 1/2 watt.	RC20GF393J
R269	RESISTOR, VARIABLE, COMPOSITION: 10,000 ohms, ±20%; 2 watts.	RV4LAYSA103B
R270	Same as R269.	
R271	RESISTOR, FIXED, COMPOSITION: 12,000 ohms, ±10%; 1/2 watt.	RC20GF123K
R272	RESISTOR, FIXED, COMPOSITION: 18,000 ohms, ±10%; 1/2 watt.	RC20GF183K
R273	Same as R269.	
R274	RESISTOR, FIXED, COMPOSITION: 39,000 ohms, ±10%; 1/2 watt.	RC20GF393K
R275	RESISTOR, FIXED, COMPOSITION: 1 megohm, ±10%; 1/2 watt.	RC20GF105K
R276	NOT USED	
R277	Same as R159.	
R278	Same as R221.	
R279	Same as R171.	
R280	RESISTOR, FIXED, COMPOSITION: 150,000 ohms, ±5%; 1/2 watt.	RC20GF154J
R281	RESISTOR, VARIABLE, COMPOSITION: 5,000 ohms, ±20%; linear taper, concentric with R283 with SPDT switch (S112)	RVX905
R282	Same as R112.	
R283	RESISTOR, VARIABLE, COMPOSITION: 500 ohms, ±20%; linear taper, concentric with R281 with SPDT switch (S112) (See R281)	RVX905
R284	Same as R169.	
R285	Same as R266.	
R286	RESISTOR, FIXED, COMPOSITION: 5.1 megohms, ±5%; 1/2 watt.	RC20GF515J

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
R287	RESISTOR, VARIABLE, COMPOSITION: dual; 50,000 ohms, ±10%; 2 watts, linear (front section), 5 megohms, ±20%; 2 watts, linear (rear section)	RVT506
R288	Same as R160.	
R289	See R287.	
R290	RESISTOR, FIXED, COMPOSITION: 180,000 ohms, ±10%; 1/2 watt.	RC20GF184K
R291	Same as R101.	
R292	Same as R101.	
R293	RESISTOR, FIXED, COMPOSITION: 120,000 ohms, ±5%; 1 watt.	RC32GF124J
R294	RESISTOR, FIXED, COMPOSITION: 1.5 megohms, ±5%; 1/2 watt.	RC20GF155J
R295	Same as R222.	
R296	RESISTOR, FIXED, COMPOSITION: 750,000 ohms, ±5%; 1/2 watt.	RC20GF754J
R297	Same as R178.	
R298	Same as R178.	
R299	Same as R113.	
R300	Same as R182.	
R301	Same as R221.	
R302	Same as R118.	
R303	Same as R119.	
R304	Same as R171.	
R305	RESISTOR, FIXED, COMPOSITION: 10 megohms, ±5%; 1/2 watt.	RC20GF106J
R306	Same as R286.	
R307	Same as R178.	
R308	Same as R113.	
R309	Same as R121.	
R310	Same as R159.	
R311	RESISTOR, VARIABLE, COMPOSITION: 3,000 ohms, ±10%; 2 watts.	RV011
R312	Same as R143.	
R313	Same as R113.	
R314	RESISTOR, FIXED, COMPOSITION: 56,000 ohms, ±5%; 2 watts.	RC42GF563J
S101	SWITCH, ROTARY: miniature; 10/P2-6T, 5 sections, shorting contacts.	S213124

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
S102	SWITCH, TOGGLE: SPDT; bat handle.	S2043
S103	SWITCH, TOGGLE: DPDT; bat handle.	S2023
S104	See R188.	
S105 thru S110	Same as S103	
S111	SWITCH, TOGGLE: SPST; bat handle.	S2022N
S112	See R281 and R283.	
S113	SWITCH, PUSHBUTTON: SPDT.	S2044
S114	SWITCH, TOGGLE: DPDT; center off, bat handle.	S2042
T101	TRANSFORMER, RADIO FREQUENCY: 500 Kc, ±5 Kc.	ZN8429
T102	TRANSFORMER, RADIO FREQUENCY: 500 Kc, ±50 Kc.	ZN8218
T402	TRANSFORMER: pulse.	T210790A
V1	TUBE, ELECTRON: duo-triode; 7 pin miniature.	6J6
V2	TUBE, ELECTRON: high-mu, twin triode; 9 pin miniature.	12AT7
V3	TUBE, ELECTRON: pentagrid converter; 7 pin miniature.	6BE6
V4	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin minature.	6AH6
V5	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin minature.	6BH6
V6	TUBE, ELECTRON: twin-diode; 7 pin miniature.	12AL5
V7	TUBE, ELECTRON: triode-remote cutoff pentode; 9 pin miniature.	6U8
V8	Same as V7.	
V9	TUBE, ELECTRON: sharp-cutoff pentode; 7 pin minature.	6AU6
V10	TUBE, ELECTRON: medium-mu twin triode; 9 pin miniature.	12AU7
V11	Same as V10.	
V12	TUBE, CATHODE RAY	5ADP7
V13	Same as V9.	
V14	Same as V10.	
V15	Same as V5.	
V16	Same as V10.	
V17	TUBE, ELECTRON: voltage reference; 7 pin miniature.	5651
V18	TUBE, ELECTRON: voltage regulator; 7 pin miniature.	OA2

REF SYMBOL	DESCRIPTION	TMC PART NUMBER
V19	NOT USED	
V20	Same as V7.	
XCR101	SOCKET, RECTIFIER Part number to be supplied at a later date.	
XCR102 thru XCR104	Same as XCR101.	
XI101	LAMPHOLDER Part number to be supplied at a later date.	
XI102 thru XI105	Same as XI101.	
* XQ3	SOCKET, TRANSISTOR	
XQ4 thru XQ6	Same as XQ3.	
XV1 thru XV11	SOCKET, ELECTRON TUBE Part number to be supplied at a later date	
* XV12	SOCKET, CATHODE RAY TUBE: 14 pin diheptal.	
XV13 thru XV18	SOCKET, ELECTRON TUBE Part number to be supplied at a later date.	
XV19	NOT USED	
XV20	SOCKET, ELECTRON TUBE Part number to be supplied at a later date.	
* XY301	SOCKET, CRYSTAL	
XY302	Same as XY301.	
XY303	Same as XY301.	
XY701	Same as XY301.	
# Y301	CRYSTAL: 100 Kc	Y3001-2
# Y302	CRYSTAL: 100 Kc	Y3001-2
Y303	CRYSTAL: 100 Kc	Y3001-1
Y701	CRYSTAL: 500 Kc, ±0.02%.	Y3006
Z101	COIL: oscillator; 600 Kc.	ZN8219
Z102	TRANSFORMER, RADIO FREQUENCY: discriminator; 600 Kc, ±50 Kc.	ZN8220
Z103	TRANSFORMER, RADIO FREQUENCY: 100 Kc.	ZN8372
Z105	TRANSFORMER, RADIO FREQUENCY: 100 Kc.	ZN8222

NOTE

Supplied as a matched pair, part number 2Y3001MR.

MANUFACTURERS CODE FOR LIST OF REPLACEABLE PARTS

SYMBOL	MANUFACTURER	PART NO.
C107	Cambion	PCS6-6
C206	Sprague Electric Company	TVL1173
C303	Centralab Division of Globe-Union, Inc.	827
C603	Sangamo Electric Company	TJU300025J
C610	Centralab Division of Globe-Union, Inc.	CI-103
EV12	JAN	S5002-42
I101	General Electric Company	1815
R228	Allen Bradley Company	TYPE "J"
R231	Allen Bradley Company	TYPE "J"
R246	Kidco	No Part No.
XF601	Littlefuse	342012
XQ3	Elco	3301
XV12	Cinch	3M14
XY301	Augat	8000-AG6

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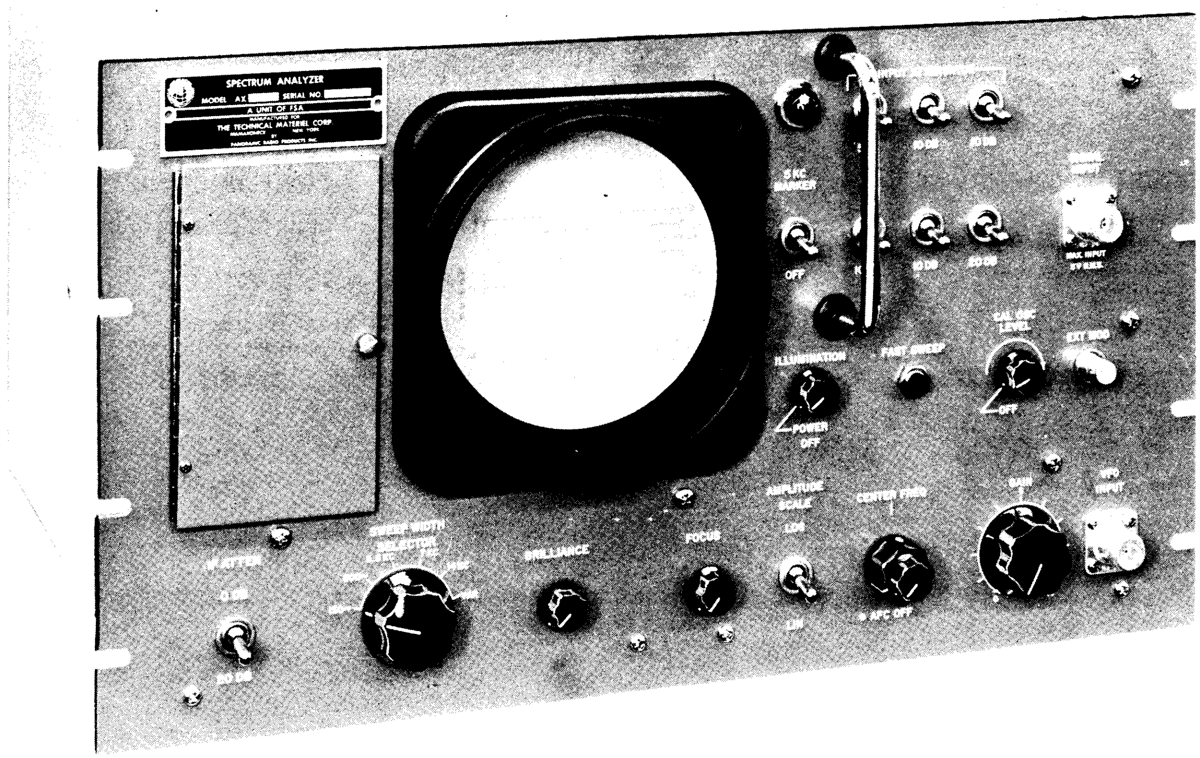


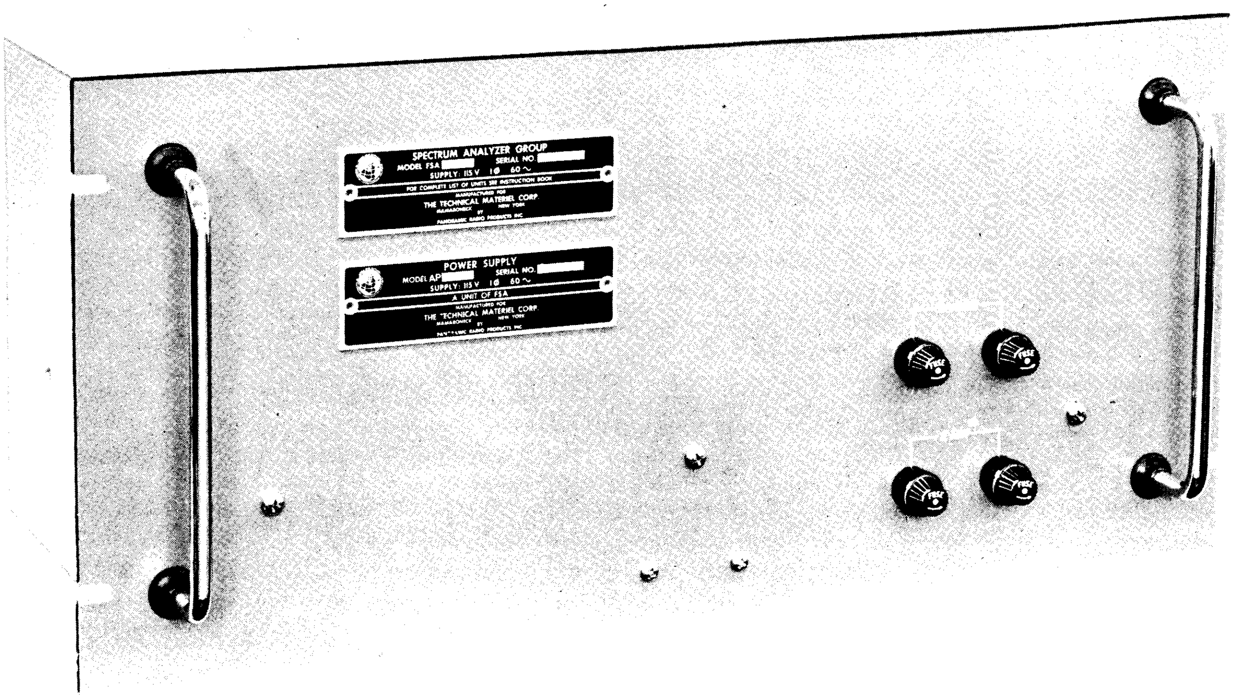


Figure 1-1. Spectrum Analyzer Group, Model FSA-3

SECTION 1
GENERAL DESCRIPTION

1-1. FUNCTIONAL DESCRIPTION.

SPECTRUM ANALYZER GROUP, Model FSA-3 (figure 1-1) is composed of SPECTRUM ANALYZER Model AX-503 and its associated POWER SUPPLY Model AP-123.

SPECTRUM ANALYZER GROUP, Model FSA-3 (hereafter referred to as the FSA) is basically an automatic scanning superheterodyne receiver, permitting the operator to visually analyze and identify any one or more radio frequency signals simultaneously. This versatile test instrument, designed for r-f spectrum analysis, is ideally suited for tuning and aligning of single sideband exciters and transmitters, permitting the operator to visually analyze intermodulation distortion, hum and noise.

The signals being scanned are displayed on a five inch crt screen as a series of spikes or pips along a calibrated horizontal axis, indicating both signal level and frequency.

The FSA provides two modes of operation. A variable sweep width mode and a pre-set sweep width mode, selected by the front panel six position SWEEP WIDTH SELECTOR switch.

In the variable mode, a variable sweep width range of 0 to 100 kc is provided for search and preliminary analysis. The 0 to 2 kc variable sweep width range is AFC controlled for detailed analysis use, (further explained in Section 3).

In the pre-set sweep width mode, narrow band sweep widths of 14 KC, 7 KC, 3.5 KC, 500 CPS and 150 CPS are selectable, provided for highly resolved, slow speed analysis.

Some of the many uses of the FSA include visual examination of signal fluctuations due to shock, component variations, vibration and load changes. Parasitic oscillations, spurious emission, hum and noise are quickly detected and identified by the proper use of the front panel controls. Signal amplitude variations and the direction of frequency drift are also displayed on the calibrated screen. For single sideband linearity testing, in-band intermodulation distortion readings of -60 db are attainable.

As an aid in understanding some of the various terms used throughout this text, refer to table 1-1, Terms and Definitions.

1-2. PHYSICAL DESCRIPTION.

The FSA is composed of two separate units: SPECTRUM ANALYZER Model AX-503 and POWER SUPPLY Model AP-123 (hereafter referred to as the SA and PS respectively). Both units are on 19 inch wide front panels, for mounting into any standard width equipment rack.

The SA front panel displays a 5 inch CRT with a calibrated screen, and the necessary controls and indicators for the tuning and analyzing of r-f signals.

The PS front panel displays two 2-ampere line fuses and two spares.

Table 1-2 lists the vacuum tube and transistor complement of the FSA.

Connector J402, mounted on the rear of SA chassis, is provided for operation of the FSA with an external manual sweep facility. When external manual sweep is not employed, shorting plug P402 must be mated with J402.

1-3. TECHNICAL SPECIFICATIONS.

INPUT CENTER FREQUENCY:	500 KC
BANDPASS REGION: (After input mixer)	450 - 550 KC
BANDPASS REGION AMPLITUDE CHARACTERISTICS (450 - 550 KC):	Uniform within ±5% or ±0.5 db.
IMAGE REJECTION:	Better than 43 db at input center frequency.
INPUT IMPEDANCE:	50 ohms
INPUT ATTENUATION:	0-65 db in 5 db steps, ±.05 db/db accuracy.

1-3. TECHNICAL SPECIFICATIONS (CONT).

AMPLITUDE SCALES:	Linear and 2 decade log, front panel selected. Calibrated range may be extended to 60 db by use of front panel 20 db attenuator.
DIRECT SENSITIVITY: (At signal input terminal)	200 uv rms or better required for full scale linear deflection in center frequency band. (450 - 550 KC)
CONVERSION SENSITIVITY:	A maximum signal level of 3 mv rms is required at the signal input terminal for a full scale log deflection when an external signal generator injection of 0.1 volt is applied at the VFO input terminal.
SCANNING RATE:	0.1 cps to 30 cps continuously variable. 0.1 cps at pre-set sweep widths of 150 cps and 500 cps. 1 cps at pre-set sweep widths of 3.5 kc, 7 kc and 14 kc.
RESOLUTION:	Continuously adjustable except on pre-set sweep ranges. Ranges from approximately 3 kc down to less than 10 cps.

SWEEP WIDTHS:

MODE	SWEEP WIDTH	
Continuously	0-100 KC	
Variable	0-2 KC	AFC Stabilized
Pre-set,	150 CPS	AFC Stabilized
automatically	500 CPS	AFC Stabilized
resolved	3.5 KC	
	7 KC	
	14 KC	

DYNAMIC AMPLITUDE RANGE:

Two-tone test: In-band residual or odd order intermodulation products better than 60 db below level of two equal reference signals deflected 20 db above full scale log when met by the following provisions:

1. Two reference signals must be separated by an intersection of at least 60 db down.

2. All front panel gain controls set at maximum.

3. IF BANDWIDTH adjusted for the broadest position consistent with visual separation of signals.

4. A maximum signal generator amplitude of 300 millivolts rms.

INDICATOR:	A 5 inch diameter, flat face CRT (5ADP7). Edge lit recticle and screen scale illumination. Camera mounting bezel provided for standard oscilloscope camera use.
POWER REQUIREMENTS:	115 vac, 60 cps single phase power from a harmonic compensator type line regulator.
POWER CONSUMPTION:	180 watts (approx).
PHYSICAL DIMENSIONS:	SPECTRUM ANALYZER, MODEL AX-503 10-1/2 in. high x 19 in. wide x 19-3/4 in. deep.

1-3. TECHNICAL SPECIFICATIONS (CONT).

PHYSICAL DIMENSIONS: (cont)	POWER SUPPLY, Model AP-123 8-3/4 in. high x 19 inches wide x 11-1/2 in. deep.
WEIGHT:	SPECTRUM ANALYZER, Model AX-503 35 lbs. approx. POWER SUPPLY, Model AP-123 30 lbs. approx.
COMPONENTS AND CONSTRUCTION:	Equipment manufactured in accordance with JAN/MIL specifications wherever practicable.
ACCESSORY EQUIPMENT SUPPLIED:	Power interconnecting cable, SA to PS, 7 ft. long. TMC Part No. CA-432-1. AC power cord with male and female twist lock connectors. TMC Part No. CA-555-1.

TABLE 1-1. TERMS AND DEFINITIONS

TERM	DEFINITION
Sweep Width	Sweep Width is the term used to define the band of the displayed frequency spectrum, measured in cycles, kilocycles or megacycles. It corresponds to the range of the FSA oscillator sweep.
Frequency Sweep Axis	Frequency Sweep Axis is the term used to define the line in which the signal deflections are produced and which can be calibrated in frequency in reference to a particular frequency scale.
Center Frequency	Center Frequency is defined as that part of the received signal corresponding to zero sweep voltage applied to the reactance modulator along the Frequency Sweep Axis.
Resolution	Resolution may be defined as the ability to separate individual signals. The Resolution of a given signal is the frequency difference measured along the sweep width scale. It is measured between the points where the signal deflection is 30 percent below peak value. Resolution may be compared to the selectivity of a receiver. Optimum Resolution is achieved when the frequency difference is minimum. Resolution of the FSA sharpens as both the SWEEP RATE and IF BANDWIDTH controls are decreased.
Sweep Rate	Sweep Rate is defined as the number of times per second the electron beam sweeps across the crt.
Deflection Amplitude	Deflection Amplitude is the height or amplitude of a given signal deflection measured from the screen baseline to the peak of the deflection.
Screen Scale	Screen Scale is the calibrated scale adjacent to the baseline. The Screen Scale is calibrated in frequency units, above and below the center frequency for a maximum sweep width setting. (See figure 3-1.)

TABLE 1-2. VACUUM TUBE AND TRANSISTOR COMPLEMENT

REFERENCE SYMBOL	TYPE	FUNCTION
SPECTRUM ANALYZER, MODEL AX-503		
V1	6J6	Input Mixer
V2	12AT7	RF Amplifier
V3	6BE6	2nd Mixer, Local Oscillator
V4	6AH6	Reactance Tube
V5	6BH6	AFC Amplifier
V6	12AL5	Discriminator
V7	6U8	IF Amplifier
V8	6U8	IF Amplifier
V9	6AU6	IF Amplifier
V10	12AU7	Detector, Video Amplifier
V11	12AU7	Amplifier, Cathode Follower
V12	5ADP7	Cathode Ray Tube
V13	6AU6	Sweep Tube
V14	12AU7	Blocking Oscillator, Cathode Follower

REFERENCE SYMBOL	TYPE	FUNCTION
V15	6BH6	Sweep Discharge
V16	12AU7	Horizontal Deflection Amplifier
V17	5651	Voltage Reference
V18	0A2	Voltage Reference
V20	6U8	IF Amplifier
Q3	2N404	500 KC Oscillator
Q4	2N404	500 KC Oscillator
Q5	2N404	5 KC Oscillator
Q6	2N404	5 KC Oscillator
POWER SUPPLY, MODEL AP-123		
V101	5V4GA	Rectifier
V102	6AS7G	Series Regulator
V103	12AX7	Amplifier
V104	5651	Voltage Reference
CR601	Int. Rect. V100HF	High Voltage
CR602	Int. Rect. V100HF	High Voltage

SECTION 2
INSTALLATION

2-1. INITIAL INSPECTION.

Each SPECTRUM ANALYZER GROUP, Model FSA-3, is thoroughly checked and calibrated at the factory before shipment. Upon arrival at the operating site, inspect the packing cases and their contents immediately for possible damage. Unpack the equipment carefully and inspect the packing material for parts which may have been shipped as loose items.

With respect to damage to the equipment for which the carrier is liable, The Technical Materiel Corporation will assist in describing methods of repair and the furnishing of replacement parts.

The equipment is shipped with all tubes and other plug-in components installed. Check that all such components are properly seated in their sockets.

2-2. MECHANICAL INSTALLATION.

Both units, Models SA and PS, comprising the FSA, are constructed to be self supporting from the front panel, however, rear support is desirable.

2-3. ELECTRICAL INSTALLATION.

The SA receives its required operating voltages from the PS power supply. The PS therefore requires a regulated line voltage input of 115/230 vac, 60 cps, single phase power. The PS is factory wired for 115 vac 60 cps operation and may be converted for 230 vac operation by making the necessary wiring changes shown in figure 2-1.

NOTE

The PS power supply must receive its primary power from a harmonic compensator type line voltage regulator to ensure proper operation. The regulator normally used with the PS is of the saturable reactor type, designed for a 60 cycle power source. For 50 cycle operation, a saturable reactor type regulator specifically designed for 50 cycle operation is necessary. A line stabilizer which is not frequency sensitive may also be used. Either unit must be capable of providing a 180 volt-ampere output.

Figure 2-2 illustrates the required interconnections for the operation of the FSA in conjunction with the following steps.

a. Connect the supplied power interconnecting cable assembly CA-432-1 from PS J601 to SA J501.

b. Connect the supplied a-c line cable assembly CA-555-1 from PS J603 to the output of a constant voltage transformer or regulator. (Refer to preceding NOTE.)

c. Connect the external VFO to the SA VFO INPUT connector J102, using a 50 ohm r-f coaxial cable.

d. Connect the input signal to the SA SIGNAL INPUT connector J103, using a 50 ohm r-f coaxial cable.

See figure 2-3 for rear panel controls and connectors.

2-4. INSTALLATION ADJUSTMENTS AND CHECKS.

After the interconnecting procedures have been completed, as specified in paragraph 2-3, perform the following steps to ascertain proper connection and operation of the FSA.

a. Rotate the ILLUMINATION control clockwise to apply power to the SA. After approximately 60 seconds, the baseline trace should appear on the crt screen.

b. Adjust the BRILLIANCE control for a desirable intensity of the baseline trace.

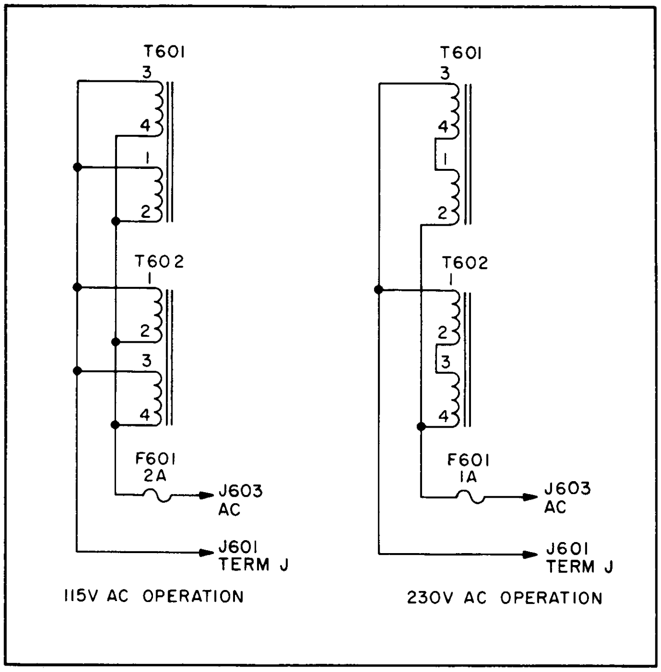


Figure 2-1. Input Voltage Changeover Connections, Model AP-123

c. Allow at least a 30 minute warmup before proceeding with the next step.

d. Set the front panel controls as follows:

INPUT ATTENUATOR . . . All switches up (no attenuation)

GAIN . . . . Fully counterclockwise

CAL OSC LEVEL . . . . . OFF

CENTER FREQ . . . . . . Center

AFC . . . . OFF

AMPLITUDE SCALE. . . . LIN

FOCUS . . . . Adjust for a sharp trace

BRILLIANCE . . . . Adjust for desired intensity

SWEEP WIDTH SELECTOR . . . . VAR

5 KC MARKER . . . . . . OFF

IF ATTEN . . . . 0 DB

VIDEO FILTER . . . . . . OFF

SWEEP RATE. . . . . Fully clockwise

IF BANDWIDTH . . . . . . Fully clockwise

SWEEP WIDTH . . . . . . Fully clockwise

V POS . . . . Adjust for coincidence of baseline trace with frequency scale.

H POS . . . . Adjust for center screen position

e. Proceed with the following steps:

(1) Rotate the CAL OSC LEVEL control fully clockwise.

(2) Advance the GAIN control for a full screen pip deflection.

(3) Rotate the SWEEP WIDTH control counterclockwise until the pip opens into a horizontal line.

(4) Adjust the CENTER FREQ control for maximum trace height.

(5) Rotate the SWEEP WIDTH control fully clockwise. A pip should appear at the approximate center frequency calibration.

(6) Center the pip to the center frequency calibration with the H POS control.

(7) Rotate the SWEEP RATE control slowly counterclockwise through its entire range. At its clockwise position (30 cps) the screen trace will appear as a line. At its extreme counterclockwise position (0.1 cps), a spot should scan from right to left across the crt screen with a 10 second duration.

(8) Return the SWEEP RATE control to its fully clockwise position.

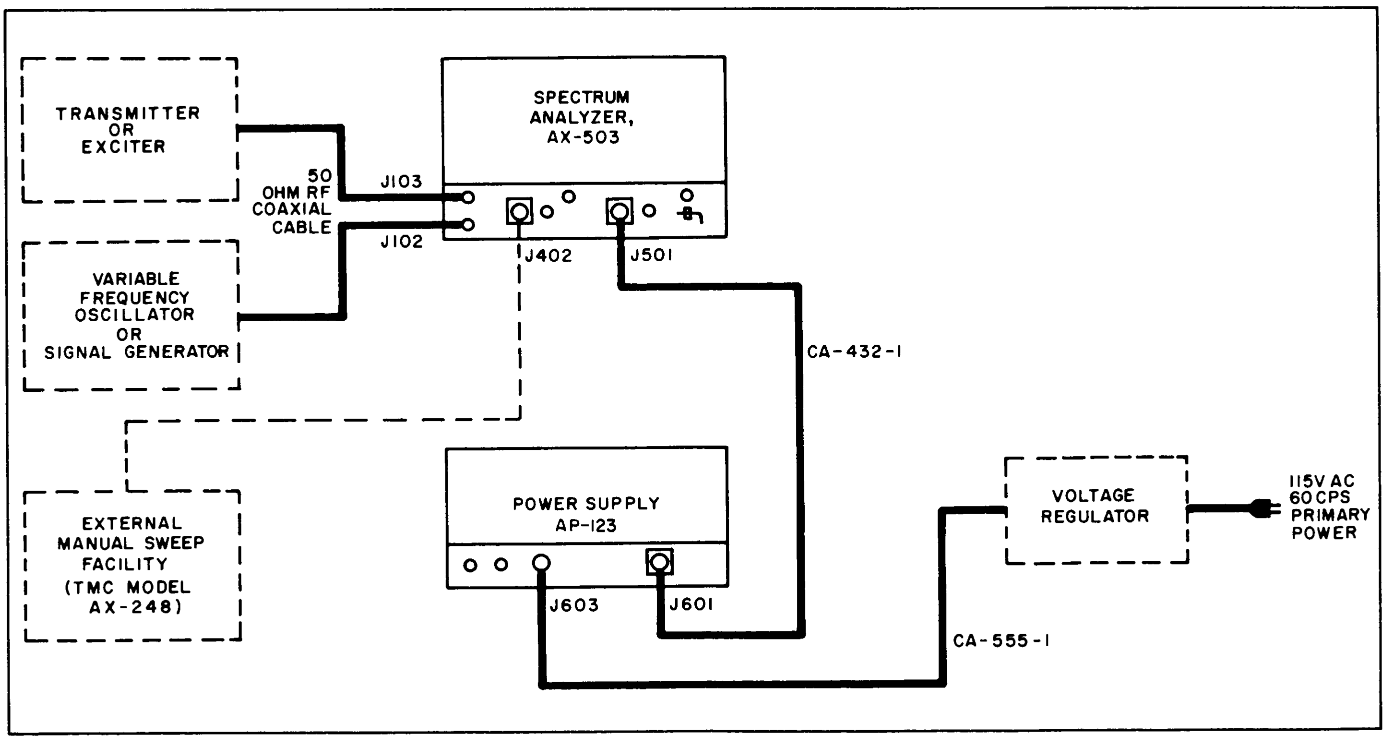


Figure 2-2. Interconnection Diagram

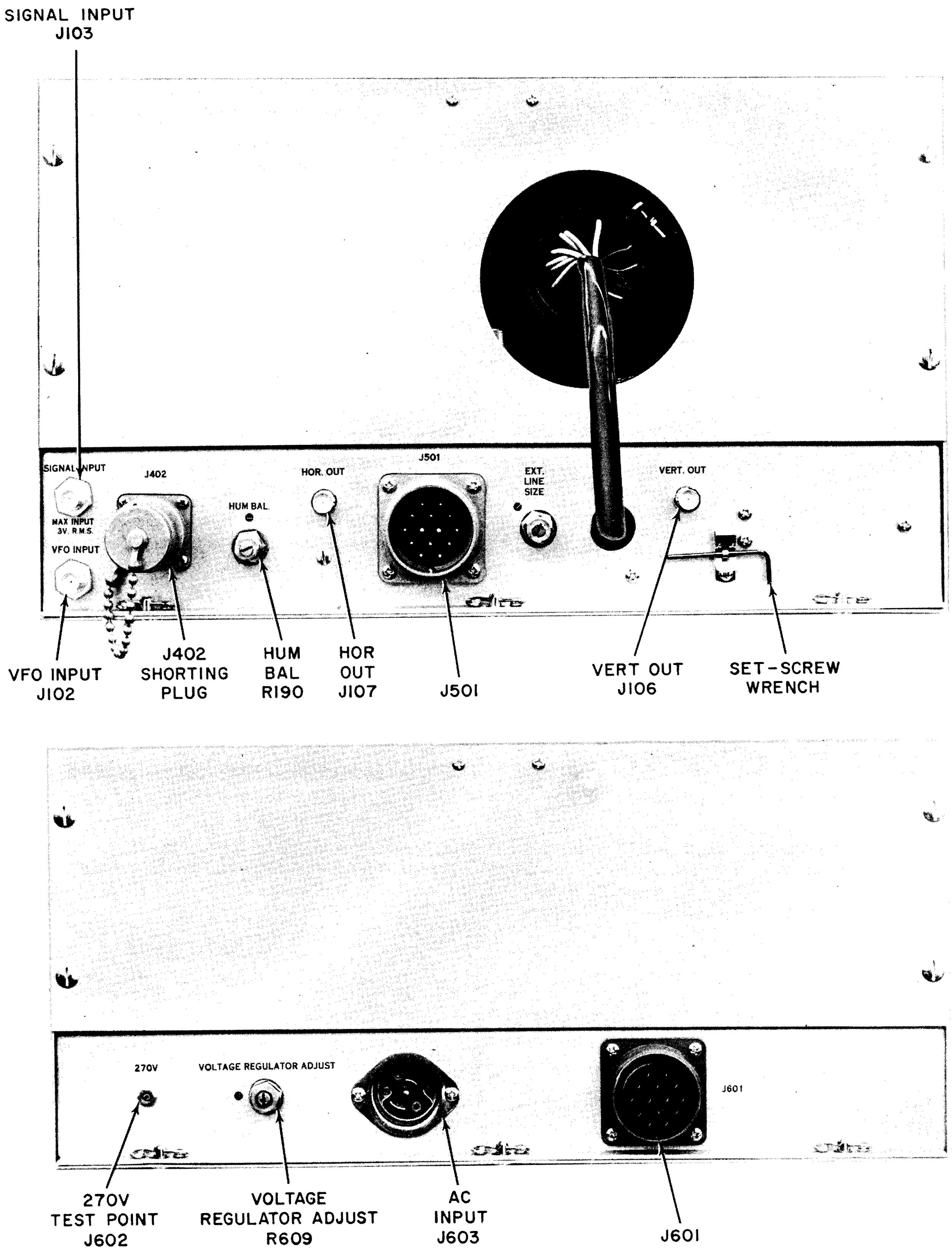


Figure 2-3. Rear Panel Controls and Connectors

(9) Adjust the SWEEP WIDTH control until the pip base covers approximately one third of the crt screen.

(10) Rotate the IF BANDWIDTH control counterclockwise; the width of the pip should decrease. Simultaneously, the pip height may change. It may be noted that a "ringing" effect will appear at the pip trailing edge. Optimum resolution is achieved when the first ringing notch beyond the apex of the pip dips into the baseline.

(11) Rotate the AFC control clockwise for AFC action. This function automatically provides a maximum scanning width of approximately ±1 kc with the necessary center frequency stability. When the SWEEP WIDTH control is rotated in a counterclockwise direction, the scanning width is reduced from ±1 kc to nominally zero. The AFC control functions as the CENTER FREQ control, thereby causing the CENTER FREQ control to act in a vernier capacity. As the AFC control is rotated clockwise, the display may shift to the left, and then to the right. It may be noted that normally the best centering action is achieved when the AFC control is in the "2 o'clock" position.

A convenient method of checking for maximum sweep is to feed a 1 kc audio signal to the EXT MOD connector. This action will produce sidebands which may be set at the end frequency calibrations of the crt screen by use of the SWEEP WIDTH control. When using this method, care must be taken in feeding only a sufficient audio amplitude to produce visible and usable sidebands. Excessive audio amplitude may disable the crystal oscillator.

It may also be noted that when the AFC is activated, an extraneous pip or pips may appear at the right side of the crt screen (outside the calibrations). The SWEEP RATE control should be set for a rate of approximately 5 cps or lower. The IF BANDWIDTH control should be set for approximately optimum resolution.

(12) To perform a CENTER FREQ test, slowly adjust the GAIN control for a full scale pip deflection.

(13) Set AMPLITUDE SCALE control to LOG. The pip on the screen should indicate a level of 20 db (center of screen). The LOG calibrations appear as horizontal lines. Dots are engraved at intervals on the screen to indicate the LIN scale.

(14) Set the IF ATTEN control to 20 DB; the pip should now indicate a level of 40 db.

(15) Set the GAIN control fully clockwise.

(16) Adjust the CAL OSC LEVEL control for a full screen deflection.

(17) Using the INPUT ATTENUATOR switches, switch in 40 db of attenuation in 5 db steps. At each of the 5 db steps inserted, the pip should indicate a corresponding reading on the calibrated screen scale, within ±1 db.

(18) Set all INPUT ATTENUATOR switches up (no attenuation).

(19) Adjust the GAIN control for full scale deflection.

(20) Set VIDEO FILTER switch to HI. This function narrows the video bandwidth to approximately 400 cps resulting in noise rejection and causing the signal pips to integrate and shift slightly.

To prevent excessive pip shape distortion, reduce the SWEEP RATE.

(21) Set VIDEO FILTER switch to LO. This function narrows the video bandwidth to approximately 40 cps resulting in a greater filtering effect. This position should be used with sweep rates of 1 cps or less.

(22) With the AMPLITUDE SCALE at LIN, adjust for an optimally resolved pip in the center of the screen.

(23) Set the SWEEP WIDTH SELECTOR control to 14 KC. The pip should appear at or near the screen center with the amplitude essentially unchanged. The sweep width is now ±7 kc and the sweep rate is 1 cps.

The SWEEP RATE, SWEEP WIDTH, VIDEO FILTER and IF BANDWIDTH controls are inoperative at this and other pre-set sweep width ranges.

(24) Set the SWEEP WIDTH SELECTOR control to 7 KC. The pip should appear at the center of the screen with essentially the same amplitude. The sweep width is ±3.5 kc.

(25) Set the SWEEP WIDTH SELECTOR control to 3.5 KC. The pip should appear at the center of the screen with essentially the same amplitude. The sweep width is ±1.75 kc.

(26) Set the SWEEP WIDTH SELECTOR control to 500 CPS. In this position, the AFC is automatically switched in, providing AFC stabilization for the 500 CPS and 150 CPS sweep widths and the sweep rate is 0.1 cps. The pip amplitude should remain essentially constant on both ranges.

(27) A FAST SWEEP pushbutton is provided to facilitate locating a signal on the ranges employing a 0.1 cps sweep rate. Pressing this pushbutton should increase the sweep rate to 1 cps and when released, the sweep rate should then return to 0.1 cps.

Use of this pushbutton may distort the pip considerably but does not impair its usefulness in locating signals on narrow sweep widths or for continuous examination of a particular sweep width portion without the normal 10 second scan delay.

SECTION 3
OPERATOR'S SECTION

3-1. GENERAL.

Operation of the FSA has been designed for a high degree of simplicity and versatility. All operating controls and indicating devices are readily accessible on the front panel and are similar in function and effect to those found on any standard type oscilloscope. However, before attempting to operate the FSA, the operator should have a basic knowledge of its function and capabilities.

Table 3-1 is a list of the front panel controls to be used in conjunction with figure 3-7.

3-2. OPERATOR'S INSTRUCTIONS.

a. To apply power to the FSA, rotate the ILLUMINATION control fully clockwise; the crt screen scale should illuminate immediately. After approximately 30 seconds, a dot should appear on the screen and start to sweep across the screen after a few seconds. The intensity of the screen scale illumination may be reduced, if desired, by rotating the ILLUMINATION control slowly counterclockwise.

If no indication is visible on the crt screen, adjust the BRILLIANCE control clockwise for a suitable visibility and adjust the FOCUS control for a fine clear line. Readjustment of the BRILLIANCE and FOCUS controls may be necessary due to various signal densities.

NOTE

When external light reflects on the screen, do not use the BRILLIANCE control to counteract it, rather use a screen hood or shield or reduce the external light.

Proper viewing of the crt screen scale is achieved when the observing eye level is at the axis of the crt at a distance of 15 inches. Any other position will introduce parallax error.

Figure 3-1 illustrates the crt calibrated screen scale of the FSA.

b. After power has been applied to the FSA and the 30 minute warmup period completed, set the front panel operating controls as follows:

CENTER FREQ.	Set to vertical marker
SWEEP WIDTH	Fully clockwise
IF BANDWIDTH	Fully clockwise
BRILLIANCE.	Set to desired brightness
SWEEP WIDTH SELECTOR .	VAR
FOCUS	Set for sharp trace
AMPLITUDE	LIN
GAIN	Set between mid-position and fully clockwise
SWEEP RATE	Fully clockwise
VIDEO FILTER	OFF
H POS.	Set for center position of center frequency pip
V POS.	Set for baseline coincident with bottom screen calibration
AFC	OFF
INPUT ATTENUATOR . .	Set all switches up
5 KC MARKER	OFF

When the IF BANDWIDTH and SWEEP WIDTH controls are both set fully counterclockwise, the centered signal will normally appear as an elevated pip or baseline with superimposed hum.

Although the frequency of the externally connected signal generator or oscillator, connected to VFO INPUT connector, may be either below or above the test signal frequency by a frequency equal to the input center frequency of the FSA (500 KC), the following rules must be used to determine this frequency. Do not choose a frequency within the FSA input bandpass region (450 KC to 550 KC).

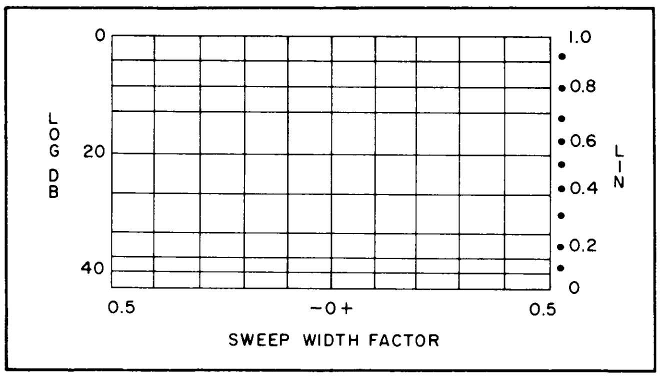


Figure 3-1. CRT Calibrated Screen Scale

(1) For test signal frequencies up to 1,070 KC, the signal generator frequency must be 500 KC above the test signal frequency.

(2) For test signal frequencies between 1,070 KC and 1,770 KC, the signal generator frequency should be above the test signal frequency. Although this is not essential, with the signal generator frequency above the test signal frequency, the presence of image frequencies and spurious signals, resulting from signal generator harmonics, will be avoided.

NOTE

An indication of the signal generator frequency being below the test signal frequency can be recognized by the signal pip moving from left (-) to right (+) of the screen as the signal generator frequency is increased.

An indication of the signal generator frequency being above the test signal frequency can be recognized by the signal pip moving from right (+) to left (-) of the screen as the signal generator frequency is increased.

When the external signal generator frequency is above the test signal frequency, the screen plus (+) and minus (-) signs apply; i.e., signals on the plus (+) side are higher in frequency than the center frequency signal and those on the minus (-) side are lower.

When the external signal generator frequency is below the test signal frequency, the screen plus (+) and minus (-) signs are reversed.

The screen signs are also reversed when the test signal frequencies are within the FSA bandpass region (450 KC to 550 KC).

Slowly scan the signal spectrum with the external signal generator until the signal appears at the center of the crt screen.

A convenient method to locate a signal is to operate the FSA at maximum gain with the external signal generator set for a high output. When the signal is located, the FSA gain may be reduced and the signal generator output reduced to obtain a signal level below full scale.

The signal level may also be reduced by use of the INPUT ATTENUATOR.

To determine the frequency of a signal appearing on the crt screen, simply add or subtract the screen calibration for a given signal with the signal generator frequency and then adding or subtracting the input center frequency. Refer to the preceeding NOTE.

Example:

With the FSA set for 100 KC scanning width, each frequency calibration mark is equivalent to a 10 KC separation. A signal pip appears at +30 on the crt screen. The external signal generator is set at a frequency of 2,450 KC. The FSA input center frequency is 500 KC. When the external signal generator frequency is increased, the signal pip moves from right to left.

Therefore, as mentioned in the preceeding NOTE, if the signal pip moves from right to left as the signal generator frequency is increased, it is evident that the signal generator frequency is above the test signal frequency. Hence, the + sign is applied, resulting in adding of the screen calibration.

The following formulas apply:

Signal Frequency = Signal generator frequency ± screen calibration ± input center frequency.

Signal Frequency = 2,450 KC +30 KC -500 KC

Signal Frequency = 1,980 KC

Observation of signals of comparable amplitudes (10:1 or less) should be made with the AMPLITUDE SCALE switch set to LIN. However, to observe signals widely divergent in amplitude, the AMPLITUDE SCALE switch should be set to LOG. This will enable simultaneous reading of amplitudes in a 40 db range.

3-3. NARROW BAND ANALYSIS.

a. With the FSA at full sweep width, test signals at close frequencies often cause their corresponding deflections to merge into and mask each other. Therefore, the ability of the FSA to separate individual signals depends on two factors: the bandwidth of the i-f section and the scanning velocity (a product of sweep width and sweep rate). At any given scanning velocity, there is a complementary i-f bandwidth to achieve optimum resolution. To reduce the scanning velocity, thereby improving the resolution, increase the sweep period (reducing the sweep rate) and decrease the spectrum width scanned within a given time (reducing the sweep width).

The i-f bandwidth of the FSA is varied by use of the IF BANDWIDTH control. Counterclockwise rotation of the IF BANDWIDTH control narrows the width of the i-f section. Adjustment of this control will affect the sensitivity of the FSA to some degree. Resolution is improved as the i-f bandwidth is narrowed. At a certain point, optimum resolution will be achieved, and further narrowing of the i-f bandwidth will decrease resolution beyond this point.

The following procedure provides the necessary steps to obtain optimum resolution:

(1) Set IF BANDWIDTH control for widest i-f bandwidth (fully clockwise).

(2) Adjust the external signal generator to position the desired band of signals at the center of the crt screen.

(3) Adjust SWEEP WIDTH control counterclockwise to spread the desired band of signals across the crt screen.

(4) Adjust the IF BANDWIDTH control slowly counterclockwise until individual signals are clearly resolved. If the signals cannot be resolved, reduce the sweep rate.

Optimum resolution may be recognized by the appearance of ringing pulses on the trailing edges of the signal pip as optimum is approached. See figure 3-2.

NOTE

Adjustment of the IF BANDWIDTH control may affect the height of the signal pip. Use of the GAIN control will return the pip height to a suitable level.

Adjustment of the IF BANDWIDTH counterclockwise after optimum resolution is achieved will diminish the resolving power and effectively reduce sensitivity.

If complete separation of the signal pips results, maximum resolution can be recognized by the indication of ringing on one side of the signal pip. A better view of ringing is achieved when the video filter is in the OFF position.

Figure 3-2 illustrates optimum resolution indicated by ringing. The progressive variations in signal pip width (illustrations a through f) is caused by the counterclockwise rotation of the IF BANDWIDTH control.

Illustrations a and b of figure 3-2, show a broad i-f bandwidth for the particular scanning velocity. Illustration c shows the start of ringing. Illustration d shows the extent of ringing at optimum resolution. Illustrations e and f show the signal pip widening and decreasing in amplitude as the i-f bandwidth is made narrower.

Further rotation of the IF BANDWIDTH control counterclockwise will cause a reduction of signal amplitude and a tendency of signal remerging.

Backing off the IF BANDWIDTH and SWEEP WIDTH controls counterclockwise and the SWEEP RATE set at a lower rate will improve signal separation, as further explained in paragraph 3-3c.

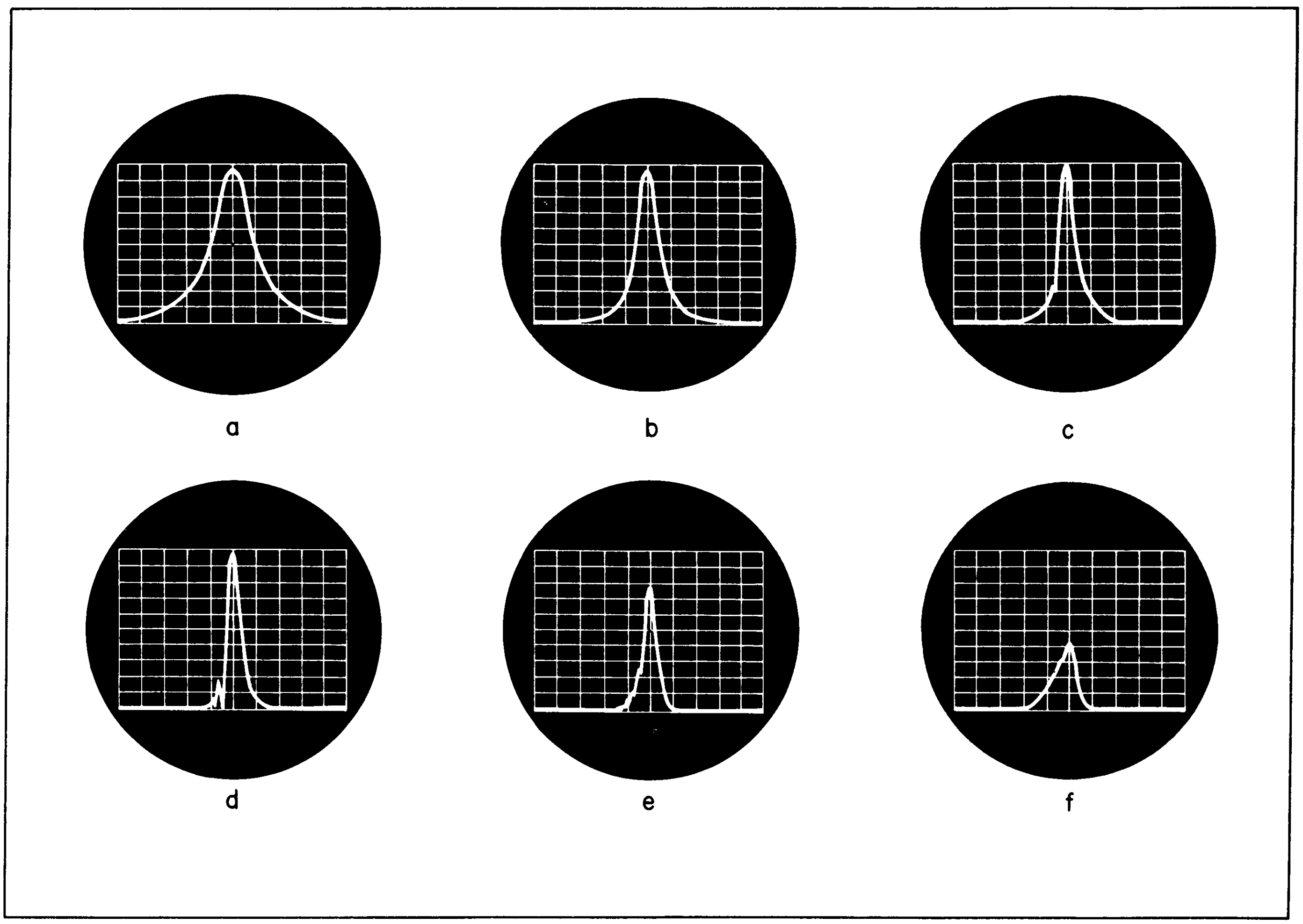


Figure 3-2. Optimum Resolution Indicated by Ringing

When observing a particular bandwidth with signals closely spaced and not completely resolved, maximum resolution is achieved when the signal is at its clearest appearance. Narrowing the i-f bandwidth will result in lessened resolution and the signal will start to jitter.

b. If a high amplitude signal is close in frequency to a low amplitude signal, the skirt of the high amplitude signal will influence the small amplitude signal. Therefore, to alleviate this error, the unequal amplitude signals must be frequency separated.

If a high amplitude difference exists between adjacent signals, the IF BANDWIDTH control should be set to display the signals as definitely separated signal pips.

Figure 3-3 illustrates, in progressive steps, resolution of signals of unequal amplitude. The progressive variations in signal pip separation (illustrations a through f) is caused by the counterclockwise rotation of the IF BANDWIDTH control.

In illustration a of figure 3-3, the i-f bandwidth is broad with no resolution of adjacent signals. Illustrations b and c shows the emergence of the smaller adjacent signal pip as the i-f bandwidth is narrowed. Illustration d shows a definite separation of the signal pips. However, due to the beating of the two signals, the indicated amplitude of the smaller signal pip is higher than its final value. Illustration e shows the i-f bandwidth approaching an optimum value by the appearance of a ringing pip on the left side of the large pip. Illustration f shows that optimum i-f bandwidth has been reached, by the extent of ringing shown.

When adjacent signals are clearly resolved, accurate relative amplitude measurements may be obtained.

When observing a particular bandwidth with signals closely spaced, the clearest signal appearance will indicate the best possible resolution. Reasonably accurate relative amplitude measurements can be obtained by reading the center of the beats. Figure 3-4 illustrates a higher amplitude ratio in illustration a than that of illustration b, resulting in a different presentation.

c. Separation of signals is best achieved with a scanning rate of 0.1 cps. A suitably small scanning width (±1 KC) as well as the necessary frequency stability may be provided by activation of AFC. Use of AFC is also possible with faster rates, up to approximately 5 cps. The following procedure pertains to AFC operation:

(1) Set IF BANDWIDTH control fully clockwise.

(2) Set SWEEP WIDTH control fully clockwise.

(3) Tune desired signal to center of crt screen with external generator or VFO.

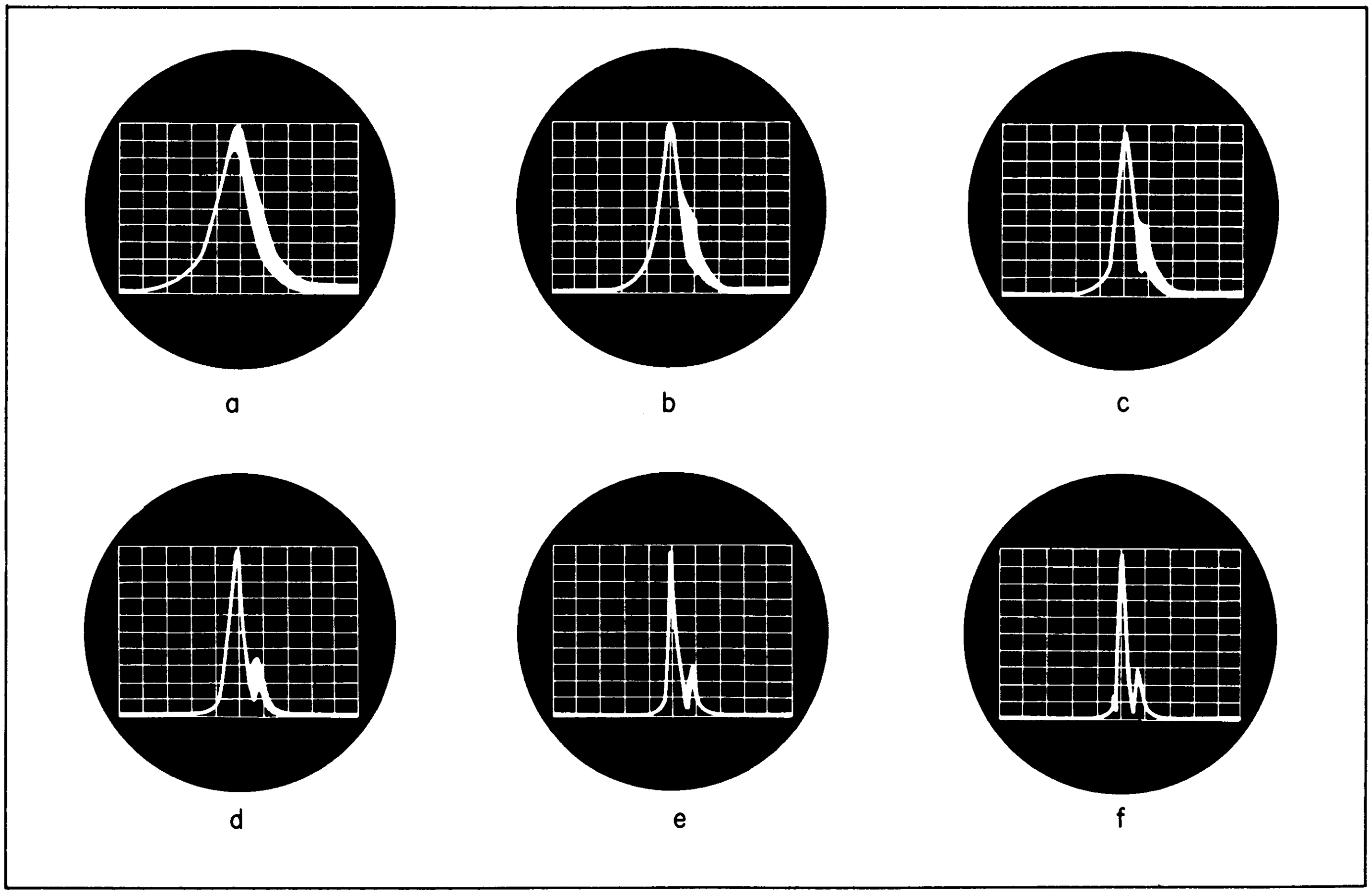


Figure 3-3. Unequal Amplitude Signal Resolution

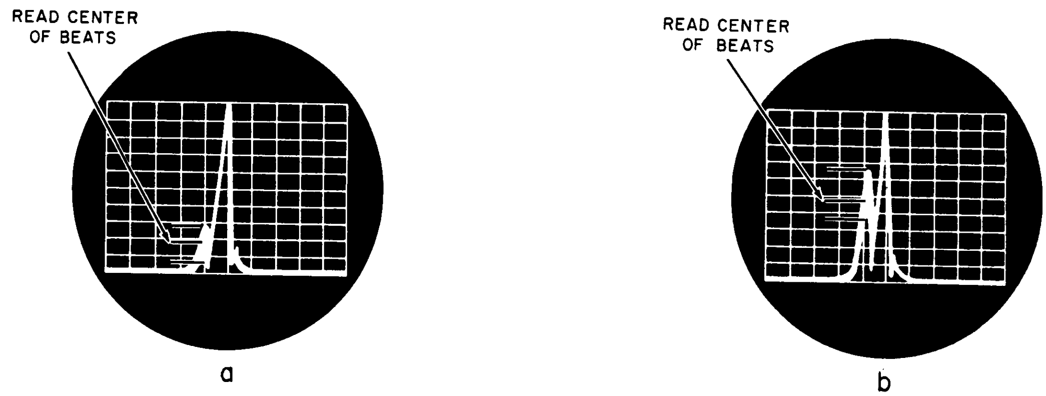


Figure 3-4. Closely Spaced Unequal Amplitude Signal Measurement

(4) Turn AFC control on, recentering the signal presentation if necessary with the external signal generator or AFC control.

NOTE

With the AFC in operation, the CENTER FREQ control functions in a vernier capacity to the AFC control.

(5) Set SWEEP RATE control to a suitable sweep rate (less than 5 cps). This setting depends on the desired degree of frequency separation and the nature of signals.

The AFC should not be used with sweep rates greater than 5 cps. With the AFC on and with the SWEEP WIDTH control fully clockwise, each screen frequency calibration mark represents 200 cps. Counterclockwise rotation of the SWEEP WIDTH control will further reduce the sweep width.

(6) Adjust IF BANDWIDTH control counterclockwise for optimum signal resolution.

(7) VIDEO FILTER action may be employed if required to reduce objectionable beating of closely spaced signals, hum, etc. The use of VIDEO FILTER action will result in signal pip integration and slight shifting of signal pips.

(8) In many cases, use of the SWEEP WIDTH SELECTOR control will prove more convenient to set up the necessary operating conditions for narrow band analysis. This function will provide optimum setting of sweep rate, sweep width, i-f bandwidth and video filtering.

3-4. THIRD-ORDER DISTORTION MEASUREMENTS.

A single sideband transmitter is usually modulated by two equal amplitude audio tones, with a frequency difference in the order of 1 KC. The r-f output consists of two signals separated by the audio difference frequency. Therefore, the presence of third-order distortion of a transmitter will appear as spurious signals, higher and lower in frequency, than the two r-f carriers by an amount equal to the difference frequency.

The internal third-order distortion of the FSA is at least 60 db down from the level of the two test signals. Use the following procedure for third-order distortion measurements:

(1) Set the external signal generator level to 0.3 volts rms.

(2) Perform the normal operating procedure to display the two r-f signals on the crt screen. Use a sweep width of at least three times the separation between the two signals.

(3) Set the AMPLITUDE SCALE switch to LOG.

(4) Set the IF ATTEN switch to 20 DB.

(5) Set the GAIN control fully clockwise.

(6) Adjust INPUT ATTENUATOR switches to obtain a full scale deflection. The GAIN control may be decreased slightly for the final adjustment.

(7) Set the IF ATTEN switch to 0 DB. The crt screen now displays signals of -20 db to -60 db relative to the two input signals. The third-order distortion amplitude pips may be read from the LOG scale of the crt screen, adding 20 db since the signals are deflected 20 db over full scale.

3-5. SIGNAL INTERPRETATION.

The following text will describe some of the various signal presentations as they would appear on the crt calibrated screen. However, due to the vast quantity of signals capable of being displayed by the FSA, only a few of the well known signals will be discussed. Figure 3-5 illustrates some of the various crt screen presentations.

a. Constant carrier signals appear as a fixed spike or pip of constant amplitude with width dependent upon the sweep width. See figure 3-5 (a) and (b).

Any deviation of the signal from a true c-w presentation may be caused by the following:

(1) Periodic drift - the signal pip moves back and forth across the crt screen.

(2) Oscillator drift - the signal pip drifts slowly across the crt screen.

(3) Squegging - an oscillator interrupted at an audio or r-f rate will cause the signal pip to resemble a pulse modulated signal. Sideband components will also be present in addition to the oscillating frequency.

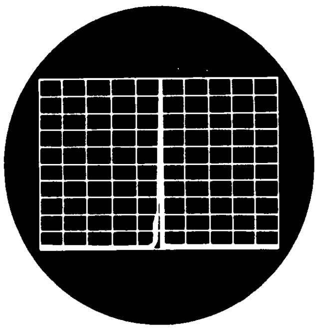
b. An amplitude modulated carrier will appear as a signal pip of varying amplitude.

A series of varying amplitude convolutions, their number depending upon the modulating frequency, will be produced by a non-constant low frequency tone modulated signal. As shown in figure 3-5(c) and (d), the nature of the display will depend upon the sweep width.

With an increase in modulating frequency, the convolutions shift toward the two sides of the deflections and the sidebands become visible. Increasing the modulating frequency makes it possible to separate the sidebands by reducing the FSA sweep width. Further separation may be obtained by use of the IF BANDWIDTH control. The higher the frequency of modulation, the further apart the sidebands will move from the center carrier deflection. The sideband amplitudes may vary by adjustment of the external signal generator or by movement of the signal across the screen.

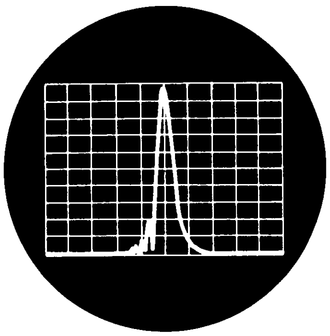
c. Single sideband signal presentations vary with the type of modulation employed.

Tone modulated single sideband signals will appear as a carrier (for a single tone) or a number of carriers (for multi-tones) of slightly different frequencies.



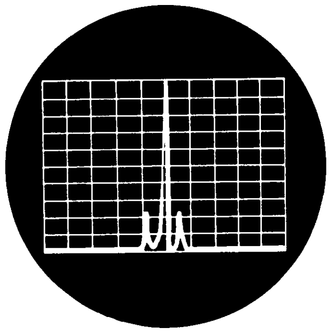
a

CONSTANT CARRIER SIGNAL AT APPROXIMATELY MAXIMUM SWEEP WIDTH.



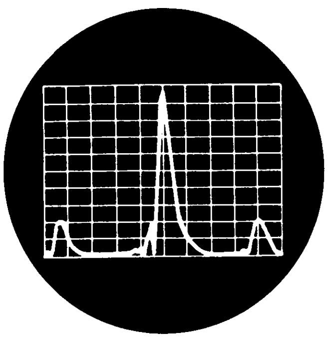
b

APPEARANCE OF CONSTANT CARRIER AT REDUCED SWEEP WIDTH.



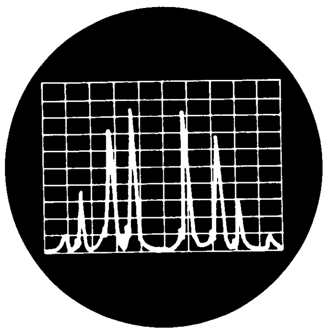
c

A-M SIGNAL, SHOWING CARRIER AND TWO SIDEBANDS.



d

SAME A-M SIGNAL AT REDUCED SWEEP WIDTH, CARRIER REMAINS AT CENTER OF SCREEN.



e

LOW LEVEL FREQUENCY-MODULATION WITH A HIGH MODULATING FREQUENCY.

Figure 3-5. Screen Presentations

Voice or music modulated single sideband signals will appear as a smear of rapid pulsating signals, occupying a finite bandwidth.

d. A low frequency modulated carrier will appear as a carrier which wobbles sideways.

e. A CW signal will appear as a spike or pip, appearing and disappearing at the keying frequency. During the disappearance cycle of the c-w signal, the frequency sweep axis is closed at the base of the signal. During high speed keying, the deflection and baseline are seen simultaneously.

f. Frequency modulated carriers will appear as a group of vertical deflections. See figure 3-5 (e).

g. MCW signals appear as c-w signals varying in amplitude. At high modulating rates, sidebands will appear as explained in paragraph e.

h. Signal interference may appear on the crt screen as a single signal varying in amplitude as with modulation. This is caused when two c-w signals are so close in frequency that aural interference or beating occurs. As frequency separation increases, the signal appears to be modulated only on one side. Further frequency separation will cause a break in the apex of the signal deflection. Reduction of sweep width will gradually separate the two signals. Further separation can be achieved by use of the IF BANDWIDTH control and by adjusting the SWEEP RATE control to a lower rate. See figure 3-6.

i. Various types of radio interference signals may appear on the crt screen. Such signals may contain broad or narrow spectral distributions and may occur at constant or random repetition rates.

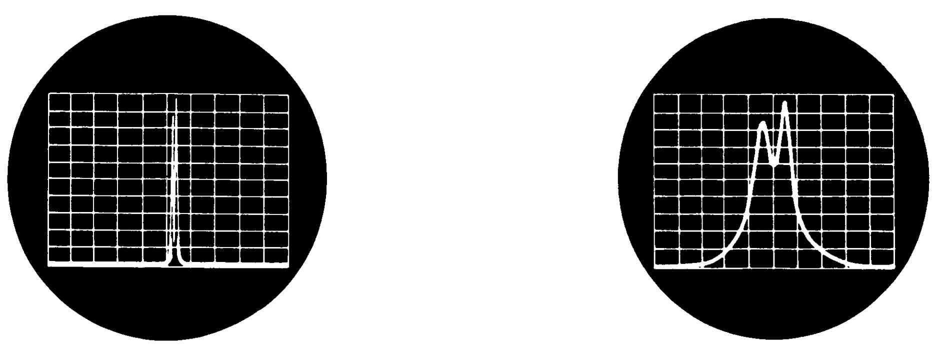
Signals occurring at a variable repetition rate (produced from vibrators, buzzers, accelerating motors, etc.) may move in either direction along the crt frequency sweep baseline. This is caused by the fact that the observed signal occurs at a variable rate while the FSA is sweeping at a fixed rate. When the observed signal and the FSA sweeping rate are synchronized, the images will remain stationary on the crt screen.

Signals from any source producing short electrical impulses (such as electrical arcing, static, switching transients, etc.) have broad spectral distributions which may cover the entire FSA frequency sweep range.

j. Images may be recognized by the fact that they move in the opposite direction with respect to normal signals on the crt screen when the external signal generator is being tuned.

k. Oscillator harmonics and converter harmonics produced by very strong signal beating are distinguishable from other signals by the fact that they move across the crt screen at a faster rate (when tuning) than normal signals. Second harmonic spurious signals move twice as fast as normal signals. A reduction in FSA gain or external signal generator gain may eliminate this type of spurious signal.

l. Spurious signals may occur when the signal strength exceeds a certain level. When this level is exceeded, the deflection caused by any signal may break up into a series of parallel deflections similar to sidebands. Reduction of signal level will remedy this.



a
TWO INTERFERING SIGNALS AT MAXIMUM SWEEP WIDTH.

b
SAME SIGNALS AT REDUCED SWEEP WIDTH, RESULTING IN IMPROVED SEPARATION OR RESOLUTION.

Figure 3-6. Interfering Signal Resolution

TABLE 3-1. PANEL CONTROL FUNCTIONS

REFERENCE DESIGNATION (Figure 3-7)	PANEL DESIGNATION	FUNCTION
1	H POS	Adjusts the position of the baseline trace along the horizontal axis.
2	V POS	Adjusts the position of the baseline trace along the vertical axis.
3	SWEEP WIDTH	Adjusts width of band of frequencies to be scanned. When turned fully clockwise, the maximum spectrum width of the FSA is displayed; i.e. over 100 KC when AFC is off or over 2 KC when AFC is on, displayed on the FSA screen. As this control is slowly backed off in a counter-clockwise direction, the viewed bandwidth becomes narrower. The portion that is still visible however, is expanded across the screen, thus becoming virtually magnified. The required stability for narrow sweep width and slow sweep rates is achieved by use of the AFC control. SWEEP WIDTH control is operative only when SWEEP WIDTH SELECTOR is in VAR position.
4	IF BANDWIDTH	This control is used to narrow the i-f bandwidth. A counterclockwise rotation narrows the width of the i-f section. Use of this control will cause a small degree of change in the sensitivity of the FSA. The frequency scanning rate is decreased by increasing the scanning period or conversely by decreasing the spectrum width scanned within a given time. This latter method may be achieved by use of the AFC and SWEEP WIDTH controls. The IF BANDWIDTH controls is operative only when the SWEEP WIDTH SELECTOR switch is in the VAR position. The i-f bandwidth is automatically set for optimum resolution on the pre-set sweep widths.
5	VIDEO FILTER	This control provides two levels of video filtering used to suppress unwanted effects such as hum, noise, spurious signals, etc. When set to H1, a moderate degree of reduction in video bandwidth is achieved. When set to L0, a high degree of reduction is achieved, suitable for use with narrow sweep widths and very slow sweep rates. The L0 filter action is automatically switched in on pre-set sweep widths of 150 cps and 500 cps. The H1 filter action is automatically switched in on pre-set sweep widths of 3.5 kc, 7 kc and 14 kc.
6	SWEEP RATE	This control provides a continuously adjustable scanning rate of from 0.1 to 30 cps. Sweep rate is decreased when control is rotated counterclockwise. This control is operative only when the SWEEP WIDTH SELECTOR switch is in the VAR position.

TABLE 3-1. PANEL CONTROL FUNCTIONS (CONT)

REFERENCE DESIGNATION (Figure 3-7)	PANEL DESIGNATION	FUNCTION
7		Cathode Ray Tube with a calibrated screen representing frequency and amplitude of a displayed spectrum.
8		Power indicator lamp.
9, 10, 11, 13, 14, 15	INPUT ATTENUATOR	Six toggle switches, providing attenuation to signal input circuit of from 5 db up to 65 db in 5 db steps.
12	5 KC MARKER	This control activates the 5 kc oscillator. When the CAL OSC LEVEL control is turned on, the 5 kc signal modulates the 500 kc oscillator test signal causing a series of pips, at 5 kc intervals to appear on the crt screen to a width of 50 kc on either side of the center 500 kc pip. This function facilitates setting up of any desired sweep width when the SWEEP WIDTH SELECTOR switch is set to VAR.
16	SIGNAL INPUT	Input signal connection point.
17	ILLUMINATION POWER OFF	Clockwise rotation applies power to unit. Continued clockwise rotation increases crt screen edge illumination.
18	FAST SWEEP	Momentary-contact pushbutton. When depressed, sweep rate speeds up from 0.1 to 1 cps on the 150 CPS and 500 CPS pre-set sweep widths. This function facilitates centering the display on the screen without having to wait 10 seconds between sweeps. Undesired portions of the scanned spectrum may be skipped by use of this control.
19	CAL OSC LEVEL	Clockwise rotation activates the 500 kc oscillator. Continued clockwise rotation increases the amplitude of the 500 kc signal. This 500 kc signal may be used as an aid in locating the center frequency of the FSA. The 500 kc oscillator may be modulated either by the internal 5 kc oscillator or by an external oscillator connected to EXT MOD connector to produce marker sidebands. The 500 kc signal, in conjunction with the INPUT ATTENUATOR toggle switches, may be used to check the accuracy of the LOG amplitude calibrations on the crt screen.
20	EXT MOD	External oscillator input connector. To be used in lieu of internal 5 kc oscillator.
21	IF ATTEN	Two position toggle switch, 0 DB and 20 DB. 20 DB position inserts 20 db attenuation in the i-f amplifier section. This function enables a full scale LOG deflection adjustment of the input signal.

TABLE 3-1. PANEL CONTROL FUNCTIONS (CONT)

REFERENCE DESIGNATION (Figure 3-7)	PANEL DESIGNATION	FUNCTION
21 (cont)		0 DB position permits the full 60 db dynamic range of the FSA to be utilized. In this case, however, only the lower 40 db portion is displayed on the crt screen. When making measurements requiring the full 60 db dynamic range of the FSA, the IF ATTEN switch should always be in the 0 DB position.
22	SWEEP WIDTH SELECTOR	Six position selector switch, providing 5 pre-set sweep widths of 150 CPS, 500 CPS, 3.5 KC, 7 KC, 14 KC and a variable position marked VAR. When in the VAR position, the sweep width may be varied from 0 to 100 KC with the SWEEP WIDTH control. The IF BANDWIDTH control may be adjusted for optimum resolution, and the SWEEP RATE control may be adjusted to any value from 0.1 cps to 30 cps. The VIDEO FILTER switch is also operative in this position.
23	BRILLIANCE	This control varies the intensity of the screen presentation.
24	FOCUS	This control varies the sharpness of the screen presentation.
25	AMPLITUDE SCALE	Two position toggle switch, LOG and LIN. In the LIN (linear) position, permits viewing of signals with amplitude ratios of 20 db (10:1). In the LOG (logarithmic) position, permits viewing of signals with amplitude ratios of 40 db (100:1). When using the LIN scale, the calibration dots along the right edge of the screen grid are used. When using the LOG scale, the horizontal lines on the screen grid are used. The LOG scale is calibrated from 0 to 40 db in 5 db steps. **NOTE** Due to the time constant factor, the LOG feature does not function properly with narrow pulses.
26	AFC (OFF)	Clockwise rotation activates the AFC (Automatic Frequency Control) circuit. This control reduces the normal maximum sweep width by a factor of 50 when the SWEEP WIDTH SELECTOR switch is in the VAR position. Continued rotation of this control adjusts the center frequency back to the center screen calibration. This action is necessary to compensate for a shifting occurring when the AFC is turned on. This effectively causes the CENTER FREQUENCY control to act as a vernier to the AFC control.

REFERENCE DESIGNATION (Figure 3-7)	PANEL DESIGNATION	FUNCTION
26 (cont)		This frequency stabilized narrow scanning width, in conjunction with the proper corresponding sweep rate and IF bandwidth adjustments, provides the best resolution capable by the FSA.
27	CENTER FREQ	This control is used to set or maintain the frequency modulated local oscillator at its specified mean frequency. This effectively keeps the input center frequency signal pip centered on the screen's center calibration. When AFC stabilization is employed, this control acts in a vernier capacity.
28	GAIN	This control adjusts the amplitude of the screen presentation. Clockwise rotation increases the gain. The GAIN control should be set for a maximum gain setting consistent with low noise on the CRT screen to reduce internal distortion at the FSA input circuits.
29	VFO INPUT	External variable frequency oscillator (VOX) input connector. An external oscillator is necessary when measuring an input signal that is outside of the 450-550 kc range.

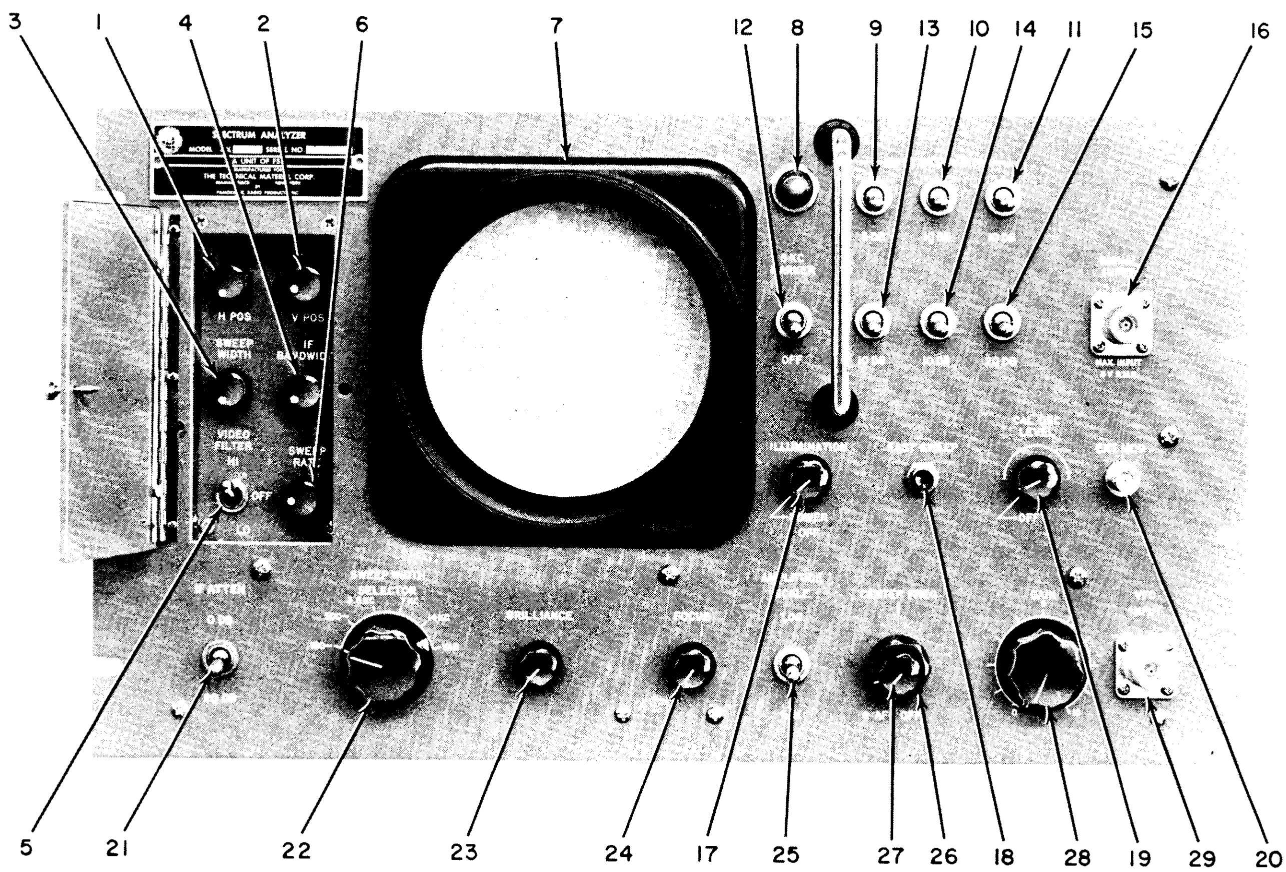


Figure 3-7. Front Panel Controls, Model AX-503

SECTION 4
PRINCIPLES OF OPERATION

4-1. GENERAL.

The FSA is basically a narrow-band superheterodyne receiver, providing a visual display of the signal distribution in a selected portion of the r-f band. The selected display portrays a plot of frequency versus amplitude on the calibrated crt screen.

As shown in block diagram, figure 4-1, the FSA consists of seven principal sections.

1. Input section.
2. Sweep generator section.
3. Mixer and sweep oscillator, reactance modulator and AFC section.
4. 100 KC i-f and video section.
5. Crt, horizontal and vertical plate outputs section.
6. Calibrating oscillator section.
7. Power supply section.

The following sub-paragraphs give a brief description of each section. Paragraph 4-2 gives a detailed circuit description.

a. Input Section. This section provides three input circuits and an output circuit of 450 to 550 kc. Incoming signals in the 450-550 kc range require no external oscillator input frequency signal since the bandpass of the first mixer is 450 to 550 kc.

However, with incoming signals outside of the 450 to 550 kc range, an external oscillator or signal generator with an input frequency 500 kc above or below the incoming signal is required. A full-scale crt screen log deflection will be produced with a 2 millivolt or less incoming signal level with the external oscillator or signal generator level at 0.3 volt rms. This sensitivity is maintained well above 30 megacycles. At reduced sensitivity, the mixer is usable up to 1000 megacycles.

b. Sweep Generator Section. This section provides two sawtooth outputs with their speeds variable from 0.1 to 30 cps. One of the sawtooth outputs provides horizontal sweep to crt. The other sawtooth output is fed to the reactance modulator in the third principal section of the FSA.

c. Mixer-Sweep Oscillator, Reactance Modulator and AFC Section. The sawtooth output from the sweep generator is fed to the reactance modulator and, in combination with Z101 network, causes the local sweep oscillator frequency to vary in accordance with the varying magnitude of the sawtooth signal. With AFC feedback circuit OFF, scanning width is ±50 kc from the center frequency, and with AFC feedback circuit ON, the scanning width is ±1 kc. AFC feedback circuit ON provides the necessary frequency stability for the narrow bandwidth. The mixer stage receives two signals; the 450 to 550 kc output circuit of the first r-f amplifier V2, and the local sweep oscillator output scanning signal (nominally at 550 to 650 kc). The scanning signal voltage progressively translates each voltage component in the 450 to 550 kc signal to a frequency difference of 100 kc at the output of the 100 kc mixer center frequency narrow-band output filter Z103.

d. 100 KC IF and Video Section. This section receives the second mixer 100 kc output voltages. These voltages, varying in magnitude in accordance with the composition of the 450 to 550 kc i-f amplifier signal, are amplified in a four-stage narrow band amplifier. These signals are then detected, amplified by a vertical amplifier stage, and fed to the vertical plates of the crt.

e. Crt, Horizontal and Vertical Output Section. The component signals in the 100 kc r-f bandwidth under surveillance are displayed by the crt. Narrower bandwidths may also be displayed on the crt screen if desired. The signal amplitude and frequency are indicated by the signal pip height and position along the calibrated horizontal axis of the crt screen. The crt electron beam is scanned across the screen by the sawtooth output of the sweep generator. The beam is progressively shifted horizontally across the screen to display the demodulated 100 kc output from the second mixer.

f. Calibrating Oscillator Section. The calibrating oscillator section will provide, if desired, a 500 kc marker to the crt. When an audio signal is supplied, via EXT MOD connector, the 500 kc modulated signal provides known frequency separated markers. The 5 kc marker oscillator functions in place of an external modulating signal, when 5 kc intervals are satisfactory.

g. Power Supply Section. The power supply section, model PS, is a conventional type, electronically regulated power supply providing +270 volts to the spectrum analyzer portion of the FSA, in addition to high voltage for the crt and filament voltage for all tubes.

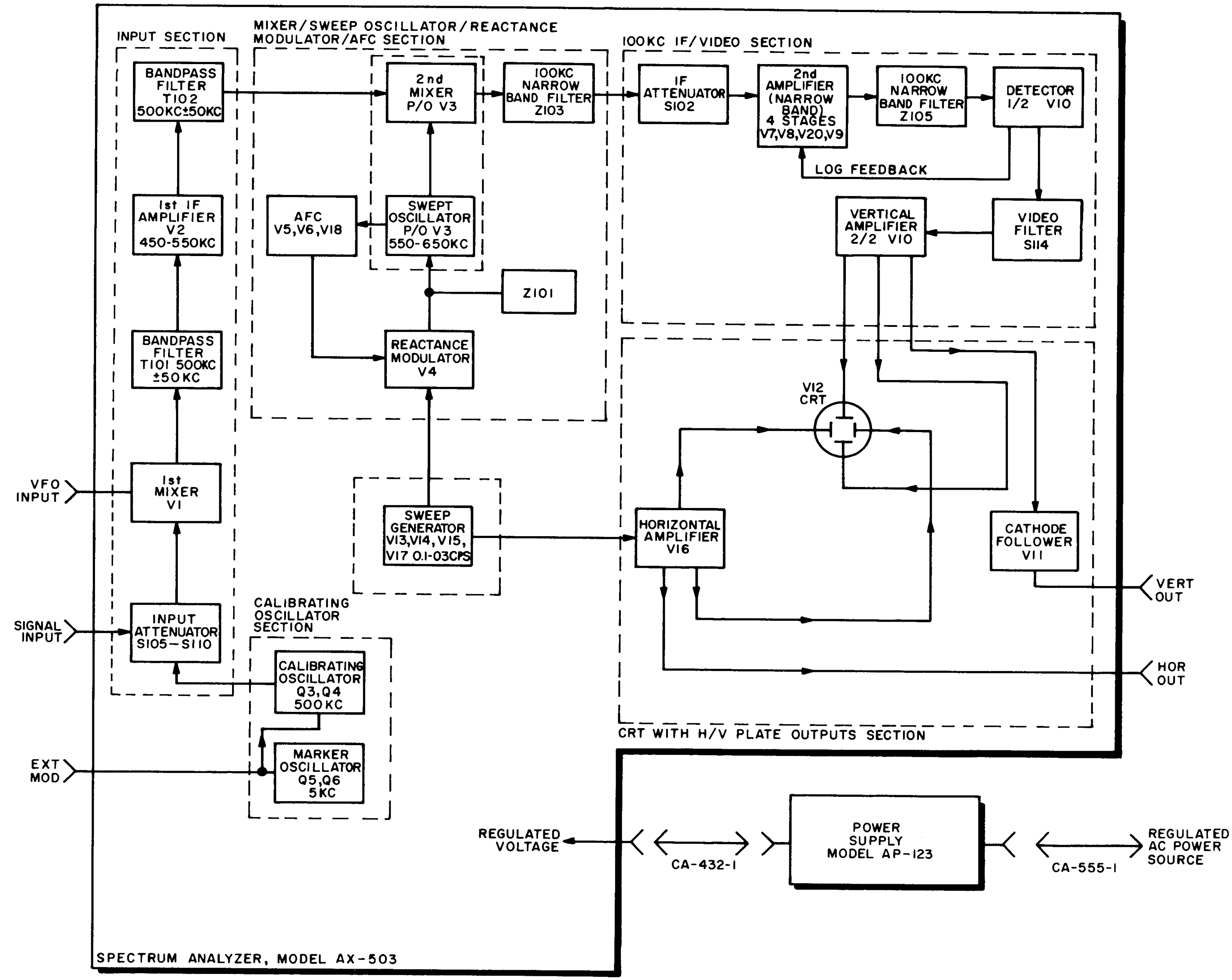


Figure 4-1. Block Diagram, Model FSA-3

008640297

4-2. CIRCUIT DESCRIPTION.

The following text will describe in detail, the circuit description and functions of the component sections comprising the FSA.

a. Input Section. The incoming signal at connectors J101 or J103 or the calibrating oscillator output is fed through a 50 ohm step type INPUT ATTENUATOR (S105 through S110) providing attenuation to the input signal of up to 65 db in 5 db steps. The attenuator accuracy is ±0.5 db/db up to 30 megacycles. Although the accuracy diminishes slightly above 30 megacycles, it can still be used effectively up to several hundred megacycles.

After the signal passes through the INPUT ATTENUATOR network, it is applied to the control grid of the input mixer V1. The output is then coupled through a 450 to 550 kc bandpass filter T101 to a neutralized cascade r-f amplifier V2. The GAIN potentiometer R311 in the cathode circuit of V2 allows attenuation of up to 20 db.

The output of V2 is then coupled to 2nd Mixer V3 via bandpass filter T102.

Coupling transformers T101 and T102 are designed to provide a bandpass region of 450 to 550 kc with a sharp cutoff at 550 kc, effectively reducing image response.

VFO INPUT connectors J102 and J104 are provided for connection to an external oscillator or signal generator used to heterodyne with the test signal to produce the required FSA operating frequency.

NOTE

The heterodyne product must be the difference of the two frequencies used. Use of the sum frequency will result in spurious screen indications due to the heterodyne products of the external signal generator output and its harmonics and the test signals.

b. Sweep Generator Section. A feedback integrator circuit, consisting of Sweep Tube V13 and cathode follower V14A, provide the sawtooth sweep voltage. Capacitor C163 is charged with a constant current, determined by the SWEEP RATE potentiometers R287 and R289 setting, resulting in a sawtooth voltage development. The sawtooth voltage developed across C163 is fed to the cathode of V14A, and is available at the HOR OUTPUT connector J107. Adjustment of SWEEP RATE potentiometers R287 and R289 determine the charging current to C163. A negative charge of C163 causes the grid of sweep tube V13 to swing negative, causing a highly amplified positive plate voltage. The output of V13 is coupled to cathode follower V14A for impedance transformation purposes.

The cathode follower V14A output causes the output side of C163 to swing positive at a greater rate than the input side going negative. The potential of the input side of C163 and the grid of V13 remain nearly zero during any single sweep. Therefore, the charging current remains at a constant level, resulting in a linear sawtooth voltage.

When a predetermined sawtooth voltage is reached, the blocking oscillator V14B conducts causing tube V15 to conduct heavily. This action causes C163 to discharge, and the charging cycle repeats itself.

The sawtooth voltage is then coupled through LINE SIZE potentiometer R310, through SWEEP WIDTH LIMIT potentiometer R277 to the grid of horizontal amplifier V16 and to reactance tube V4 through the sweep width divider network.

The second half of V16 functions as a direct coupled phase inverter, with both plates of V16 direct coupled to the crt horizontal deflection plates.

The following chassis mounted controls, applying to this section, are factory set and should be changed by qualified personnel only.

(1) LINE SIZE potentiometer R310.

(2) 30-cycle adjust potentiometer R292.

(3) 0.1-cycle adjust potentiometer R291.

(4) SWEEP WIDTH LIMIT potentiometer R277.

(5) SWEEP WIDTH 7 KC potentiometer R273.

(6) SWEEP WIDTH 3.5 KC potentiometer R270.

c. Mixer, Sweep Oscillator, Reactance Modulator and AFC section. Pentagrid converter V3, is used to function as a 2nd mixer and local oscillator. The local oscillator center frequency is 600 kc. Reactance stage V4 sweeps the oscillator between 550 kc and 650 kc in accordance with the applied sawtooth voltage at its grid. CF PAD R279 varies the reactance tube V4 screen voltage, tuning the oscillator center frequency.

The output of local oscillator V3 is coupled and amplified by AFC amplifier V5. The amplified output of V5 is coupled to a frequency discriminator stage V6, having a center frequency of 600 kc. The frequency discriminator effectively reduces the normal 100 kc local oscillator sweep width to 2 kc, stabilizing it against drift. Local oscillator hum modulation is reduced by a factor of 50 by the AFC circuitry.

The mixer portion of V3 receives 450 to 550 kc signals from r-f amplifier V2 and 550 to 650 kc signals from the local sweep oscillator portion of V3. The mixer portion of V3, coupled through a 100 kc center frequency narrow band output filter Z103, provides variable 100 kc signals. These signals result from the local oscillator's frequency-modulated voltages and the component signal voltages in the r-f band under surveillance. Therefore, the 100 kc component signal voltages from the narrow-band 100 kc center frequency output filter Z103, represent the amplitude and frequency of the voltage components in the output of the 450 to 550 kc r-f amplifier V2 during the scanning cycle.

d. 100 KC IF and Video Section. The output of 2nd mixer V3 is coupled through IF ATTENUATOR S102, providing either 0 db or 20 db attenuation to the input of the 100 kc i-f amplifier V7. Although the IF ATTENUATOR is normally used in the 0 db position, setting to the 20 db position permits a convenient method of setting the signal level at 20 db above full-scale log deflection.

The first i-f amplifier V7 is a neutralized amplifier having a crystal filtered cathode circuit. The filter is operated in a series resonant configuration coupling into the control grid of the pentode section of V7. The grid return to ground is a resistance shunted, parallel resonant circuit. Decreasing the shunting resistance, by means of the SWEEP WIDTH SELECTOR switch S101A-T, the effective series resonance of the crystal filter is decreased, narrowing the crystal bandwidth.

The second i-f amplifier V8 is similar in circuitry to the first i-f amplifier V7. IF BANDWIDTH potentiometer R146 and R152 form part of the i-f selectivity circuits. The SWEEP WIDTH SELECTOR switch S101C-T controls the selectivity and the gain is controlled by S101B-T.

The third i-f amplifier V20 is similar in circuitry to the first and second i-f amplifiers. The grid return to ground is shunted by S101E-T.

The fourth i-f amplifier V9 is a conventional i-f amplifier stage. When AMPLITUDE SCALE switch S103 is in LOG position, a d-c feedback voltage from diode detector V10 is applied to the grid of V9, reducing its gain during strong signals. The feedback voltage amplitude and the controlling operating point of the i-f stage logarithmic characteristics are determined by the LOG SCALE ADJ potentiometer R174 and LOG ZERO ADJ potentiometer R171.

The detector V10 output is direct coupled to the control grid of the second section of V10 through a low pass RC filter network. VIDEO FILTER switch S114 provides two degrees of filtering plus an off position.

The video amplifier V10 output is direct coupled to one of the vertical deflection plates of the crt and also to the grid of phase inverter V11. The output of phase inverter V11 is also direct coupled to the other vertical deflection plate of the crt. The variable cathode bleeder resistor R186 of Phase Inverter V11 controls the d-c potential of the associated vertical deflection plate, thereby controlling the vertical positioning.

The second section of V11 functions as a cathode follower, providing a vertical output voltage at VERT OUT connector J106 for use in driving an external slave oscilloscope or other indicating units.

e. CRT, Horizontal and Vertical Plate Output Section. Cathode-ray tube V12, a 5-inch diameter screen, has its vertical deflection plates driven by V10 and V11. The horizontal deflection plates are driven by V16.

The crt screen contains a LOG DB scale, with db line calibrations ranging from 0 db to -40 db on the left side of the screen. A LIN scale, on the right side of the screen, contains linear dot calibrations ranging from 1.0 to 0.

A signal with reference or 0 db deflection on the LOG scale will drop 20 db with a 20 db attenuation insertion. A signal with 1.0 deflection on the LIN scale will drop to 0.1 deflection with a 20 db attenuation insertion.

f. Calibrating Oscillator Section. Transistor Q3 is a crystal controlled 500 kc oscillator. The output of Q3 drives an emitter follower stage Q4 whose output is then coupled, through an isolation resistor R108, to the input section of the FSA. The calibrating oscillator output is varied by the CAL OSC LEVEL potentiometer R101, which determines the supply voltage delivered to Q3 and Q4. EXT MOD connector J105 provides connection of an external audio modulating signal to modulate the 500 kc oscillator, thereby providing frequency markers with known separations.

The 5 kc marker oscillator section consists of transistors Q5 and Q6, comprising a bridged-T resistance-capacity oscillator. The oscillator frequency is adjustable over a restricted range, factory adjusted to 5000 cps ±2 percent. The oscillator output is at a low impedance.

g. Power Supply Section. The power supply section consists of a conventional, electronically regulated circuit, providing +270 volts to the analyzer section. CR601 and CR602 provide the high voltage for the crt. The negative crt supply bleeder current operates voltage reference tube V17 which supplies voltage to the sweep circuits. Voltage regulator V18 supplies voltage to the r-f amplifier and second mixer stages.

SECTION 5
TROUBLESHOOTING

5-1. INTRODUCTION.

This section explains how to locate and diagnose equipment troubles and maladjustments. By proper use of the various troubleshooting aids shown in this section, the technician can quickly locate and diagnose the particular fault at hand.

The following troubleshooting aids are provided:

a. Voltage and resistance measurements, model SA (figure 5-1).

b. Voltage and resistance measurements, model PS (figure 5-2).

c. Tube locations, model SA (figure 5-3).

d. Tube locations, model PS (figure 5-4).

e. Transistor voltage measurements (table 5-1).

5-2. TROUBLESHOOTING TECHNIQUES.

When a piece of equipment has been working satisfactorily and suddenly fails, the cause of failure may be apparent either because of circumstances occurring at the time of failure or due to symptoms of fast failures. Therefore, the first check is to ascertain that proper equipment operating voltages are present and that all tubes and fuses are in proper operating condition. A visual check for loose or frayed interconnecting cables may also eliminate further investigation.

If the above mentioned checks fail to locate the fault, the unit should be removed from its mounting, dust covers removed, and visually checked section by section for burned elements, charring, corrosion, arcing, excessive heat, dirt, dampness, etc.

If the fault is still not located, the technician should then proceed with voltage and resistance checks.

5-3. TROUBLESHOOTING PROCEDURES.

The voltage and resistance values shown in figure 5-1 and 5-2 are nominal measurements taken under the conditions listed below. Large deviations from the normal values shown should be carefully investigated. During this process, use of the schematic diagrams provided in section 8 will prove to be of great assistance. Figures 5-3 and 5-4 provide tube locations.

All measurements taken with RCA Vacuum Tube Voltmeter, Model WV-77B. All voltage and resistance readings shown are taken from indicated tube pin to ground. Resistance measurements were made with interconnecting cables removed and the ILLUMINATION control in the on position.

All measurements taken with front panel controls at the following settings:

IF ATTEN	0 DB
SWEEP WIDTH SELECTOR . . .	VAR
BRILLIANCE	Bright trace
FOCUS	Sharp trace
AMPLITUDE SCALE	LIN
CENTER FREQ.	Vertical marker
AFC	OFF
GAIN	10 (maximum)
CAL OSC LEVEL	OFF
5 KC MARKER	OFF
INPUT ATTENUATOR	All switches up (no attenuation)
H POS	Normal setting
V POS	Normal setting
SWEEP WIDTH	Fully clockwise
IF BANDWIDTH	Fully clockwise
VIDEO FILTER	OFF
SWEEP RATE	Fully clockwise

Notes:

a. Voltage readings indicated above line, resistance readings indicated below line.

b. All voltages are DC unless otherwise specified.

c. All resistance values are in ohms.

d. * indicates low resistance readings.

e. NC indicates no connection.

CAUTION

It is recommended that resistance measurements of the transistor circuitry not be attempted due to possible damage to transistors.

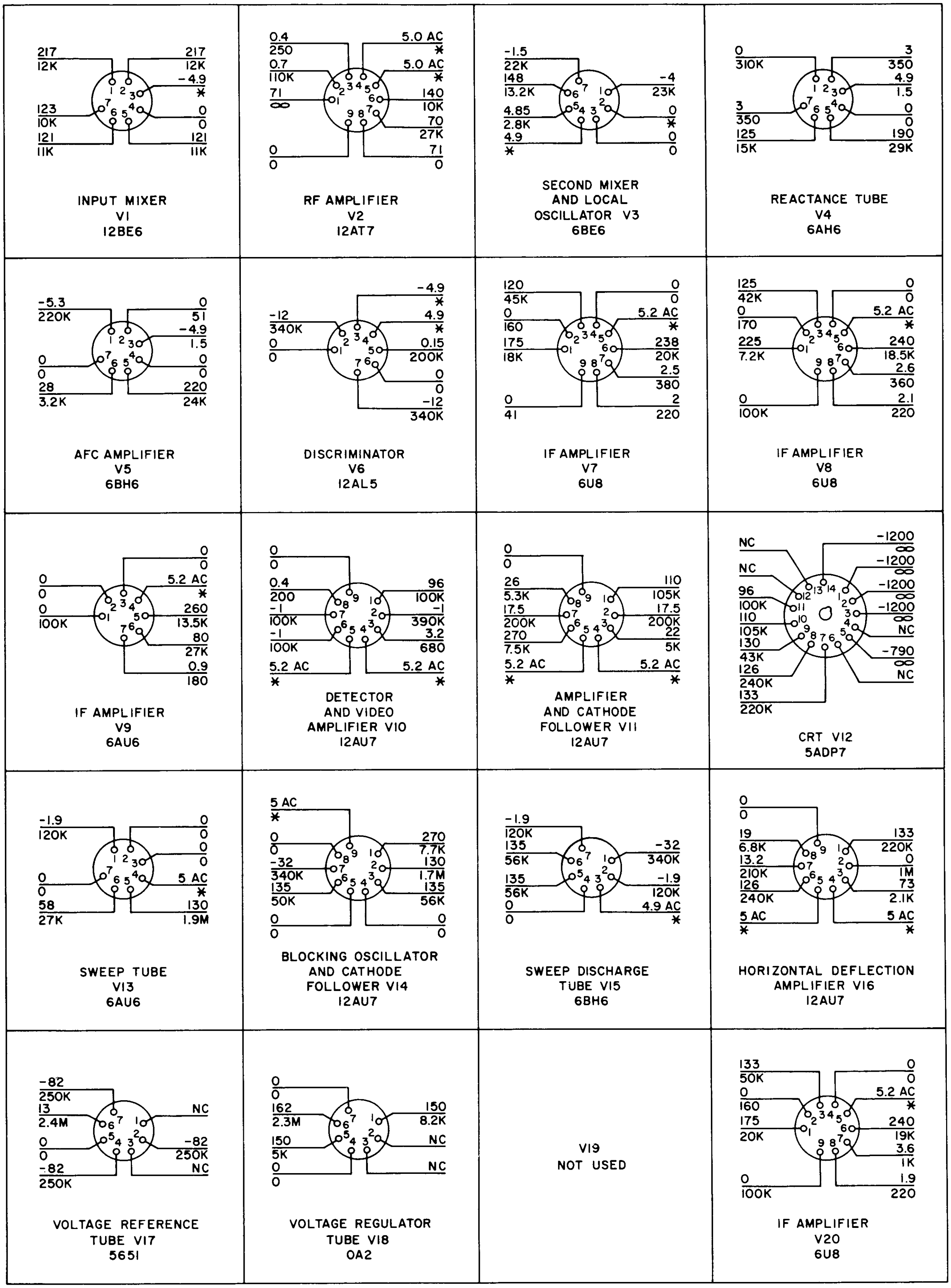


Figure 5-1. Voltage and Resistance Measurements, Model AX-503

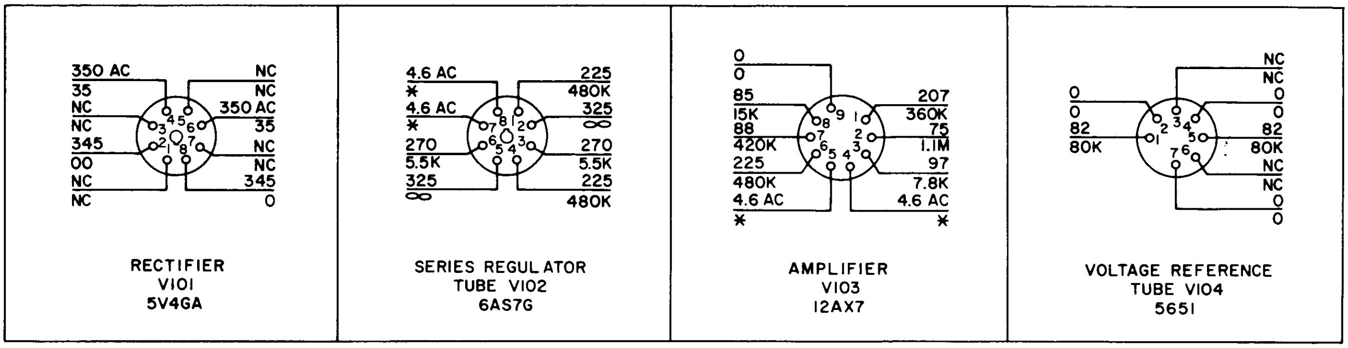


Figure 5-2. Voltage and Resistance Measurements, Model AP-123

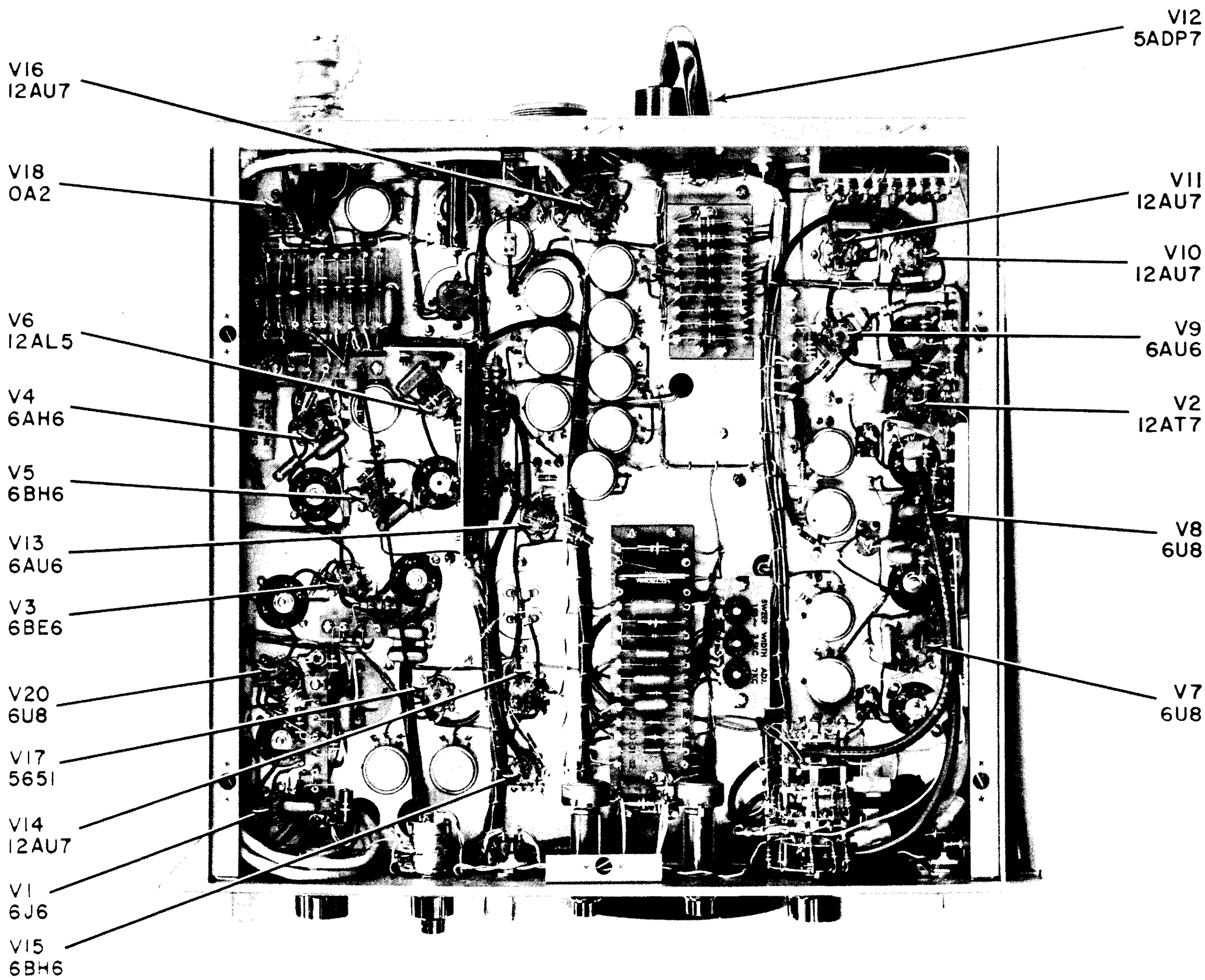


Figure 5-3. Tube Locations, Model AX-503

TABLE 5-1. TRANSISTOR VOLTAGE MEASUREMENTS

PIN	CALIBRATING OSCILLATOR		5 KC MARKER OSCILLATOR	
	Q3	Q4	Q5	Q6
E	+4.7	+4.3	+15.8	+28.2
B	+6.7	+4.7	+15.0	+27.8
C	+0.05	+0.0	+0.95	+15.8

NOTE

The transistor voltage values shown are typical; variations by a fact of 2 or more in either direction may be found.

Q3 and Q4 measurements made with CAL OSC LEVEL control fully clockwise.

Q5 and Q6 measurements made with 5 KC MARKER ON.

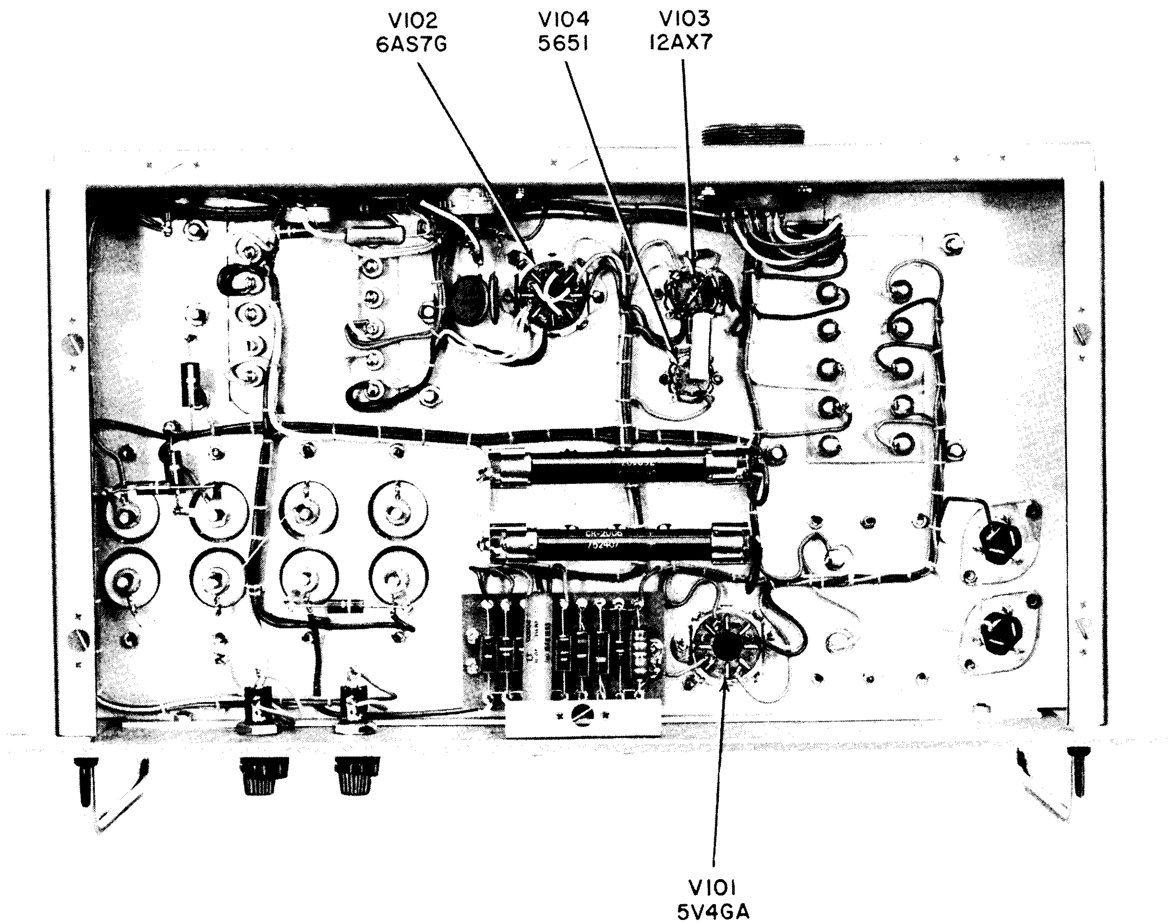


Figure 5-4. Tube Locations, Model AP-123

SECTION 6
MAINTENANCE

6-1. INTRODUCTION.

Maintenance may be divided into three catagories: operator's maintenance, preventive maintenance and corrective maintenance.

The operator may, at certain times, be required to perform various aspects of operator's maintenance. This type of maintenance may consist of simply keeping the unit clean and observing for tight interconnecting cable connections. However, should normal operating procedures produce unsatisfactory results, a check of the interconnections and associated equipment levels to the FSA may clear the fault. A check of the vacuum tubes and power supply fuses may also be necessary.

NOTE

Never replace a fuse with one of higher rating unless continued operation is more important than probable damage to the equipment. If a fuse burns out immediately after replacement, do not replace it a second time until the trouble has been located and corrected.

The corrective maintenance procedures provide information useful in locating and diagnosing equipment troubles and maladjustments, existing and/or pending, and information necessary to remedy the equipment troubles and maladjustments.

The FSA has been designed to provide long-term, trouble-free operation under normal duty conditions. It is recommended that any necessary maintenance be performed by a competent maintenance technician familiar with troubleshooting techniques. If a fault cannot be corrected, it is recommended that the FSA be returned to The Technical Materiel Corporation for servicing.

6-2. PREVENTIVE MAINTENANCE.

a. In order to prevent equipment failure due to tube failure, dust, dirt and other destructive elements, it is suggested that a schedule of preventive maintenance be set up and adhered to.

b. At periodic intervals, the equipment should be removed from its mounting for cleaning and inspection. All accessible covers should be removed and the wiring and all components inspected for dirt, corrosion, charring, discoloring or grease. Remove dust with a soft brush or vacuum cleaner. Remove dirt or grease from other parts with any suitable cleaning solvent. Use of carbon tetrachloride should be avoided due to its highly toxic effects. Trichlorethylene or methyl chloroform may be used, providing the necessary precautions are observed.

WARNING

When using toxic solvents, make certain that adequate ventilation exists. Avoid prolonged or repeated breathing of the vapor. Avoid prolonged or repeated contact with skin. Flammable solvents shall not be used on energized equipment or near any equipment from which a spark may be received. Smoking, "hot work", etc. is prohibited in the immediate area.

c. While the unit is dismounted, check the tubes, all of which are accessible on the top of the chassis. Replace all tube shields.

d. Carefully inspect for loose solder connections or screws, especially those on solder lugs.

6-3. CORRECTIVE MAINTENANCE.

Corrective maintenance of the FSA will consist mainly of replacement of tubes and other components. It should be noted that when replacing tubes or other components, the technician should observe for exact or equivalent replacements by referring to the parts list in section 7. Polarity and positioning of certain components should be observed before removing so that the replacement component will fit and operate properly.

Table 6-1 is a list of test equipment necessary for checking and alignment of the FSA.

TABLE 6-1. TEST EQUIPMENT REQUIRED

ITEM	TYPE
Signal Generator (50 kc to 65 mc, 0.1 uv to 3 v.)	Hewlett-Packard, Model 606 A or equivalent
Signal Generator (5 cps to 600 kc, 0 to 5 v.)	Hewlett-Packard, Model 200 CD or equivalent
Vacuum-tube Voltmeter	RCA, Model WV-77C or equivalent

6-4. SCREWDRIVER ADJUST CONTROLS.

The screwdriver adjust controls listed below pertain to circuits seldom requiring adjustment. However, should a touch-up adjustment be necessary, perform the following procedures pertaining to the particular circuit in question. All FSA screwdriver adjust controls are located on the top of the chassis except the Sweep Width Adjust 150~, 3.5 KC and 7 KC potentiometers, which are located on the bottom or underside of the chassis.

a. Line Size. Adjustment of this control is made for a correct baseline length of approximately one-quarter inch on either side of the frequency scale limits.

b. Sweep Width Limit. This control is adjusted to provide correct sweep width in the 14 KC position of the SWEEP WIDTH SELECTOR control. As it is interlocked with, and affects, the sweep width in all other positions, it must be set and locked for correct 14 KC sweep width before further adjustment of sweep widths is attempted.

(1) Set SWEEP WIDTH SELECTOR control to 14 KC.

(2) Set CAL OSC LEVEL control fully clockwise.

(3) Adjust GAIN and CENTER FREQ controls to give approximately full scale signal centered on the screen.

(4) Connect a 7 kc signal source to the EXT MOD connector. Adjust 7 kc source amplitude for approximately one-quarter scale sideband pips.

(5) Adjust Sweep Width Limit screwdriver adjust control to place the sideband pips as near coincidence as possible with left and right extremes of the frequency scale.

(6) Set SWEEP WIDTH SELECTOR control to VAR. Using a suitable frequency source, check the sweep width with the manual SWEEP WIDTH control in its full clockwise position. This should be 105 KC ±5% KC and is not subject to further adjustment following step 5 above.

NOTE

Since the following adjustments must be made with the bottom chassis shield removed, it is possible to introduce appreciable 60 cps hum pickup into the screen presentation. Care should be observed so as not to confuse the consequent 60 cps sidebands with the 75 cps calibrating sidebands.

(7) With SWEEP WIDTH SELECTOR control set to 7 KC and the modulating signal source shifted to 3.5 KC, adjust the under-chassis 7 KC ADJ control to secure best coincidence of sideband pips with the screen frequency scale extremes.

(8) With SWEEP WIDTH SELECTOR control set to 3.5 KC and the modulating signal source shifted to 1.75 kc, adjust the under-chassis 3.5 KC ADJ control to secure best coincidence of sideband pips with the screen frequency scale extremes.

(9) With the CAL OSC pip carefully centered, set the SWEEP WIDTH SELECTOR control to 500 CPS and shift the modulating signal source to 250 cps.

c. Sweep width Limit AFC. This control determines the amount or "stiffness" of the feedback voltage derived from the discriminator in the stabilized sweep positions. By setting the ratio of bucking to sawtooth driving voltages, it governs the sweep widths with automatic frequency control active.

(1) Following step b. (9), adjust Sweep Width Limit AFC screwdriver adjust control for coincidence of sideband pips with screen frequency scale extremes.

(2) Set SWEEP WIDTH SELECTOR control to 150 CPS and shift modulating frequency source to 75 cps.

(3) Adjust under-chassis 150 CPS ADJ control for best coincidence of sideband pips with the extremes of the frequency scale.

d. Astigmatism. Adjustment of this control, in conjunction with the FOCUS control, is made to produce a sharp circular spot over the full width of the CRT.

e. IF Gain. This control, effective when the SWEEP WIDTH SELECTOR is in the VAR position, adjusts the i-f amplifier gain for the specified sensitivity.

(1) (a) Set front panel controls as follows:

IF ATTEN	20 DB
SWEEP WIDTH SELECTOR . .	VAR
AMPLITUDE SCALE	LIN
CENTER FREQ	Vertical marker
AFC	OFF
GAIN	10 (maximum gain)
CAL OSC LEVEL	OFF
INPUT ATTENUATOR	All up (no attenuation)
5 KC MARKER	OFF
H POS	Normal setting
V POS	Normal setting
SWEEP WIDTH	Fully clockwise
IF BANDWIDTH	Fully clockwise
VIDEO FILTER	OFF
SWEEP RATE	Fully clockwise

(b) Connect a 3 mc signal source, at an amplitude of 1 millivolt, to front panel SIGNAL INPUT connector.

(c) Connect a 2.5 mc signal source, at an amplitude of 0.3 volts, to front panel VFO INPUT connector.

(d) Adjust IF Gain screwdriver adjust control for a full scale pip on the screen.

(2) 14 KC. When the SWEEP WIDTH SELECTOR control is in the 14 KC position, this screwdriver adjust control adjusts the i-f gain. It is adjusted for the same overall gain obtained in step e. (1).

(3) 7 KC, 3.5 KC, 500 CPS and 150 CPS. These screwdriver adjust controls are adjusted in a similar manner as for the 14 KC IF Gain control in step (2).

f. Log Scale Adj, Log Zero Adj and Lin Cal. These three controls are employed to calibrate the vertical signal compressor circuit for accurate coincidence with the engraved DB lines of the amplitude scale. Replacement of the crt (V12), the detector (V10) or the gain controlled i-f stage (V9) or normal aging of these elements may require resetting of these controls.

(1) Set the baseline trace accurately on the screen bottom line using the V POS control.

(2) Set the Lin Cal screwdriver adjust control to the center of its rotational range.

(3) Apply 20 db attenuation using the front panel INPUT ATTENUATOR switches.

(4) Adjust the CAL OSC LEVEL control for full scale pip deflection with AMPLITUDE SCALE switch in LIN position.

(5) Apply an additional 10 db attenuation with the front panel INPUT ATTENUATOR.

(6) Set AMPLITUDE SCALE switch to LOG.

(7) Adjust Log Scale Adj screwdriver adjust control for pip top coincidence with the -30 DB line of the vertical scale.

(8) Switch out the 30 db attenuation and adjust the Log Zero Adj screwdriver adjust control for coincidence of the pip top with the top or 0 DB line of the screen.

(9) Reinsert the 30 db attenuation and retrim the Log Scale Adj screwdriver adjust potentiometer for coincidence of the pip with the -30 DB scale line.

(10) Repeat steps (7) through (9) until less than 1 db variance exists at the 0 DB and -30 DB scale lines. Check coincidence at all screen LOG calibration lines by varying inserted attenuation from zero to 40 db in 5 db steps.

(11) If steps (1) through (10) do not yield a satisfactory calibration, note whether the compression distortion tends to occur in the high level or low level portions of the screen. If low level fit is good but high level errs on the plus (above the line) side, repeat the entire procedure using a slightly more clockwise setting of the Lin Cal screwdriver adjust control. If high level fit is good but low level fit errs on the plus (above calibration line) side, repeat the entire procedure using a more counterclockwise setting of the Lin Cal screwdriver adjust control.

NOTE

In the exceptional case where the ranges provided in these controls do not permit proper LOG scale adjustment, it may be necessary to replace V9.

g. .1~ Adj and 30~ Adj Sweep Rate Adjustments.

(1) Set SWEEP WIDTH SELECTOR control to 500~. Adjust the .1~ Adj screwdriver adjust control until the horizontal spot motion period is 0.1 cps.

(2) (a) Set SWEEP WIDTH SELECTOR control to VAR.

(b) Set SWEEP RATE control fully clockwise.

(c) Modulate the calibrating oscillator with a 60 cps signal and turn the SWEEP RATE control fully clockwise.

(d) Adjust Center Freq screwdriver adjust control until the baseline rises and a sine wave is displayed on the screen.

(e) Adjust the 30~ Adj screwdriver adjust control until two cycles of the sine wave appear on the screen.

(3) Repeat the procedure shown in step g. (1). Due to an interaction between the .1~ Adj and 30~ Adj screwdriver adjust controls, it may be necessary to repeat the entire procedure several times.

h. CF Pad.

(1) Set Center Freq screwdriver adjust control to its center rotational position.

(2) Set SWEEP WIDTH SELECTOR control to VAR.

(3) Set SWEEP RATE control fully clockwise.

(4) Set IF BANDWIDTH control fully clockwise.

(5) Set SWEEP WIDTH control fully counterclockwise.

(6) Adjust CF Pad Screwdriver adjust control until baseline rises to a peak or maximum reading (the GAIN and CAL OSC LEVEL controls should be set to produce an on-screen deflection near full scale).

(7) Return SWEEP WIDTH control fully clockwise.

(8) Adjust H POS control to place the pip in coincidence with the center frequency scale calibration.

i. Voltage Regulator Adjust. The voltage regulator screwdriver adjust control (located on the rear of the power supply chassis) is adjusted to produce a reading of +270 volts at the 270 V test point jack.

6-5. CIRCUIT ALIGNMENT.

The FSA has been factory aligned before shipment and should not require realignment under normal conditions. However, when tubes are replaced, a touch-up alignment may be necessary due to non-uniformity in vacuum tube operating characteristics. Table 6-2 lists the touch-up alignment procedures to be performed when the indicated tubes are replaced. See figure 6-1 for alignment control locations.

If touch-up alignment and tuning fail to produce satisfactory results, perform the factory alignment procedures provided.

a. General. Transformers T101, T102, Z101, Z102, Z103 and Z105 are tuned by means of movable iron cores. Top and bottom windings are tuned with slotted #6-32 threaded rods extending respectively from the top and bottom of the coil structure. To adjust the bottom cores, it is necessary to remove the chassis bottom plate. Allow equipment and signal generator to warm up for at least one half hour before attempting alignment.

TABLE 6-2. TOUCH-UP ALIGNMENT

TUBE	ADJUSTMENT
V1	Replacement tube should provide third order distortion of less than 60 db and direct sensitivity (at 500 kc), at least half as large as conversion sensitivity. Adjust IF Gain controls.
V2	No adjustments necessary.
V3	Adjust CF Pad and Sweep Width Limit controls.
V4	Adjust CF Pad, Z101 and Sweep Width Limit controls.
V5	No adjustments necessary.
V6	No adjustments necessary.
V7	Adjust IF Gain controls.
V8	Adjust IF Gain controls.
V9	Adjust Log Scale and Log Zero controls.
V10	Adjust Log Scale and Log Zero controls.
V11	No adjustments necessary.
V12	Adjust Line Size, Log Zero, Log Scale and Sweep Width Limit controls.
V13	No adjustments necessary.
V14	No adjustments necessary.
V15	Replacement tube should be selected for best linearity.
V16	No adjustments necessary.
V17	No adjustments necessary.
V18	No adjustments necessary.
V20	Adjust IF Gain controls.
V101	No adjustments necessary.
V102	No adjustments necessary.
V103	No adjustments necessary.
V104	Adjust Voltage Regulator Adjust control.

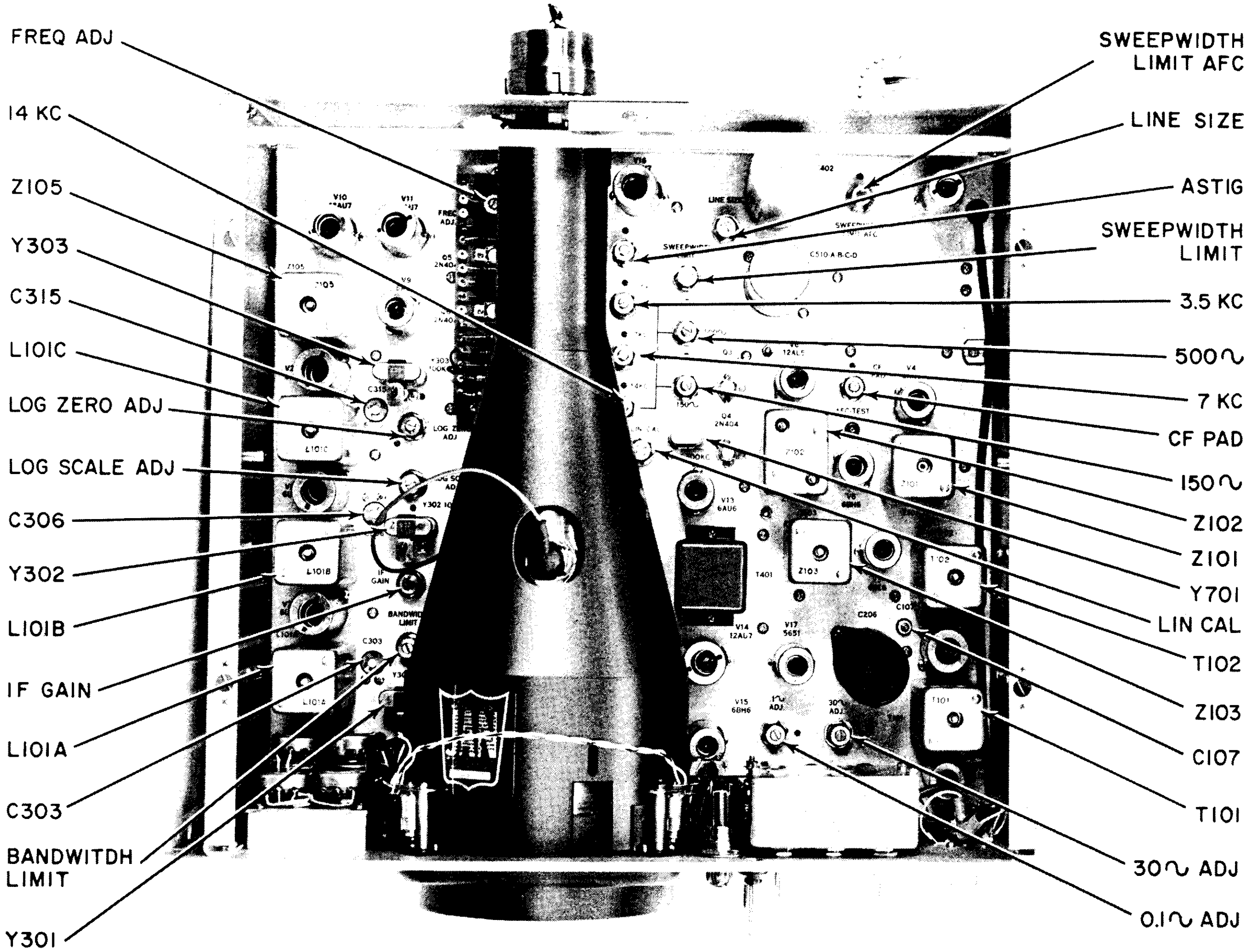


Figure 6-1. Alignment Control Location, Model AX-503

Alignment to be performed with the front panel controls positioned as follows:

IF ATTEN	0 DB
SWEEP WIDTH SELECTOR	VAR
BRILLIANCE	Set for bright trace
FOCUS	Set for sharp trace
AMPLITUDE SCALE	LIN
CENTER FREQ.	Vertical marker
GAIN.	10 (maximum gain)
AFC	OFF
CAL OSC LEVEL.	OFF
INPUT ATTENUATOR.	Set all switches up
5 KC MARKER	OFF
H POS	Set for normal operation
V POS	Set for normal operation
SWEEP WIDTH	Fully clockwise
IF BANDWIDTH	Fully clockwise
VIDEO FILTER	OFF
SWEEP RATE	Fully clockwise

b. IF AMPLIFIER ALIGNMENT.

The i-f amplifier alignment procedures, listed in table 6-3, are performed using a signal generator capable of providing 100 kc (i-f) and 500 kc (input center frequency) signals.

Connect a .01 mfd capacitor in series with the signal generator output and proceed with table 6-3 instructions.

TABLE 6-3. IF AMPLIFIER ALIGNMENT

STEP	INITIAL SETTING OR ADJUSTMENT	PROCEDURE
1	Sweep Width control set set at minimum. 100 kc, 40,000 uv signal generator output connected to V9, pin 1.	Tune Z105 top and bottom cores for maximum baseline size. When either core is tuned for maximum deflection, further tuning is not required due to windings being paralleled.
2	Sweep Width control set to minimum. 100 kc, 40,000 uv signal generator output connected to V3, pin 7.	Tune Z103 top and bottom cores for maximum baseline rise.
3	Sweep Width control set to maximum. 500 kc, 700 uv signal generator output connected to V3, pin 7.	Center pip on screen using Center Freq control and CF Pad control if necessary. Slowly reduce sweep width, simultaneously readjusting Center Freq control to keep the pip on the screen. Adjust until base of pip occupies approx. 25 percent of the frequency scale.
4	Continuously adjust Sweep Width control as required to keep entire pip within the screen limits. 500 kc, 700 uv signal generator output connected to V3, pin 7.	**NOTE** Due to the crystal holder capacity, varying with respect to crystal position in holder, it is necessary to mark the crystal positions before removing. When replacing crystals in holders, replace with same orientation as it was before removed. Remove crystals Y301 and Y302.
5		Set Bandwidth Limit screwdriver adjust control to the center of its rotational range. Screen display should approximate shape shown in figure 6-2 a and b.
6		Adjust capacitor trimmer screw nearest Y303 slowly counterclockwise; note change in display shape. The rejection slot should sharpen and disappear on one side of the display and approach from the opposite side.
7		Slowly reverse rotation for best pip symmetry and removal of rejection slot. See figure 6-2 b.
8		Tune L101 C for a pip display of minimum height and broadest width. Increase signal input level, if necessary, to increase display amplitude for a readable screen presentation.
9		Check for correct rejection slot removal (refer to step 3). Set input amplitude for full scale pip deflection. Increase input amplitude by 10 times. Set AMPLITUDE SCALE toggle switch to LOG. Adjust Log Scale Adj control, if necessary, for a full scale pip deflection. Pip display should remain approximately symmetrical with no rejection slot appearance. If rejection slot does appear, readjust trimmer to remove it and retune as shown in step 8. Reduce input amplitude 10 times and set AMPLITUDE SCALE toggle switch to LIN.

TABLE 6-3. IF AMPLIFIER ALIGNMENT (CONT)

STEP	INITIAL SETTING OR ADJUSTMENT	PROCEDURE
10		Remove crystal Y303.
11		Replace crystal Y302. Repeat procedures in steps 5 through 9 using capacitor nearest Y302 and L101 B.
12		Remove crystal Y302.
13		Replace crystal Y301. Repeat procedures in steps 5 through 9 using capacitor nearest Y301 and L101 A.
14		Replace crystals Y302 and Y303 in the same orientation prior to removal. Repeat step 9 with all crystals installed but disregard reference to step 8. If trimmer resetting is necessary, make small gradual trimmer adjustment. **NOTE** If a trimmer is readjusted with no noticeable effect, restore trimmer to its prior setting and readjust one of the other trimmers.
15		Adjust Bandwidth Limit screwdriver adjust control for broadest symmetrical peak (without double peak) possible. Proper adjustment should produce less than 20 percent amplitude drop as SWEEP WIDTH control is varied maximum counterclockwise to maximum clockwise positions.

c. FM OSCILLATOR ALIGNMENT.

The following f-m oscillator alignment procedure consists of a series of approximate adjustments, narrowed down until correct results are obtained.

(1) Set Sweep Width Limit screwdriver adjust control fully clockwise.

(2) Adjust CF Pad screwdriver adjust control for +85 volts, measured from CF Pad potentiometer arm to ground.

(3) Set front panel CAL OSC LEVEL control fully clockwise.

(4) Adjust front panel GAIN control for a full scale pip deflection.

(5) Connect an accurate 50 kc signal with an amplitude of usable sidebands (approx 1/4 screen scale), to front panel EXT MOD connector.

(6) Adjust Z101 core to center the oscillator (center) pip on the crt screen.

(7) Adjust Sweep Width Limit screwdriver adjust control to position the ±50 kc sideband pips directly under the ±50 vertical screen calibrations. Readjust CF Pad control slightly, if necessary, to make slight centering readjustments.

(8) Observe for linearity, by noting location of center pip relative to vertical CF screen calibration. Correct linearity is achieved when the ±50 kc pips are directly under the ±50 vertical screen calibrations and the center pip is within ±1/4 of a division of the CF screen calibration.

(9) If correct linearity is not observed, adjust CF Pad screwdriver adjust control slightly clockwise and recenter display with Z101. Recheck linearity as shown in steps (7) and (8).

(10) Repeat steps (7), (8) and (9) until linearity and sweep width are correct.

d. RF ALIGNMENT.

The r-f transformers employed in the FSA are equipped with sliders, making it possible to adjust the spacing between primary and secondary windings. The sliders are adjusted to obtain the proper frequency separation between the peak frequencies.

If the frequency separation is correct, trimming the cores of the two r-f transformers, to obtain desired flatness, is all that is necessary. However, if the frequency separation is not correct, the full alignment procedure must be performed.

NOTE

The sliders have been waxed down to prevent movement. If it becomes necessary to adjust the sliders, the wax must be removed. Upon completion of alignment, rewax sliders to prevent movement.

The following r-f alignment procedure requires "cut and try" methods. The frequency response of the section is determined by injection of constant amplitude signals of various frequencies over the FSA r-f band.

(1) Neutralization Capacitor C107 adjustment:

(a) Connect a temporary resistance of 51,000 ohms, 1/2 watt at the junction of R218 and R219 and B+.

Figure 6-2. Removal of Crystal Rejection Slot

(b) Set the front panel GAIN control almost fully counterclockwise (at the first scale division from full counterclockwise end).

(c) Connect a 500 kc signal to the front panel SIGNAL INPUT connector. Adjust input signal amplitude to produce an approximate 1/4 scale pip. Adjust front panel GAIN control slightly, if necessary, to produce the required pip amplitude.

(d) Adjust neutralizing capacitor C107 for minimum pip deflection.

(e) Remove temporary resistance connected in step (a).

(2) Interstage Transformer T102 alignment:

(a) Adjust T102 primary and secondary windings for approximately 1/4 inch spacing.

(b) Connect a 500 kc signal, through a 0.1 mfd coupling capacitor, to pin 6 of V2.

(c) Tune the secondary winding (bottom core) of T102 for a center screen peak deflection.

(d) Connect a 515 kc signal to pin 2 of V2.

(e) Tune the primary winding (top core) of T102 for a peak deflection.

(f) Reset signal generator frequency to 485 kc.

(g) Tune the secondary winding (bottom core) of T102 for a peak deflection.

(h) Vary signal generator frequency between high and low frequency peaks read on the crt screen. The peaks should appear at approximately 515 kc and 485 kc.

NOTE

If frequency separation is less than specified, decrease coil spacing. If frequency separation is greater than specified, increase coil spacing.

(i) Repeat steps (d) through (h) until proper frequency separation and peak deflections are obtained.

(3) Input Transformer T101 alignment:

(a) Adjust T101 primary and secondary windings for approximately 1/16 inch spacing.

(b) Connect a signal generator, set at 500 kc, to pin 5 of V1.

(c) Tune the secondary winding (bottom core) of T101 for a center screen peak deflection.

(d) Connect a 550 kc signal to the front panel SIGNAL INPUT connector through the input cable.

(e) Tune the primary winding (top core) of T101 for maximum pip deflection.

(f) Set signal generator frequency to 450 kc.

(g) Tune the secondary winding (bottom core) of T101 for maximum pip deflection.

(h) Vary signal generator frequency between 450 kc and 550 kc. Observe frequency peaks on crt screen. Peaks should appear at 450 kc and 550 kc.

NOTE

If frequency separation is less than specified, decrease coil spacing. If frequency separation is greater than specified, increase coil spacing.

(i) Repeat steps (d) through (h) until proper frequency separation and peak deflections are obtained.

(4) Adjust cores of interstage r-f transformer T102 for proper flatness as shown in table 6-4.

e. DISCRIMINATOR ALIGNMENT.

(1) Adjust CF Pad screwdriver adjust control as described in paragraph 6-4. h.

(2) Set SWEEP WIDTH SELECTOR control to 3.5 KC and center pip on screen.

(3) Set SWEEP WIDTH SELECTOR control to 500~; pip should appear near center of screen. If normal indication is observed, proceed with step (4).

(4) Set SWEEP WIDTH SELECTOR control to 150~; pip should appear near center of screen. If pip is off-screen or cannot be centered on one or more of these ranges, adjust Disc Zero control, located on top of Z102, with an insulated tool.

(5) Start on narrowest sweep range, at which a pip is visible, and center pip with Disc Zero control. To expedite this procedure, press FAST SWEEP pushbutton, however, final check must be made at a 0.1 cps sweep rate.

(6) Repeat the above step on the next narrower sweep width range. The final adjustment should be on the 150~ sweep width setting.

(7) The completion of this procedure should produce a condition where the pip will appear approximately centered on all sweep ranges.

NOTE

The Disc Zero adjust control is very critical, particularly on the narrowest sweep width. It may be necessary to obtain the final setting by tuning through the correct point several times.

TABLE 6-4. TRANSFORMER T102 FLATNESS ALIGNMENT

STEP	INITIAL SETTING OR ADJUSTMENT	PROCEDURE
1	Signal Generator set at 450 kc, then 550 kc, connected to SIGNAL INPUT connector.	If the 450 kc signal pip is larger than the 550 kc pip, adjust T102 bottom core clockwise and top core counterclockwise for equal pip amplitude. If the 550 kc signal pip is larger than the 450 kc pip, adjust T102 bottom core counterclockwise and top core clockwise for equal pip amplitude.
2	Signal Generator set at 450 kc, 500 kc and 550 kc, connected to SIGNAL INPUT connector.	If the 450 kc and the 550 kc pips are larger than the 500 kc pip, adjust T102 top and bottom core clockwise. If the two pips are lower, adjust counterclockwise.
3		Repeat steps 1 and 2 until flatness response is within ±5%.

SECTION 7
PARTS LIST

7-1. INTRODUCTION.

Reference designations have been assigned to identify all component parts of the equipment. They are used for marking the equipment (adjacent to the part they identify) and are included on drawings, diagrams and the parts list. The letters of a reference designation indicate the kind of part (generic group), such as resistor, capacitor, transistor, etc. The number differentiates between parts of the same generic group. Sockets associated with a particular plug-in device, such as a tube or fuse, are identifed by a reference designation which includes the reference designation of the plug-in device. For example, the socket for fuse F601 is designated XF601. The parts for each major unit are grouped together. Column 1 lists the reference designations of the various parts in alphabetical and numerical order. Column 2 gives the name and description of the various parts. Column 3 lists each Technical Materiel Corporation part number.

(TO BE SUPPLIED)

SECTION 8
SCHEMATIC DIAGRAMS

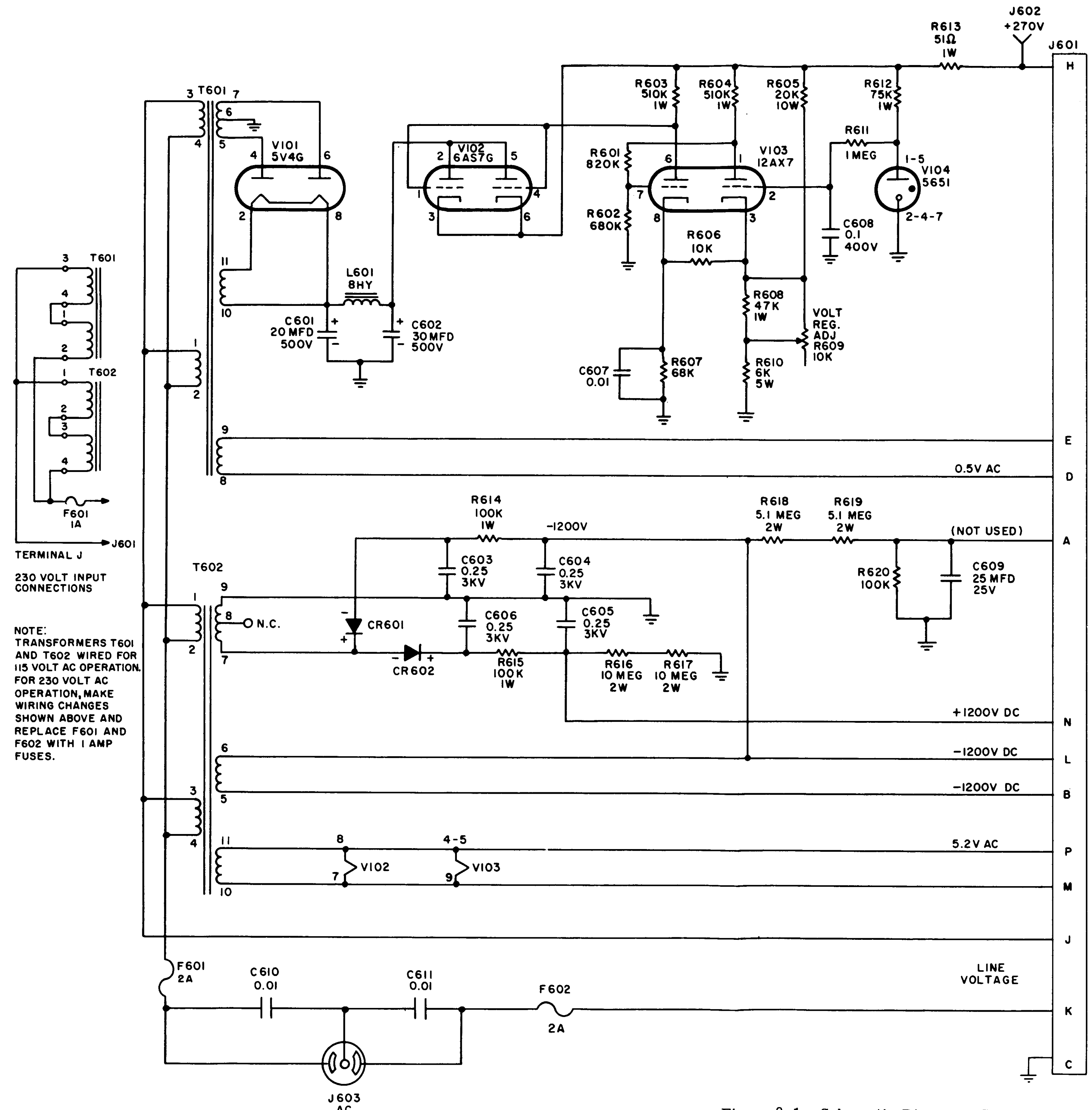


Figure 8-1. Schematic Diagram, Spectrum Analyzer, Model AX-503

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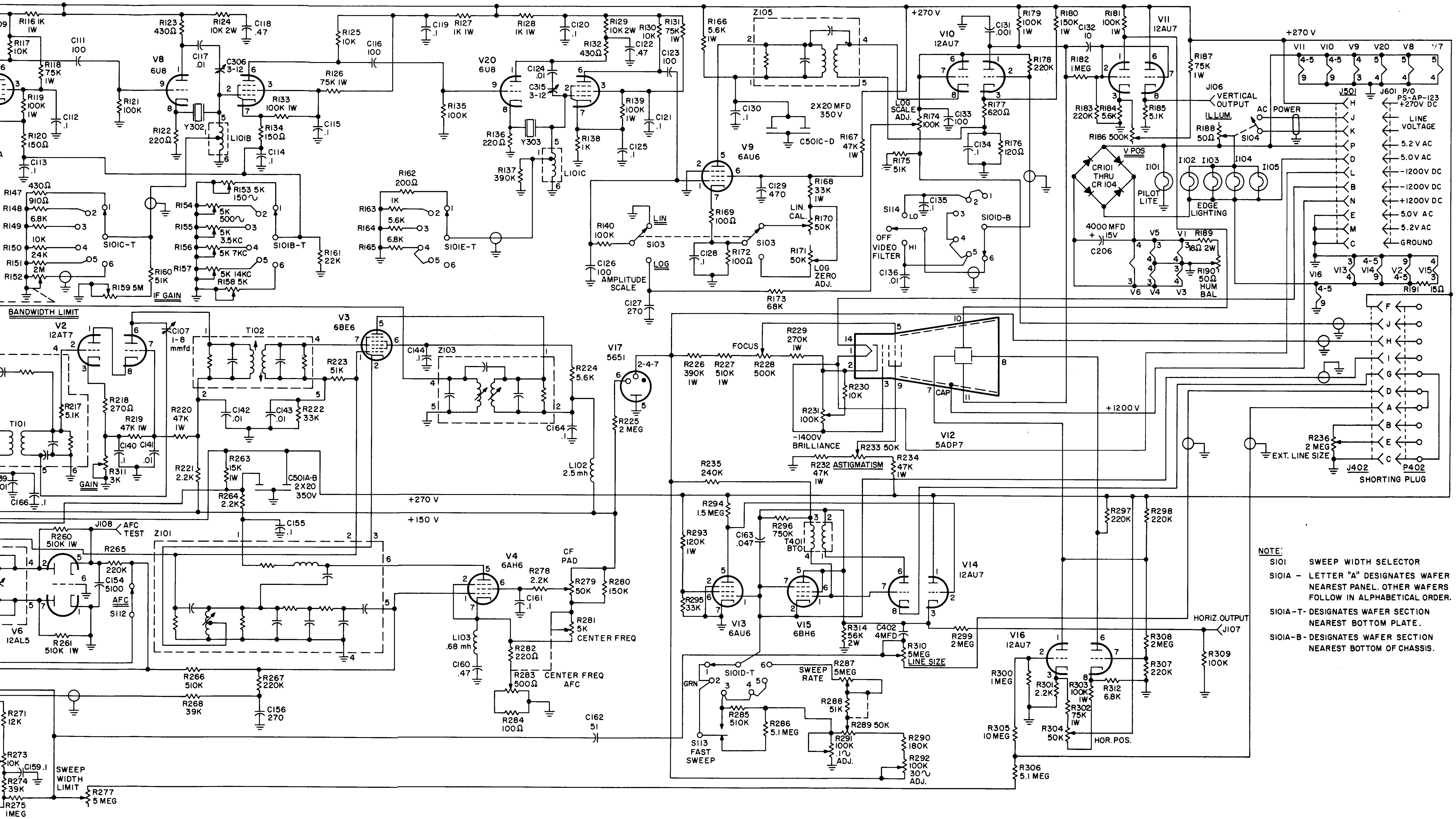

Figure 8-2. Schematic Diagram, Power Supply, Model AP-123

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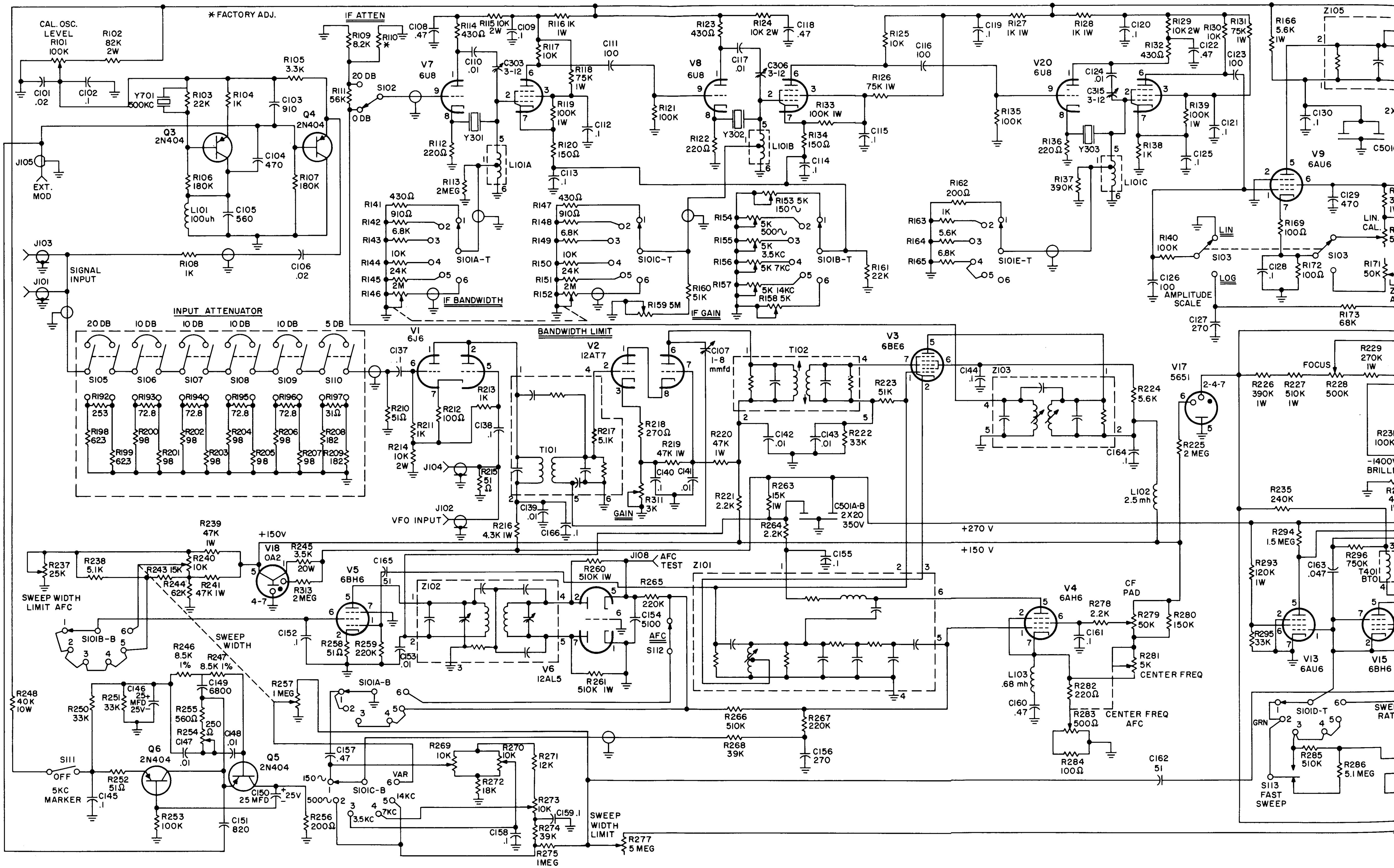

* FACTORY ADJ.
CAL. OSC. LEVEL R101 100K
EXT. MOD
J105
SIGNAL INPUT
J101
J103
Y701 500KC
Q3 2N404
Q4 2N404
L101 100uh
IF ATTEN
20 DB
0 DB
S102
INPUT ATTENUATOR
20 DB
10 DB
10 DB
10 DB
10 DB
5 DB
S105
S106
S107
S108
S109
S110
V7 6U8
V8 6U8
V20 6U8
V9 6AU6
Y301
Y302
Y303
L101A
L101B
L101C
IF BANDWIDTH
S101A-T
S101B-T
S101C-T
S101E-T
BANDWIDTH LIMIT
IF GAIN
R159 5M
LIN.
LOG
S103
AMPLITUDE SCALE
LIN. CAL.
V1 6J6
J104
J102
VFO INPUT
V2 12AT7
GAIN
T101
T102
V3 6BE6
Z103
Z101
Z102
Z105
L102 2.5 mh
+270 V
+150 V
V17 5651
FOCUS
V18 0A2
+150V
V5 6BH6
V6 12AL5
AFC TEST
J108
AFC
S112
V4 6AH6
L103 .68 mh
CF PAD
CENTER FREQ
CENTER FREQ AFC
V13 6AU6
V15 6BH6
T401 BTO
S101D-T
S113 FAST SWEEP
GRN
SWEEP WIDTH LIMIT
R277 5 MEG
S101A-B
S101B-B
S101C-B
VAR
14KC
7KC
3.5KC
150
500
SWEEP WIDTH
SWEEP WIDTH LIMIT AFC
Q5 2N404
Q6 2N404
C150 25 MFD 25V
S111 OFF
5KC MARKER
R248 40K 10W
C501A-B 2X20 350V