INSTRUCTION MANUAL

FOR

BROADBAND LINEAR POWER AMPLIFIERS

MODELS 1020, 1052, 2020B, 2052B, 3552B, 5001, 5020B, 15100B

Manual No. 1-500783-380

Eaton Corporation
Electronic Instrumentation Division
5340 Alla Road
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SECTION I

INTRODUCTION AND DESCRIPTION

1-1. INTRODUCTION

This manual contains operation and maintenance instructions for the Broadband Linear Power Amplifiers, Models 1020, 1052, 2020B, 2052B, 3552B, 5001, 5020B, and 15100B. The manual is divided into four sections and an appendix.

Section I provides, in addition to the introduction, a general description of the amplifiers with a tabular listing of pertinent data for each amplifier.

Section II provides performance verification testing of the amplifiers.

Section III provides a general operation of the amplifiers and a tabular listing of equipment operating controls and indicators keyed to illustrations of the equipment.

Section IV contains procedures necessary to maintain the equipment in a serviceable condition. Included are procedures for preventive maintenance, and the replacement instructions for repairable modules.

Appendix A contains block diagrams and wiring diagrams for each amplifier.

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tions are not strictly observed. The human eye is particularly susceptible to developing cataracts when subjected to repeated exposure to high-power levels of RF radiation. Do not operate exposed circuitry or radiating elements at high power levels when personnel must work in close proximity to the radiating source (particularly when close to the human head); always replace circuit shields during any high-power operations.

WARNING

Maintenance personnel must observe all safety precautions at all times. Do not replace components inside the equipment with the input power turned on. Under no circumstances should any person reach into an enclosure for the purpose of servicing or adjusting the equipment except in the presence of someone who is capable of rendering aid. Remove power from the system for all procedures that do not require power. For those procedures that do require power, be extremely cautious in handling test leads, tools, and equipment in the proximity of live RF circuitry. Always follow Eaton's recommended procedures during any powered operation.

Hazardous line voltages exist within the subject equipment; avoid physical contact with these voltages to avoid injury.

element. Do not disconnect the system RF output coaxial cable unless the primary power has been removed. Similarly, hazardous RF voltages exist at the output stage of any active amplifier assembly, which should not be accessed unless the primary power is removed.

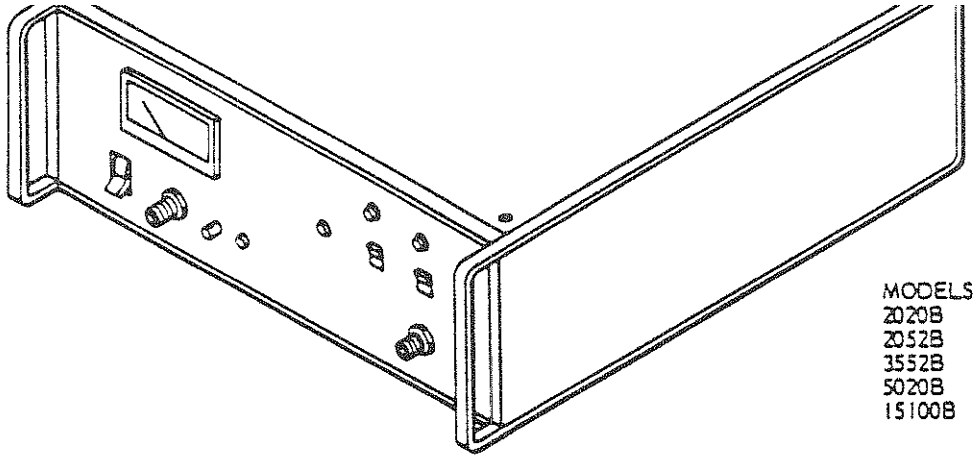
Personnel are warned that although no radiation hazard exists with the primary power line, physical contact with such voltages can be lethal. Primary line voltage (approximately 300 volt peak) exists in the amplifier.

Make sure that electrical power to the system is disconnected before proceeding with any maintenance action. Failure to comply may cause injury or death to personnel.

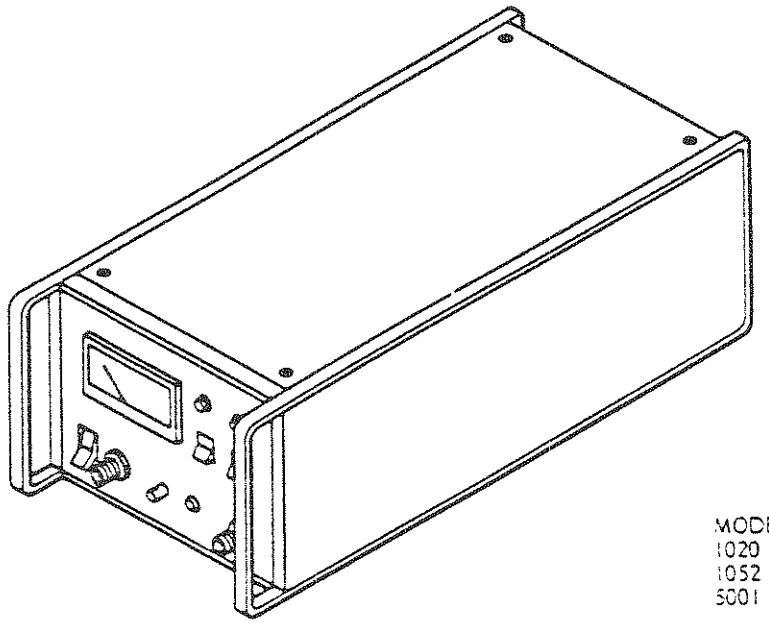
1-2. GENERAL DESCRIPTION

Eaton solid-state broadband linear amplifiers (Figure 1-1) are designed to be driven by signal sources such as milliwatt sweepers and frequency synthesizers and provide high power RF levels from 1 MHz to 1000 MHz (see Table 1-1 for specification of each amplifier).

Eaton linear amplifiers feature a true directional wattmeter to measure forward and reflected power delivered to the load. Additionally, an output sample dc voltage from the directional coupler, proportional to the forward power, is made available to the front panel for external leveling. Leveling the amplifier output increases the flatness typically by a factor of two, and improves the effective output impedance. In order to accomplish the above operation it is necessary to use a source with external leveling capability and a negative input voltage requirement.



MODELS
2020B
2052B
3552B
5020B
15100B



MODELS
1020
1052
5001

Figure 1-1. Typical Broadband Linear Amplifier

(50 ohms load)	
Compression	1 dB max at 40 W
Gain/Sens (max mW in for W out)	37 dB min (10 mW for 50 W)
Gain Variation	± 1.5 dB
Total Harmonics Distortion	25 dBc at 1 dB comp.
Input VSWR	2:1
Spurious Response	-60 dBc min
Noise Figure	10 dB
Active VSWR Protection (All phase angles)	No
Over Temperature (Shutdown)	Auto Restart
Operating Ambient	0 - 50°C
Size	7 x 8.5 x 17.25 in (17.78 x 21.59 x 43.81 cm)
Weight	22 lbs (10 kg)
Required AC Power	115/230 VAC 10% 1 Ø 50-60 Hz 10%, 500 W

High Range	± 1 dB at 80 W
Low Range	± 1 dB at 20 W

(50 ohms load)			
Compression	1 dB max at 10 W	1 dB max at 20 W	1 dB max at 40 W
Gain/Sens (max mW in for W out)	40 dB min (1 mW for 10 W)	43 dB min (1 mW for 25 W)	47 dB min (1 mW for 50 W)
Gain Variation	± 1.5 dB	± 1.5 dB	± 1.5 dB
Total Harmonics Distortion	-25 dB at 1 dB comp.	-25 dB at 1 dB comp.	-25 dB at 1 dB comp.
Input VSWR	1.5:1	1.5:1	1.5:1
Spurious Response	-60 dBc max	-60 dBc max	-60 dBc max
Noise Figure	11 dB	11 dB	11 dB
Active VSWR Protection (All phase angles)	No	Yes	Yes
Over Temperature (Shutdown)	No	Auto Restart	Auto Restart
Operating Ambient	0 - 50°C	0 - 50°C	0 - 50°C

Size	1020:	7 x 8.5 x 17.25 in (17.78 x 21.59 x 43.81 cm)
	2020B/5020B:	7 x 17 x 17.25 in (17.78 x 43.18 x 43.81 cm)
Weight	1020:	22 lbs (10 kg)
	2020B/5020B:	43 lbs (19.5 kg)
Required AC Power	115/230 VAC 10% 1 Ø 50-60 Hz 10%,	1020: 125 W 2020B: 350 W 5020B: 500 W

[illegible]	± [illegible] at 20 W	± [illegible] at 40 W	± [illegible] at 80 W
Low Range	± 1 dB at 5 W	± 1 dB at 10 W	± 1 dB at 20 W

(50 ohms load)			
Compression	1 dB max at 10 W	1 dB max at 15 W	1 dB max at 30 W
Gain/Sens (max mW in for W out)	40 dB min (1 mW for 10 W)	43 dB min (1 mW for 25 W)	47 dB min (1 mW for 50 W)
Gain Variation	± 2 dB	± 2 dB	± 2 dB
Total Harmonics Distortion	-25 dB at 1 dB comp.	-25 dB at 1 dB comp.	-25 dB at 1 dB comp.
Input VSWR	2:1	2:1	2:1
Spurious Response	-60 dBc min	-60 dBc min	-60 dBc min
Noise Figure	14 dB	14 dB	14 dB
Active VSWR Protection (All phase angles)	No	Yes	Yes
Over Temperature (Shutdown)	No	Auto Restart	Auto Restart
Operating Ambient	0 - 50°C	0 - 50°C	0 - 50°C

Size	1052:	7 x 8.5 x 17.25 in (17.78 x 21.59 x 43.81 cm)
	2052B/3552B:	7 x 17 x 17.25 in (17.78 x 43.18 x 43.81 cm)
Weight	1052:	22 lbs (10 kg)
	2052B/3552B:	43 lbs (19.5 kg)
Required AC Power	115/230 VAC 10% 1 ø 50-60 Hz 10%,	1052: 200 W 2052B: 400 W 3552B: 500 W

High Range	± 1 dB at 20 W	± 1 dB at 40 W	± 1 dB at 80 W
Low Range	± 1 dB at 5 W	± 1 dB at 10 W	± 1 dB at 20 W

(50 ohms load)	
Compression	1 dB max at 15 W
Gain/Sens (max mW in for W out)	43 dB min (1 mW for 20 W)
Gain Variation	± 2 dB
Total Harmonics Distortion	-25 dB at 1 dB comp.
Input VSWR	3:1
Spurious Response	-60 dBc min
Noise Figure	14 dB
Active VSWR Protection (All phase angles)	Yes
Over Temperature (Shutdown)	Auto Restart
Operating Ambient	0 - 50°C

Size	7 x 17 x 17.25 in (17.78 x 43.18 x 43.81 cm)
Weight	43 lbs (19.5 kg)
Required AC Power	115/230 VAC 10% 1 Ø 50-60 Hz 10%, 400 W

	± 1 dB at 40 W
Low Range	± 1 dB at 10 W

This section of the manual presents Performance Verification Tests that may be used to verify that an amplifier is functioning in accordance with the specifications listed in Table 1-1. This test may be used after a repair or when the performance of an amplifier is suspect.

2.2 PERFORMANCE VERIFICATION TESTS

The following tests should be conducted to verify the performance of an amplifier using the test setups shown in the referenced figures.

a. Performance Check. Performance of Eaton linear amplifiers may be verified by using a power meter rated over the frequency range, a high-power attenuator, and a 100-dB step attenuator with 0.1 dB steps.

(1) Connect the amplifier, attenuators, and power meter as shown in Figure 1.

(2) Set the attenuator initially to 10 dB.

(3) Increase power at the frequency source to the rated power of the amplifier.

(4) Manually tune the frequency source over the amplifier's frequency range.

(5) The step attenuator should not have to be varied more than the flatness specification to maintain a constant output power.

b. Compression Check. To test for the 1-dB compression point, perform the following:

(1) Connect the amplifier as shown in Figure 2-1.

(2) With the attenuator set in the 20-dB position, adjust the source to drive the amplifier to an output level at 10 dB below the 1-dB compression point.

(3) Reduce the attenuation until the power increases to the 1-dB compression point.

(4) The attenuation should not have to be decreased by more than 11 dB in this test.

c. Harmonic Level Check. To check the harmonic level, use a frequency source with harmonics and spurious signals 10 dB below the rated specification for the amplifier.

(1) Connection amplifier as shown in Figure 2-2.

(2) Check power level where measurement is made (see Table 1-1 for specification).

amplifier.

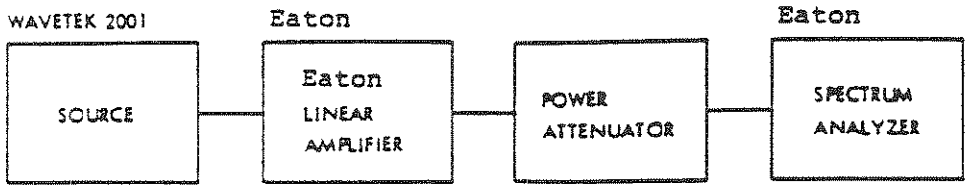
(3) The output power should not vary more than the rated specification, under level conditions (see Table 1-1).

NOTE

If a sweeper with leveling is not available, it is still possible to check if the coupler voltage is present at the ALC connector. Operate the amplifier as shown in Figure 2-1. With the output set to full power, measure the ALC voltage with the adjustment potentiometer fully clockwise. The voltage should be greater than -0.2 volts.

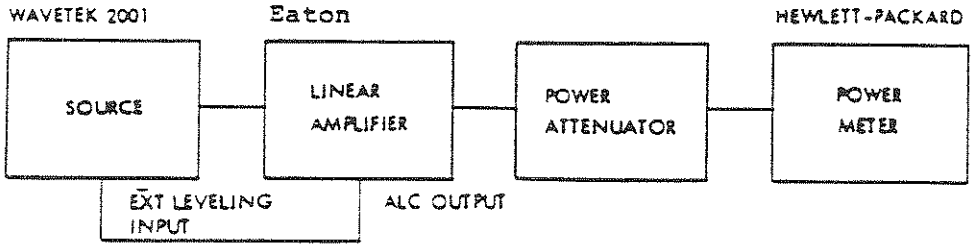
AW3393-2

Figure 2-1. Setup for Performance Check of Amplifier



AW3393-3

Figure 2-2. Setup for Harmonic Level Check



AW3393-4

Figure 2-3. Setup for Internal Directional Flatness

Because of potential hazards to personnel and to equipment, operators are advised to be aware of such dangers and of the steps necessary to prevent their occurrance. WARNINGS describe conditions that, if not avoided, are lethal or injurious to personnel.

WARNING

The high power amplifiers can operate at frequencies up to 1000 megahertz and at power levels up to 50 watts, which together can cause lethal or severe radiation injury if recommended safety precautions are not strictly observed. (The human eye is particularly susceptible to developing cataracts when subjected to high-level RF radiation.) Accordingly, personnel are warned not to stand near any active antenna or other radiating element. Do not disconnect the system RF output coaxial cable unless the primary power has been removed. Similarly, hazardous RF voltages exist at the output stage of any active amplifier assembly, which should not be accessed unless the primary power is removed.

Personnel are warned that although no radiation hazard exists with the primary power line, physical contact with such voltages can be lethal. Primary line voltage (approximately 300 volt peak) exists in the amplifier.

CAUTION

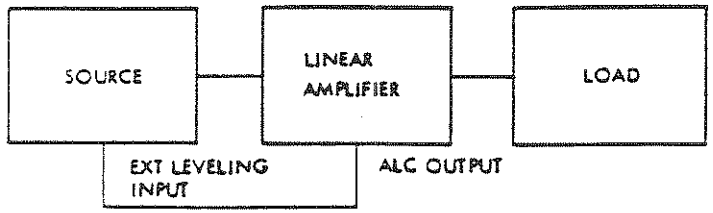
For Models 1020, 1052, 5001

Eaton linear amplifiers are designed to withstand an overdrive of 10 dB above the input power level required for rated output power with an output load VSWR of 1.5:1 or less. For load VSWRs greater than 1.5:1, limit the drive to an input power level required for full rated output into a 1:1 load VSWR. If the above conditions are met, Eaton linear amplifiers will be stable and protected under any load VSWR. When operating any amplifier, especially into a high VSWR load, if increasing the input power does not increase the output power appreciately, DO NOT OPERATE ABOVE THAT OUTPUT LEVEL UNDER ANY CONDITION.

The forward and reflected power is summed and compared with a set reference to establish a safe output operating area. If the output load is a low VSWR (little reflected power), the amplifier will be allowed to deliver its maximum power. However, if the load has a moderate to high VSWR, the amplifier is allowed to deliver less than its maximum power. As the VSWR increases, the available output power decreases until the point where the amplifier will safely drive into an infinite VSWR. To lessen the possibility of damage by sudden high VSWR (for example, a cable failure), a high speed (approximately 10 microseconds) comparator is used to sense this condition and set the pin diode module at its maximum attenuation level for approximately 1 millisecond, which allows the lower speed protective loop time to react to the overload condition.

AW3393-5

Figure 3-1. Typical Operational Hook-up.



AW3393-6

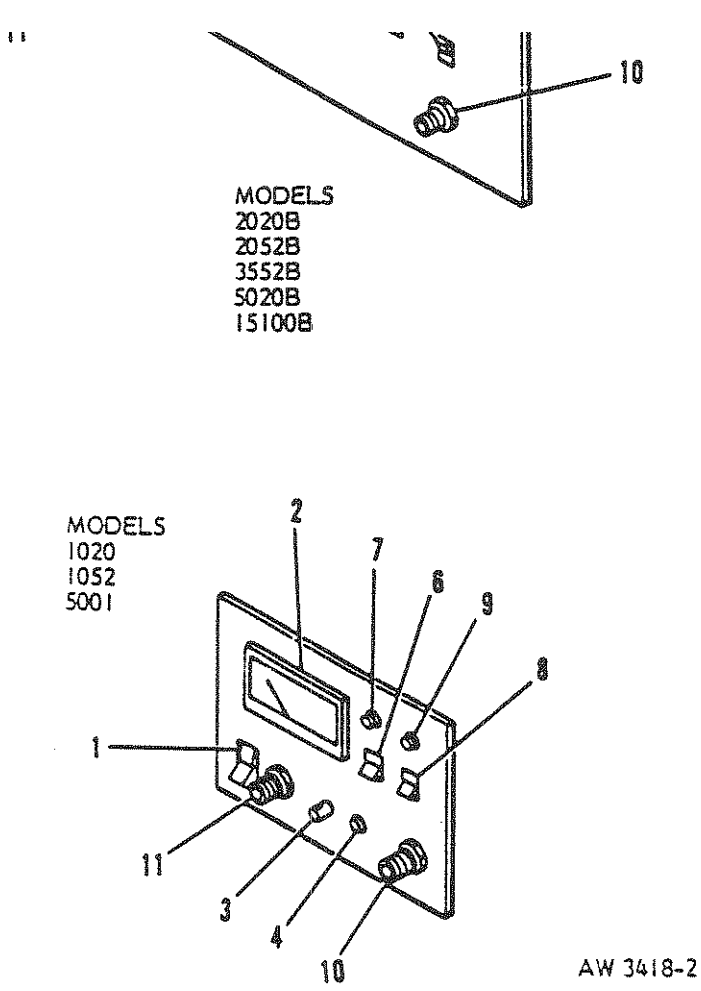
Figure 3-2. Typical Leveling Operational Hook-up.

NOTE

Excessive VSWR, caused by a poor load, causes the amplifiers output to be reduced by the protective circuitry and causes the amplifier OVERLOAD indicator to light (a signal to the operator). The OVERLOAD indicator also lights if the amplifier is being driven beyond its safe output power level.

3-3. CONTROLS AND INDICATORS (Figure 3-3)

Primary controls and indicators required to operate and monitor an amplifier are located on the front panel. Figure 3-3 illustrates front-panel controls and indicators and Table 3-1, cross-referenced to Figure 3-3, provides a functional description of these controls.



NOTE: Call-out numbers are cross-reference index numbers for descriptions found in Table 3-1.

Figure 3-3. Operator Controls, Indicators, and Connectors on Amplifier Panel

to control power to amplifier.

2	No panel placarding (wattmeter)	RF power meter scaled in watts: High and low scales are selected by panel switch (item 6) and measure either forward or reflected power as selected by panel switch (item 8). Full scale ranges depend upon the amplifier as follows:

Model	Low Full Scale	High Full Scale
5001	20 W	80 W
1020	5 W	20 W
2020B	10 W	40 W
5020B	20 W	80 W
1052	5 W	20 W
2052B	10 W	40 W
3552B	20 W	80 W
15100B	10 W	40 W

3	ALC OUT	Type BNC connector: Used for supplying the forward voltage produced by the directional coupler, for external leveling purposes. Measured dc voltage is an analog of the output power level.
4	ALC OUT ADJ	Trim potentiometer, screwdriver adjustment: Used to adjust dc-voltage scaling of ALC measured at panel connector (item 3).
*5	OVER LOAD	LED indicator (red): When lighted, indicates that amplifier is being driven to its safe limits of operation.

* Not on Models 1020, 1052, and 5001.

6	HIGH/LOW	Two-position toggle switch: Used to set full-scale range of wattmeter (refer to item 2) to either high or low wattage scale (HIGH = 4 X LOW).
7	HIGH (METER CAL)	Trim potentiometer, screwdriver adjustment: Used to adjust calibration of the high scale of the wattmeter (item 2).
8	FWD/RFL	Two-position toggle switch: Used to select wattmeter (item 2) input to read either forward (FWD) RF power or reflected (RFL) RF power as measured at the amplifier output.
9	LOW (METER CAL)	Trim potentiometer, screwdriver adjustment: Used to adjust calibration of the low scale of the wattmeter (item 2).
10	RF OUTPUT	Type N RF connector: Coaxial RF signal that is the output of the amplifier.
11	RF INPUT	Type N RF connector: Coaxial signal-input for driving amplifier.

This section contains procedures and practices necessary to maintain the equipment. These procedures include preventive maintenance such as cleaning and lubrication, inspection criteria, and information necessary to remove, disassemble, inspect, reassemble, and install modules of the amplifier.

4-2. PREVENTIVE MAINTENANCE

Cleaning is recommended at periodic intervals to help maintain the equipment in serviceable condition.

a. Cleaning. Clean the equipment in accordance with the following procedures:

(1) Clean exterior surfaces of the equipment excluding meter faces using a soft, clean cloth, moistened with isopropyl alcohol.

(2) Clean interior surfaces of the equipment with a soft, clean cloth, moistened with isopropyl alcohol. Loosen stubborn accumulations of dirt or other foreign matter with a non-metallic, stiff bristle brush.

(3) Clean filter screen on front panel of amplifier by removing from the panel and washing in a mixture of hot water and detergent. Allow filter screen to air dry before reinstalling on amplifier.

The repair of module components is beyond the scope of this manual. It is strongly recommended that the local factory representative be contacted for repair information.

4-4. MODULE REPLACEMENT

The following paragraphs provide procedures necessary to disassemble the amplifier to the module level, to inspect the equipment, and to reassemble the equipment.

NOTE

Establish the condition of a module or most probable cause of its malfunction to determine the extent of disassembly required without the complete tear down and rebuild of an amplifier.

WARNING

Make sure that electrical power to the system is disconnected before proceeding with any maintenance action. Failure to comply may cause injury or death to personnel.

NOTE

Perform maintenance functions in a clean, dust-free area.

b. Removal of Output Module. Perform the following procedures to remove output module from amplifier (refer to Figures 4-1 or 4-2).

NOTE

Figure 4-1 shows the disassembly of amplifiers 1020, 1052, 5001 and Figure 4-2 is for amplifiers 2020B, 2052B, 3552B, 5020B, and 15100B.

(1) Remove all screws attaching the top and bottom covers to chassis.

(2) Remove top and bottom covers. (For Models 1020, 1052, 5001, remove vinyl side panel.)

(3) Disconnect and tag the coaxial cables from the output module.

(4) Disconnect and tag the wires leading from the output module and terminating either at the metering board assembly or the terminal strip located on the power supply.

(5) Remove the attaching screws for the output module.

(6) Remove the output module.

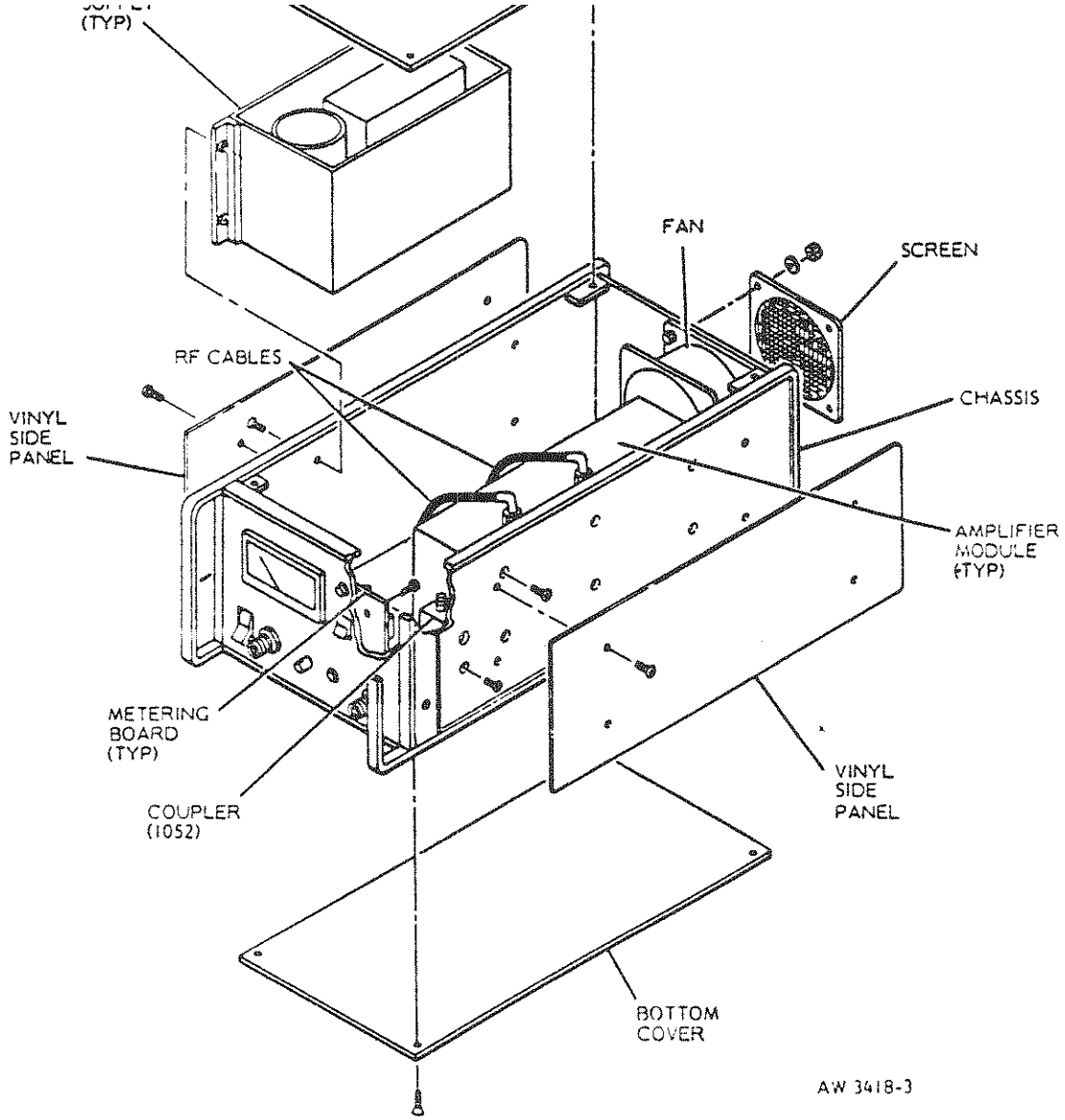


Figure 4-1. Disassembly of Amplifiers 1020, 1052, 5001.

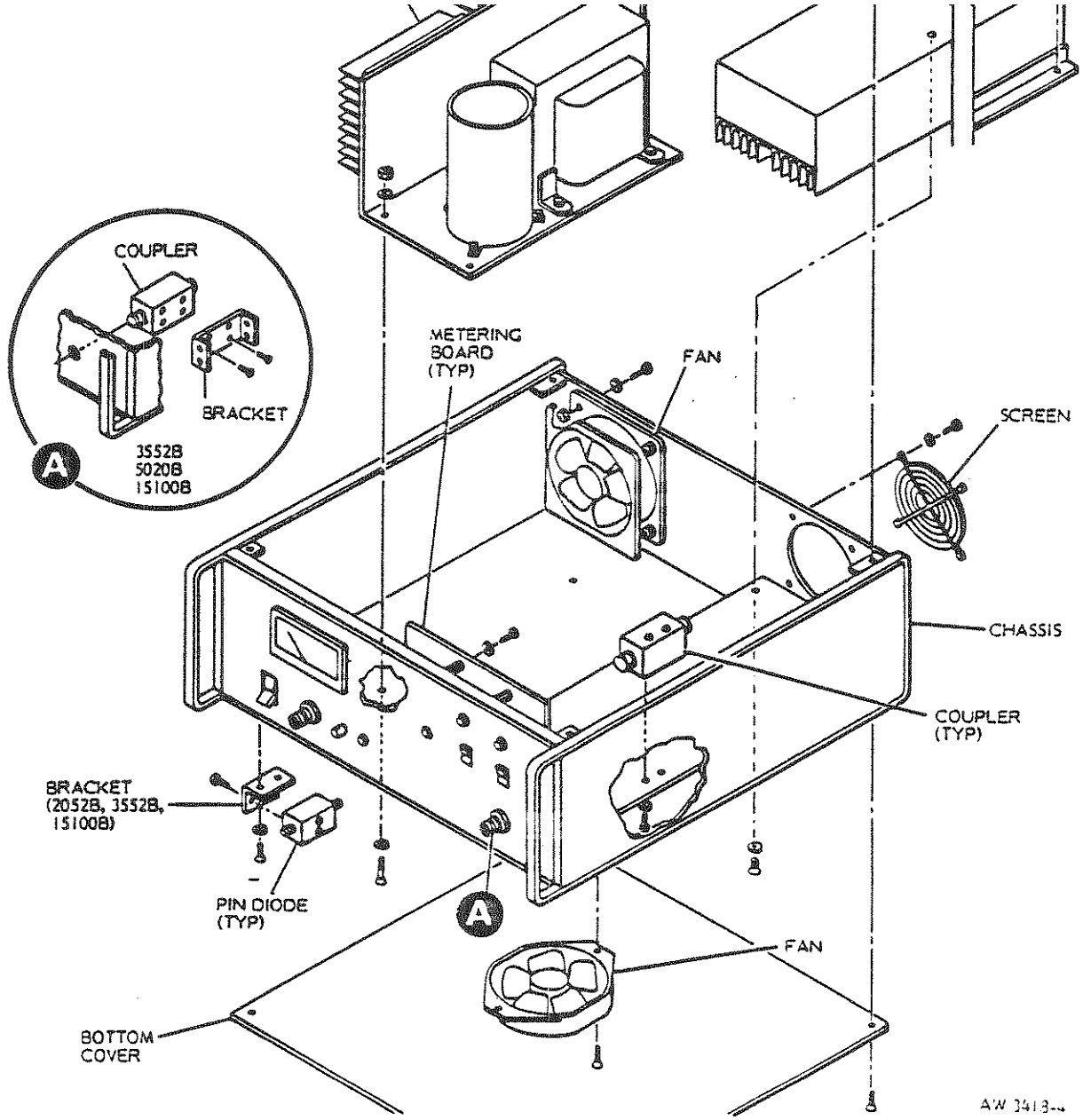


Figure 4-2. Disassembly of Amplifiers 2020B, 2052B, 3552B, 5020B, 15100B

(3) Disconnect and tag the connectors and the wires on the terminal strip.

(4) Remove the attaching hardware for the power supply.

(5) Remove the power supply from the chassis.

d. Removal of Coupler. Perform the following procedures to remove coupler from amplifier (refer to Figure 4-2 and for Model 1052, to Figure 4-1):

(1) Remove all screws attaching the top and bottom covers to chassis.

(2) Remove the top and bottom covers. (For Model 1052, remove side panel.)

(3) Disconnect and tag the coaxial cables and wiring attached to the coupler.

(4) Remove the attaching hardware for the coupler and remove coupler.

e. Removal of Protection/Metering Board and Face Panel Components. Perform the following procedures to remove metering board and face panel components from amplifier (refer to Figures 4-1 or 4-2):

(1) Remove all screws attaching the top and bottom covers to chassis.

(2) Remove the top and bottom covers.

(3) Carefully unsolder circuit board connections from two switches and from ALC OUT plug.

pin diode board from amplifier (refer to Figure 4-2):

(1) Remove all screws attaching the top and bottom covers to chassis.

(2) Remove the top and bottom covers.

(3) Tag and disconnect all cabling from the pin diode assembly.

(4) Remove attaching screws and remove pin diode assembly.

g. Inspection of Components. Inspect system components in accordance with the following procedures:

(1) Inspect circuit boards for evidence of arcing or shorting. Check for damaged or peeling circuit traces.

(2) Inspect all wiring for evidence of shorts, breaks, or burned insulation.

(3) Inspect output module and power supply for evidence of overheating or other physical damage.

reconnecting wiring.

(b) Ensure that all components are clean and in serviceable condition before reassembly (refer to Preventive Maintenance Section for cleaning procedures).