



HEWLETT  
PACKARD

# OPERATING AND SERVICE MANUAL MODEL 3551A TRANSMISSION TEST SET

This manual applies to instruments with serial numbers prefixed 2632A and lower.

## IMPORTANT NOTICE

This loose leaf manual does not normally require a change sheet. All major change information has been integrated into the manual by page revision. In cases where only minor changes are required, a change sheet may be supplied.

If the Serial Number of your instrument is lower than the one on this title page, the manual contains revisions that do not apply to your instrument. Backdating information given in the manual adapts it to earlier instruments.

Where practical, backdating information is integrated into the text, parts list and schematic diagrams. Backdating changes are denoted by a delta sign. An open delta ( $\Delta$ ) or lettered delta ( $\Delta_A$ ) on a given page, refers to the corresponding backdating note on that page. Backdating changes not integrated into the manual are denoted by a numbered delta ( $\Delta_1$ ) which refers to the corresponding change in the Backdating section (Section VIII).

Manual Part No. 03551-90004 (Includes Binder)  
Binder Part No. 9282-0534  
Printed Pages part No. 5957-4421  
Microfiche Part No. 5957-4422

© Copyright Hewlett-Packard Company/Colorado Telecommunications Division 1974  
5070 Centennial Blvd., P.O. Box 7050, Colorado Springs, CO 80933

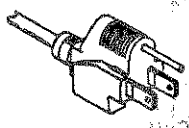
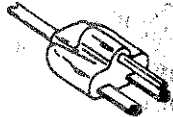
Printed: March 1986  
Revised: June 1986



## NOTICE

The following Hewlett-Packard power cords are included in the Canadian Standards Association (CSA) certification approval of HP telecommunications test equipment.

Only power cords approved by the CSA may be used in Canada.

Option	Plug Type	Plug Description	Length (In/cm)	Color	Part Number	Check Digit
9 0 3		Straight NEMA 5-15P	80/203	Jade Gray	8120-1378	1
		90°	80/203	Jade Gray	8120-1521	6
9 0 4		Straight NEMA 6-15P	90/228	Black	8120-0698	6

Manual Part Number: 5959-2332  
 Microfiche Part Number: 5959-2333

Printed in U.S.A. AUGUST 1987



## **NOTICE**

The 310 test cables are not standard equipment.  
They are optional accessories that can be ordered.  
Below are the part numbers for your convenience.

HP 18182A: Test Cable 310 connector to alligator clips.

HP 15513A: Test Cord 310 connector on each end.



## SAFETY SYMBOLS

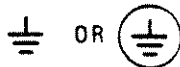
### General Definitions of Safety Symbols Used On Equipment or In Manuals.



Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.



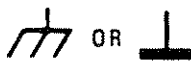
Indicates dangerous voltage (terminals fed from the interior by voltage exceeding 1000 volts must be so marked).



Protective conductor terminal. For protection against electrical shock in case of a fault. Used with field wiring terminals to indicate the terminal which must be connected to ground before operating equipment.



Low-noise or noiseless, clean ground (earth) terminal. Used for a signal common, as well as providing protection against electrical shock in case of a fault. A terminal marked with this symbol must be connected to ground in the manner described in the installation (operating) manual, and before operating the equipment.



Frame or chassis terminal. A connection to the frame (chassis) of the equipment which normally includes all exposed metal structures.



Alternating current (power line).



Direct current (power line).



Alternating or direct current (power line).

**WARNING**

The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in injury or death to personnel.

**CAUTION**

The **CAUTION** sign denotes a hazard. It calls attention to an operating procedure, practice, condition or the like, which, if not correctly performed or adhered to, could result in damage to or destruction of part or all of the product.

**NOTE :**

The **NOTE** sign denotes important information. It calls attention to procedure, practice, condition or the like, which is essential to highlight.





# SECTION I

## GENERAL INFORMATION

### 1-1. INTRODUCTION.

1-2. The -hp- Model 3551A Transmission Test Set is designed for use in testing telecommunications equipment. It provides calibrated test signals while simultaneously making frequency or level measurements on voice frequency systems, program systems and data circuits. Some of the features provided are dial and hold capabilities, input impedances of 135 Ω, 600 Ω, and 900 Ω, choice of four noise weighting filters and digital readout of level or frequency.

1-3. This manual contains operating and service information necessary for operating and maintaining the 3551A. Included are specifications, installation information, operating instructions, circuit theory, performance tests, adjustment procedures, a complete replaceable parts list, troubleshooting information and schematics. Throughout this manual, the 3551A Transmission Test Set will be referred to as Test Set.

1-4. Section I of this manual contains general information about the Test Set. Information on specifications and instrument and manual identification is given.

### 1-5. SPECIFICATIONS.

1-6. Table 1-1 is a complete list of the critical specifica-

tions that are controlled by tolerances. Table 1-2 contains general information that describes the operating characteristics of the Test Set.

1-7. Any changes in specifications due to manufacturing, design or traceability to the U.S. National Bureau of Standards are included in Table 1-1 in this manual. Specifications listed in this manual supersede all previous specifications for the Test Set.

### 1-8. INSTRUMENT AND MANUAL IDENTIFICATION.

1-9. Instrument identification by serial number is located on the right side. Hewlett-Packard uses a two-section serial number consisting of a four-digit prefix and a five-digit suffix, separated by a letter designating the country in which the instrument was manufactured. (A=U.S.A.; G = West Germany; J = Japan; U = United Kingdom).

1-10. This manual applies to instruments having the serial numbers indicated on the title page. It has been updated by page revision to include the latest changes in the instrument at the time of shipment from the factory. Information in Section VIII adapts this manual to instruments with lower serial numbers. Part numbers for this manual and the microfiche copy of the manual are also shown on the title page.

Table 1-1. Specifications.

RECEIVER:	TRANSMITTER:
<p>Level Measurement Accuracy:</p> <p style="text-align: center;">FREQUENCY</p> <p style="text-align: center;">20 kHz</p> <p style="text-align: center;">500 Hz</p> <p>135 Ω Impedance not specified below 500 Hz or - 65 dBm TC ± 0.005 dB/°C at T &lt; 15° C and T &gt; 35° C</p> <p>Noise Measurement Accuracy:</p> <p>Message circuit noise: ± 1 dB (+ 20 dBm to + 85 dBm). ± 2 dB (0 dBm to + 20 dBm).</p> <p>Noise-with tone: ± 1 dB (+ 20 dBm to + 85 dBm). ± 2 dB (+ 10 dBm to + 20 dBm).</p> <p>Noise-to-ground: ± 1 dB (+ 60 dBm to + 125 dBm). ± 2 dB (+ 40 dBm to + 60 dBm).</p> <p>Frequency Measurement Accuracy: ± 1 count</p>	<p>Frequency Accuracy: ± 1 count</p> <p>Level Accuracy:</p> <p style="text-align: center;">FREQUENCY</p> <p style="text-align: center;">500 Hz</p> <p>135 Ω Impedance not specified below 500 Hz TC ± 0.005 dB/°C at T &lt; 15° C and T &gt; 35° C</p> <p>Harmonic Distortion: &gt; - 50 dB (THD 100 Hz to 4 kHz). &gt; - 40 dB (THD 40 Hz to 100 Hz and 4 kHz to 20 kHz). &gt; - 60 dB (THD HOLD TONE)</p>
<p><b>BRIDGING LOSS:</b> &lt; 0.2 dB</p>	

Table 1-1. Specifications (Cont'd).

<p><b>RETURN LOSS:</b>                  &gt;-30 dB (135 Ω, 500 Hz to 4 kHz)                  &gt;-30 dB (600 Ω and 900 Ω), 40 Hz to 4 kHz)                  &gt;-20 dB (135 Ω, 600 Ω, 900 Ω), 4 kHz to 20 kHz).</p>		C Message	
<p><b>LONGITUDINAL BALANCE:</b>                  &gt; 60 dB at 6 kHz for Receive mode                  &gt; 50 dB at 6 kHz for Send mode</p>		FREQUENCY Hz	dB BELOW REF
<p>Weighting Filters Response:</p>			
Program			
FREQUENCY Hz	dB REF to 1000 Hz		
100	- 26.3 ± 2 dB	60	55.7 ± 2 dB
200	- 17.3 ± 2 dB	100	42.5 ± 2 dB
300	- 12.2 ± 2 dB	200	25.0 ± 2 dB
400	- 9.0 ± 2 dB	300	16.5 ± 1 dB
500	- 6.6 ± 1 dB	400	11.4 ± 1 dB
600	- 4.7 ± 1 dB	500	7.5 ± 1 dB
800	- 2.0 ± 1 dB	600	4.7 ± 1 dB
900	- 0.8 ± 1 dB	700	2.7 ± 1 dB
1000	0	800	1.5 ± 1 dB
1500	+ 3.2 ± 1 dB	900	0.6 ± 1 dB
2000	+ 4.8 ± 1 dB	1000	0
2500	+ 5.6 ± 2 dB	1200	0.2 ± 1 dB
3000	+ 6.0 ± 2 dB	1300	0.5 ± 1 dB
4000	+ 6.5 ± 2 dB	1500	1.0 ± 1 dB
5000	+ 6.5 ± 2 dB	1800	1.3 ± 1 dB
6000	+ 6.4 ± 3 dB	2000	1.3 ± 1 dB
7000	+ 5.8 ± 3 dB	2500	1.4 ± 1 dB
8000	+ 4.0 ± 3 dB	2800	1.9 ± 1 dB
9000	- 1.5 ± 4 dB	3000	2.5 ± 1 dB
10,000	- 8.5 ± 4 dB	3300	5.2 ± 2 dB
		3500	7.6 ± 2 dB
		4000	14.5 ± 3 dB
		4500	21.5 ± 3 dB
		5000	28.5 ± 3 dB
		*	
15 kHz Flat		3 kHz Flat	
FREQUENCY Hz	dB BELOW REF	FREQUENCY Hz	dB BELOW REF
60	0 ± 1.75	60	0 ± 1.75
250	0 ± 1.0	250	0 ± 1.0
1000	0	1000	0
10,000	0.8 ± 1.5	2000	0.5 ± 1.75
15,000	3.0 ± 3.0	2500	1.5 ± 2.0
20,000	6.2 ± 3.0	3000	3.0 ± 3.0
30,000	12.3 ± 3.0	6000	12.3 ± 3.0
*		*	

\* Increases at ≥ a two-pole Butterworth roll off to 60 dB below reference.

Table 1-2. General Information.

<p><b>RECEIVER:</b></p> <p><b>Level Measurements:</b>          Frequency range: 40 Hz to 60 kHz          Dynamic range: + 15 dBm to - 70 dBm          Resolution: 0.1 dB          Sample rate: 10/second (NORMAL), 2/second (DAMPED)          Detector type: average responding.</p> <p><b>Noise Measurements:</b>          Dynamic range          Message circuit noise: 0 dBm to + 85 dBm.          Noise-with-tone: 10 dBm to + 85 dBm (600 Ω, 900 Ω).          Noise-to-ground: + 40 dBm to + 125 dBm.          Resolution: 1 dB          Sample rate: 2/second          Detector type: Quasi RMS          Weighting filters: C message, 3 kHz Flat, 15 kHz Flat, Program.</p> <p><b>Frequency Measurements:</b>          Frequency range: 40 Hz to 60 kHz          Dynamic range: + 15 dBm to - 70 dBm.          Resolution: 1 Hz (40 Hz to 10 kHz),          10 Hz (10 kHz to 60 kHz).          Sample rate: 10/second (NORMAL), 2/second (DAMPED)</p> <p><b>TRANSMITTER:</b>          Frequency range: 40 Hz to 60 kHz          Ranges: 40 Hz to 1 kHz          200 Hz to 6 kHz.          2 kHz to 60 kHz          1004 Hz fixed.          Resolution: 1 Hz (40 Hz to 10 kHz),          10 Hz (10 kHz to 60 kHz).          Sample rate: 10/second          Level range: + 10 dBm to - 60 dBm (40 Hz to 60 kHz),          + 6 dBm to - 60 dBm (Hold Tone).          Resolution: 0.1 dB.          Sample rate: 10/second.</p> <p><b>HOLD CURRENT:</b>          Nominally 20 mA constant current.</p>	<p><b>GENERAL</b></p> <p>Monitor: built-in speaker, monitors received or transmitted signal.          Balanced impedances: 135 Ω, 600 Ω, 900 Ω.          Maximum input/output voltage: 300 V dc metallic or 200 V peak longitudinal.          Battery supply: 4 - 6 hours continuous operation on internal rechargeable batteries at 25° C. Battery drain is automatically turned off when discharged below proper operating level.          Complete recharge in 12 to 16 hours.          AC line: 100 V, 120 V, 220 V, 240 V ± 10%;          48 Hz to 440 Hz; 15 VA.</p> <p><b>Temperature range:</b>          Operating: 0° C to 55° C (32° F to 130° F).          Storage: - 20° C to 65° C (- 4° F to 149° F).          Relative humidity: 0 to 95% (&lt; 100° F, &lt; 40° C).  <b>Weight:</b>          Net: 6.6 kg (14.5 lb).          Shipping: 7.3 kg (16 lb).</p> <p><b>Outline Drawing:</b></p> <p><b>NOTE:</b> Dimensions in millimeters and (inches).</p>
---	---



## SECTION II INSTALLATION

### 2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for installation and interfacing the Test Set. Included are initial inspection procedures, power and grounding requirements, environmental information, installation instructions, interfacing and instructions for repackaging for shipment.

### 2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be free of marks or scratches and operating correctly upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. If damage has occurred, file a claim with the carrier. Test the electrical performance of the instrument using the Performance Test Procedures outlined in Section V. If there is damage or deficiency see the warranty on the reverse side of the title page in this manual.

### 2-5. POWER REQUIREMENTS.

2-6. The Test Set can be operated from the internal battery pack or from an external ac power source. Paragraph 2-7 explains the internal battery characteristics. Paragraph 2-13 explains the external ac power source characteristics.

#### NOTE

*The Test Set cannot be operated in the battery mode while an external ac power source is connected to the instrument.*

### 2-7. Battery.

2-8. The internal battery pack consists of three rechargeable battery packs (+5 V, +12 V and -12 V) which provides four to six hours of continuous use without needing to be recharged. To recharge the battery, plug the Test Set into an external ac power source and press the POWER pushbutton labeled CHARGE or ~ AC. Recharging time for the batteries is 12 to 16 hours.

2-9. The battery packs may be charged at temperatures between 5°C and 40°C (41°F to 104°F), but will accept a greater charge if the temperature is between 5°C and 25°C. Figure 2-1 shows the decrease in charge acceptance at temperatures up to 40°C. Charging at temperatures outside the specified range may cause the batteries to vent, with a resulting decrease in capacity.

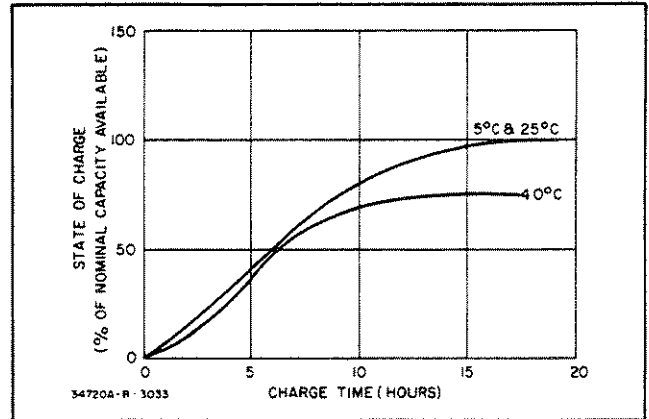


Figure 2-1. Battery Charge Acceptance vs. Temperature.

2-10. When possible the batteries should be stored in the discharged state. If the batteries are stored in the charged state they should be recharged for a period of 14 to 15 hours every 3 months. If this is not done, significant loss of battery capacity will occur. To minimize self-discharge during storage the batteries should be stored at a temperature of 20°C or lower. Although a nickel-cadmium battery will eventually lose all of its charge through self discharge it can be returned to service with a normal recharge.

#### CAUTION

*Permanent battery damage may result if the batteries are stored at high temperatures for a prolonged period.*

2-11. The cycle-life of the batteries is based, by the manufacturer, on an end point of 80% of the rated 225 milliampere-hour capacity. This is with a ten hour charge and discharge current of 22.5 milliamperes with discharge carried to the normal ten-hour end voltage (1.10 Volts/battery) of every cycle. Under these conditions a cycle-life in excess of 100 cycles can be expected.

2-12. The internal power supply has a sensing circuit which monitors the three battery voltages. If battery voltage falls below minimum operating level (approximately +4 V dc for the +5 V dc battery and ±10 V dc for the respective ±12 V dc batteries), the voltage is automatically switched off to all circuitry except the sensing circuit. See Paragraph 2-5 for recharging procedures. Section V contains information concerning replacement of the batteries.

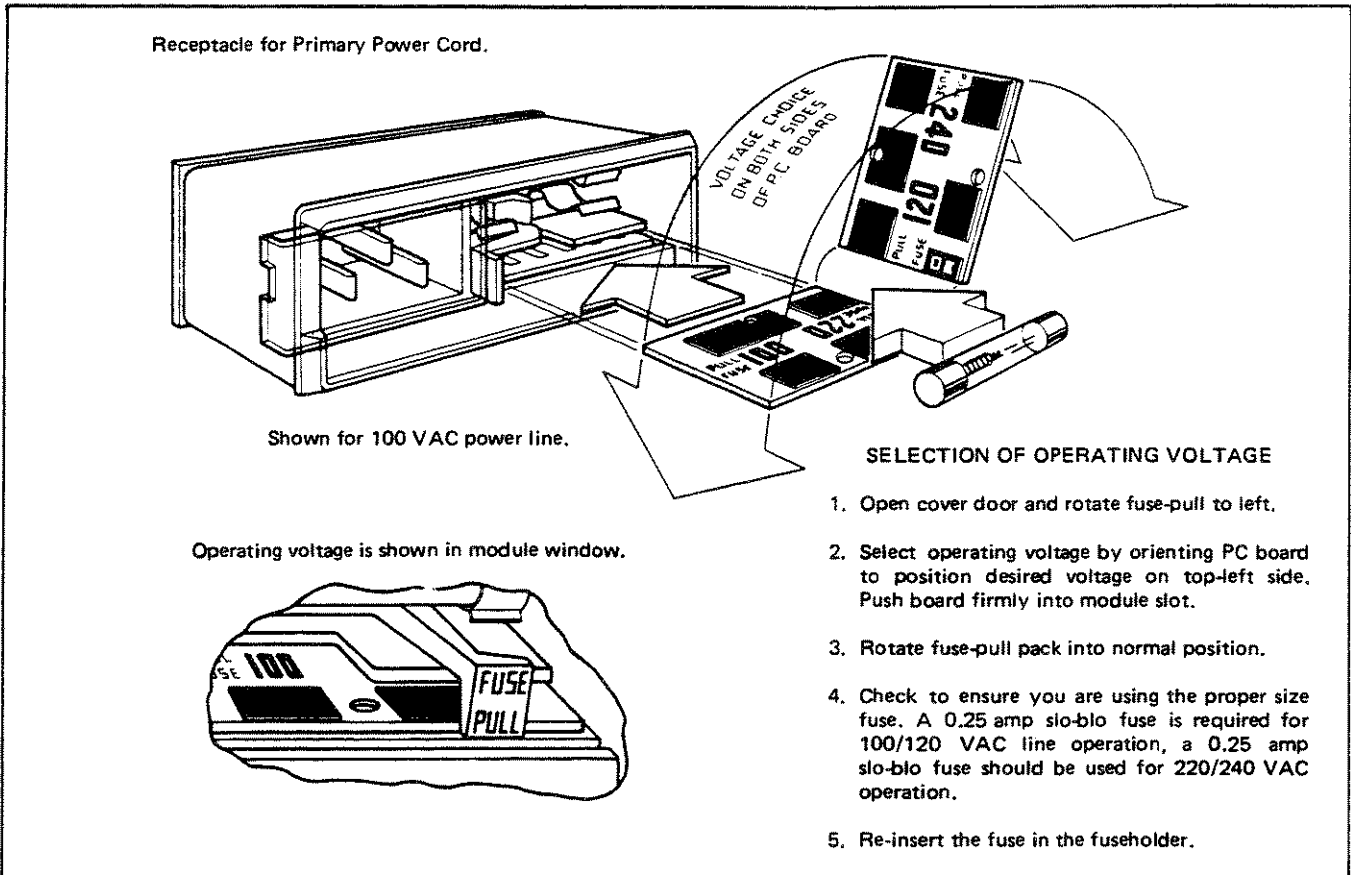


Figure 2-2. Voltage Selection.

### 2-13. AC Power.

2-14. The Test Set can be operated from any power source supplying 100 V ac, 120 V ac, 220 V ac or 240 V ac (- 10% + 5%), 48 Hz to 440 Hz. Power dissipation is 15 VA maximum. The Test Set is set for 120 V operation at the factory. If it is necessary to change the primary voltage setting, refer to Figure 2-2.

#### CAUTION

*If the instrument is not set for the proper primary voltage and not properly fused, it may be seriously damaged.*

### 2-15. Power Cords and Receptacles.

2-16. Figure 2-3 illustrates the standard configurations used for ac power cords. The -hp- part number directly above each drawing is the part number for an instrument power cord with a connector of that configuration. If the appropriate power cord is not received with your instrument, notify the nearest -hp- Sales and Service Office and a replacement cord will be provided.

### 2-17. Grounding Requirements.

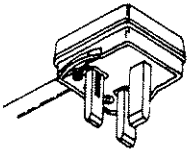
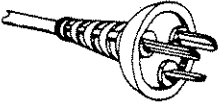
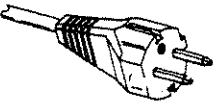
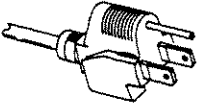


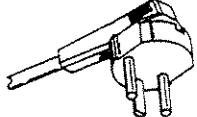
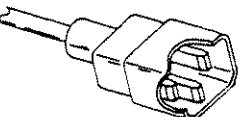
2-18. To protect operating personnel, the National Elec-

trical Manufacturer's Association (NEMA) recommends that the instrument panel and cabinet be grounded. The Test Set is equipped with a three conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power plug is the ground connection.

#### WARNING

*For operator protection connect the front panel ground terminal to earth ground when operating in the battery mode.*

Figure 2-3. HP Plug Styles

Plug Type	Cable HP Part Number	C D	Plug Description	Cable Length (inches)	Cable Color	For Use In Country
<p>250V</p> 	8120-1351 8120-1703	0 6	Straight *BS1363A 90°	90 90	Mint Gray Mint Gray	United Kingdom, Cyprus, Nigeria, Rhodesia, Singapore
<p>250V</p> 	8120-1369 8120-0696	0 4	Straight *NZSS198/ASC112 90°	79 87	Gray Gray	Australia, New Zealand
<p>250V</p> 	8120-1689 8120-1692	7 2	Straight *CEE7-Y11 90°	79 79	Mint Gray Mint Gray	East and West Europe, Saudi Arabia, Egypt, So. Africa, India (unpolarized in many nations)
<p>125V</p> 	8120-1348 8120-1398 8120-1754 8120-1378 8120-1521 8120-1676	5 5 7 1 6 2	Straight *NEMA5-15P 90° Straight *NEMA5-15P Straight *NEMA5-15P 90° Straight *NEMA5-15P	80 80 36 80 80 36	Black Black Black Jade Gray Jade Gray Jade Gray	United States, Canada, Japan (100V or 200V), Mexico, Philippines, Taiwan
<p>250V</p> 	8120-2104	3	Straight *SEV1011 1959-24507 Type 12	79	Gray	Switzerland
<p>250V</p> 	8120-0698	6	Straight *NEMA6-15P			United States Canada
<p>220V</p> 	8120-1957 8120-2956	2 3	Straight *DHCK 107 90°	79 79	Gray Gray	Denmark
<p>250V</p> 	8120-1860	6	Straight *CEE22-VI (Systems Cabinet use)			

\*Part number shown for plug is industry identifier for plug only. Number shown for cable is HP Part Number for complete cable including plug.

E = Earth Ground; L = Line; N = Neutral





**2-19. ENVIRONMENTAL REQUIREMENTS.**

**2-20. Operating Temperatures.**

2-21. In order for the Test Set to operate within the specifications listed in Table 1-1, the operating temperature must be within the range of 0°C to +55°C (+32°F to +131°F). Refer to Paragraph 2-10 for storage information.

**2-22. Relative Humidity.**

2-23. The allowable relative humidity for proper operation of the Test Set is 0% to 95% for temperatures below 40°C (+105°F). As temperatures increase above 40°C, the allowable relative humidity for proper operation will decrease.

**2-24. INTERFACE CONNECTIONS.**

2-25. The Test Set is equipped with two types of input/output connectors. The TIP and the RING connectors are both standard sized binding posts. These binding posts are spaced to accept the standard dual banana plug such as the Pomona 1269 dual banana plug adapter. The other type of connector is the WECO 310 jack. For a list of interfacing adapters and cables, refer to Table 2-1.

**2-26. REPACKAGING FOR SHIPMENT.**

**NOTE**

*If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the*

*instrument identifying the owner and indicating the service or repair to be accomplished. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number. If you have any questions, contact your nearest -hp- Sales and Service Office.*

2-27. The following is a general guide for repackaging the instrument for shipment. If the original container is available, place the instrument in the container with appropriate packing material and seal well with strong tape or metal bands. If the original container is not available, proceed as follows:

- a. Wrap the instrument in heavy paper or plastic before placing in an inner container.
- b. Place packing material around all sides of the instrument and protect panel face with cardboard strips or plastic foam.
- c. Place instrument and inner container in a heavy carton and seal with strong tape or metal bands.
- d. Mark shipping container "DELICATE INSTRUMENT," "FRAGILE," etc.

**Table 2-1. Interfacing Plugs.**

Description	Manufacturer*	Manufacturer's Part No.	Notes
Adapter: Dual banana plug to BNC	Pomona	1269	
Test Lead: Mini test clips to dual banana plug	Pomona	3786-C-18 3786-C-24 3786-C-36 3786-C-48 3786-C-60	for 18" for 24" for 36" for 48" for 60"
Adapter: BNC to PJ-051**	Pomona	2798	
Patch Cable: PJ-051** on both ends	Pomona	2524-A-18 2425-A-24 2425-A-36 2425-A-48 2425-A-60	for 18" for 24" for 36" for 48" for 60"
Patch Cable: 516** plug on both ends	Trimm	***851-1W-pp ***851-1X-pp ***851-1-pp	cable shield not connected cable shield connected to sleeve on both ends cable shield connected to sleeve on one end only

\*Pomona Electronics Co. Inc. 1500 East Ninth Street, Pomona, CA 91766

Trimm Inc., P.O. Box 489, Libertyville, IL 60048

\*\*Equivalent to WECO 310

\*\*\* For various lengths of cable change 1 to length in feet desired (851-2W-pp for 2 ft. length, 851-3W-pp for 3 ft. length, etc.).



## SECTION III

### OPERATING INSTRUCTIONS

#### 3-1. INTRODUCTION.

3-2. This section contains information and instructions necessary for proper operation of the Transmission Test Set. Included is a brief description of instrument capabilities, power and warm-up information, a functional description of all controls, indicators and connectors, and operating procedures.

#### 3-3. INSTRUMENT CAPABILITIES.

3-4. The Model 3551A Transmission Test Set is capable of measuring noise level, tone level or tone frequency, while simultaneously sending tone. It features both two-wire and four-wire balanced circuits with selectable impedances of 135 ohms, 600 ohms, or 900 ohms. Send and receive impedances are always the same. For frequency measurements, the autoranging four-digit readout is calibrated in kHz. Resolution is 1 Hz from 40 Hz to 10 kHz, and 10 Hz from 10 kHz to 60 kHz. The send oscillator covers a frequency range from 40 Hz to 60 kHz in three bands, and the output level is variable from +10 dBm to -60 dBm. In addition, a fixed frequency position of 1004 Hz is provided to be used as the holding tone when making noise-with-tone measurements. Noise measurement capability includes noise-with-tone, message circuit noise, and noise-to-ground. Four selectable weighting networks are provided: C - message; 3 kHz Flat; 15 kHz Flat; and Program.

3-5. The digital LED (light emitting diode) readout displays either the level or frequency of the input or output. It is calibrated in dBm for tone measurements and dBm for noise measurements, with a dynamic range of 85 dB. Overrange and underrange conditions are indicated by blanking the numerical display and flashing the polarity sign to indicate whether the level is above (+) or below (-) the range of the Test Set. A set of clip-on dial terminals is provided for connecting a lineman's handset. This allows one line to be dialed up and then held in an off-hook condition while making either send or receive measurements.

#### 3-6. POWER AND WARM-UP.

3-7. The Test Set can be operated from an internal battery pack, or from an external ac power source. The internal battery pack will provide four to six hours of continuous use without needing to be recharged unless the audio monitor is on. Use of the audio monitor will discharge the batteries at a much faster rate. The internal power supply contains a sensing circuit, which monitors the battery voltage. If the voltage drops too low for proper operation, the voltage is automatically switched off to all circuitry

except the sensing circuit. To recharge the batteries, simply plug an external ac power source into the Test Set.

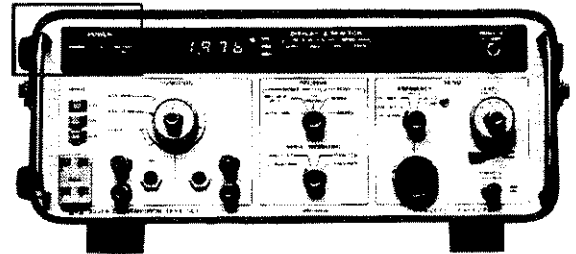
#### NOTE

*Do not operate the Test Set in the BATTERY mode while it is connected to an external ac source. The instrument will not operate under these conditions. Refer to Section V for battery replacement. The Test Set can be operated from a 100 V, 120 V, 220 V or a 240 V external ac power source. Ensure that the ac power module is set for the ac voltage used, and the proper fuse is used. For instructions on setting the power module and selecting the fuse, see Section II, Paragraph 2-5.*

3-8. The Test Set should be allowed to warm up for a minimum of five minutes before use. This allows the instrument to stabilize.

#### 3-9. FRONT PANEL CONTROLS.

3-10. In the following description the front panel controls, indicators and connectors have been divided into functional groups. The functional groups are: power, dial and hold, input/output function select, receive, send, and display and monitor. For step-by-step operation, refer to Paragraph 3-47.



#### 3-11. Power.

3-12. Input power to the Test Set is controlled by three pushbutton switches (CHARGE, AC and BATTERY).

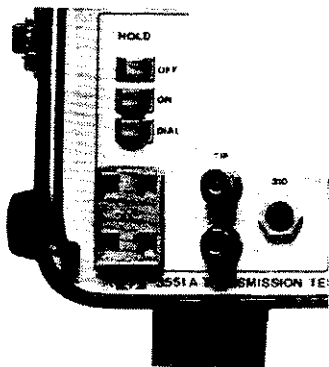
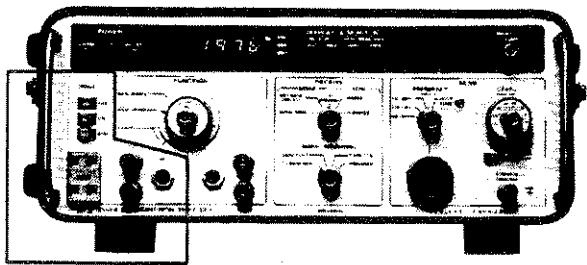
**WARNING**

*For operator protection connect the front panel ground terminal to earth ground when operating in the battery mode.*

To turn on the Test Set, press the AC pushbutton if external ac power is connected, or the BATTERY pushbutton if no external ac power is available. Use of the audio monitor in BATTERY operation will discharge the battery at a rate much faster than normal.

**NOTE**

*Do not try operating the Test Set in the BATTERY mode while it is plugged into an external ac source. The instrument will not operate under these conditions. For information concerning warm-up conditions, refer to Paragraph 3-6. For information concerning external power and fuse specifications and selection, refer to Paragraph 2-5, Section II.*

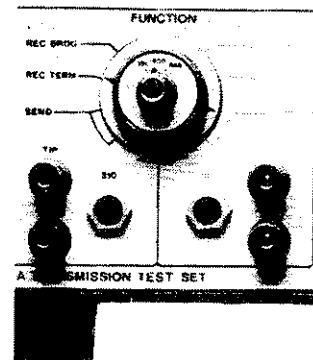
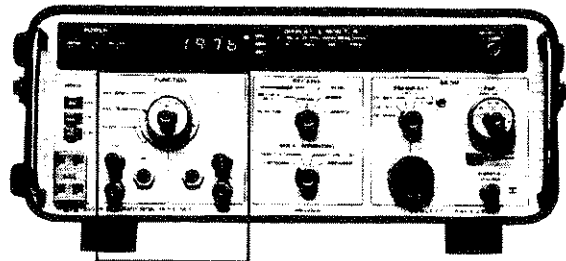
**3-13. Dial and Hold.**

3-14. The dial and hold operation is controlled by three pushbutton switches (OFF, ON and DIAL). This operation allows the operator to connect a lineman's handset to the DIAL terminals, dial a line and connect a hold circuit across the dialed line. When the DIAL pushbutton is pressed, the two terminals labeled DIAL, are connected in parallel with the input/output terminals TIP and RING (labeled in black) and the 310 input/output jack (labeled in black). After the line has been seized, the ON pushbutton will connect an internal holding circuit in parallel with the same input/

output terminals. To release the line, the pushbutton labeled OFF is pressed. If the line fails to hold, refer to Paragraph 5-32. If HOLD is used on fringe lines, the reading may be in error on some older instruments. See Appendix B.

**NOTE**

*If a dry line is connected to the black input/output terminals, the HOLD OFF pushbutton must be pressed.*

**3-15. Input/Output Function Select.**

3-16. The input/output function select section contains the input/output terminals, the input/output function select switch, and the impedance switch.

3-17. The Test Set has two sets of input/output terminals. Each set consists of a Western Electric 310 jack connected in parallel with two binding posts. The binding posts, labeled TIP and RING, will each accept a standard sized banana plug. The two binding posts for each set are spaced so they will also accept a standard sized dual banana plug (see Section II, Paragraph 2-24, for interfacing information).

3-18. Either set of the input/output terminals can be used to receive or send. When one set is connected for receiving, the other set is simultaneously connected for sending. The selection of terminals is determined by the position of the input/output function select switch.

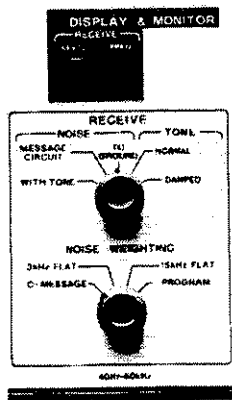
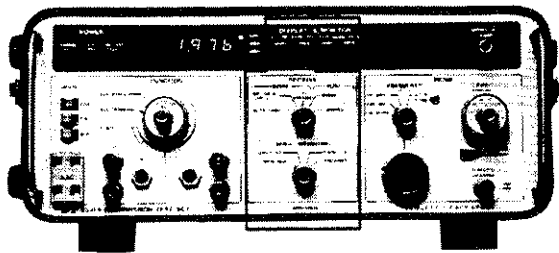
3-19. The input/output function select switch has four positions for each set of terminals—two send (SEND) positions, and two receive (REC BRDG, REC TERM) positions. The send positions connect the corresponding terminal set to the Test Set Send Oscillator. The operator is

then provided with a calibrated test signal at this terminal set (see Paragraph 3-35 and Table 3-6). The receive position connects the corresponding terminal set to the Test Set receive circuits. The operator can connect a transmission line to this terminal set for making desired frequency and level measurements (see Paragraph 3-21 and Table 3-3).

**CAUTION**

*Ring voltage may be applied to the 3551A ONLY if the FUNCTION switch is set to REC BRDG. If ringing voltage is applied accidentally to either the RECEIVE or SEND terminals when FUNCTION is set to REC TERM, the terminating resistors will be destroyed.*

3-20. The Test Set input/output impedance is determined by the position of the input/output function select switch, and the IMP (impedance) switch. In the REC TERM position and the SEND position of the input/output function select switch, the impedance of the corresponding terminal sets can be selected by the IMP switch. Three impedance selections are available—135 ohm, 600 ohm and 900 ohm. The impedance terminations are protected by a dc blocking capacitor. Accidental application of battery voltage to the input will not damage the instrument.



**3-21. Receive.**

3-22. The receive function of the Test Set is controlled by the RECEIVE NOISE/TONE switch, NOISE WEIGHTING switch, and DISPLAY & MONITOR RECEIVE control. The Test Set is capable of measuring noise with tone, message circuit noise, noise to ground, and tone, in the range of 40 Hz to 60 kHz. For noise measurements, there

are four weighting filters available—C message, 3 kHz Flat, 15 kHz Flat and Program. All measurements can be made for level, and frequency for receive tone. The results of these measurements are displayed in digital form, and can be monitored by a speaker.

3-23. **Receive Noise/Tone.** The RECEIVE NOISE/TONE switch selects the receive mode of operation. There are three noise measuring modes available (noise with tone, message circuit noise, and noise to ground) and two tone modes (40 Hz - 60 kHz), NORMAL and DAMPED.

3-24. **Noise with Tone Mode.** Noise measurements with tone may be used to give a measure of the noise encountered by a continuous data signal, or the noise a listener would hear during a speech burst. In the WITH TONE position of the RECEIVE NOISE/TONE switch, a sharp notch filter is switched into the Test Set input circuitry. The notch filter is designed to filter out a 1004 Hz signal applied at the transmitting station. Once the tone has been filtered out at the receive end, the noise can be applied to a weighting filter (usually C message), then measured. The dynamic measurement range in the noise with tone mode is 10 dBm to 85 dBm.

3-25. **Message Circuit Noise Mode.** In the MESSAGE CIRCUIT position of the RECEIVE NOISE/TONE switch, background noise can be measured with both input lines isolated from earth ground (metallic noise). Any of the four weighting filters can be used. Dynamic range for the message circuit noise mode is 0 dBm to 85 dBm.

3-26. **Noise-to-Ground Mode.** In the TO GROUND position of the RECEIVE NOISE/TONE switch, the noise level between two balanced lines and ground can be measured. The signal is applied to ground through a 40 dB pad in the Test Set. The loss due to the 40 dB pad is automatically adjusted for in the Test Set display circuits. It is necessary to establish a good earth or system ground and connect it to the Test Set front panel ground binding post for this measurement. The dynamic range of the noise-to-ground mode is 40 dBm to 125 dBm.

3-27. Message circuit noise indications and noise-to-ground indications of a balanced line can be used to compute the balance of a line. The degree of balance, where the greater part of background noise is due to noise-to-ground, is given by the equation, Balance (in dB) = noise-to-ground minus message circuit noise. For example, if the message circuit noise level is 26 dBm and the noise-to-ground level of the same circuit is 90 dBm, the balance is  $90 - 26 = 64$  dB.

3-28. **Tone Mode.** In the NORMAL position of the RECEIVE NOISE/TONE switch, tone level and frequency measurements can be made in the frequency range of 40 Hz to 60 kHz and a dynamic range of - 70 dBm to + 15 dBm. These measurements can be used for determining loss and attenuation distortion on message trunks and data service. Level measurements can also be used in conjunction with noise measurements to determine the signal-to-noise ratio

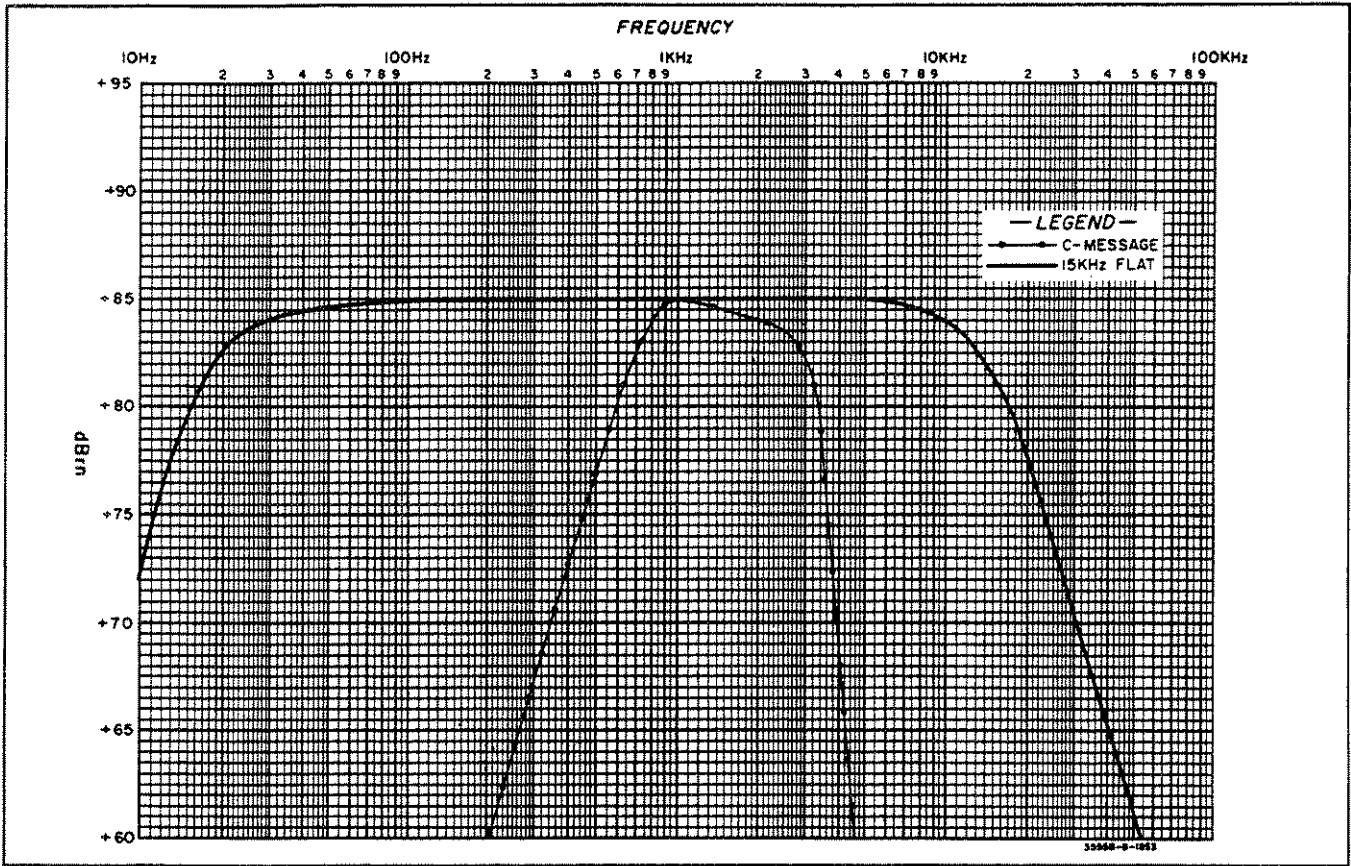


Figure 3-1. C-MSG and 15 kHz FLAT Weighting Curves.

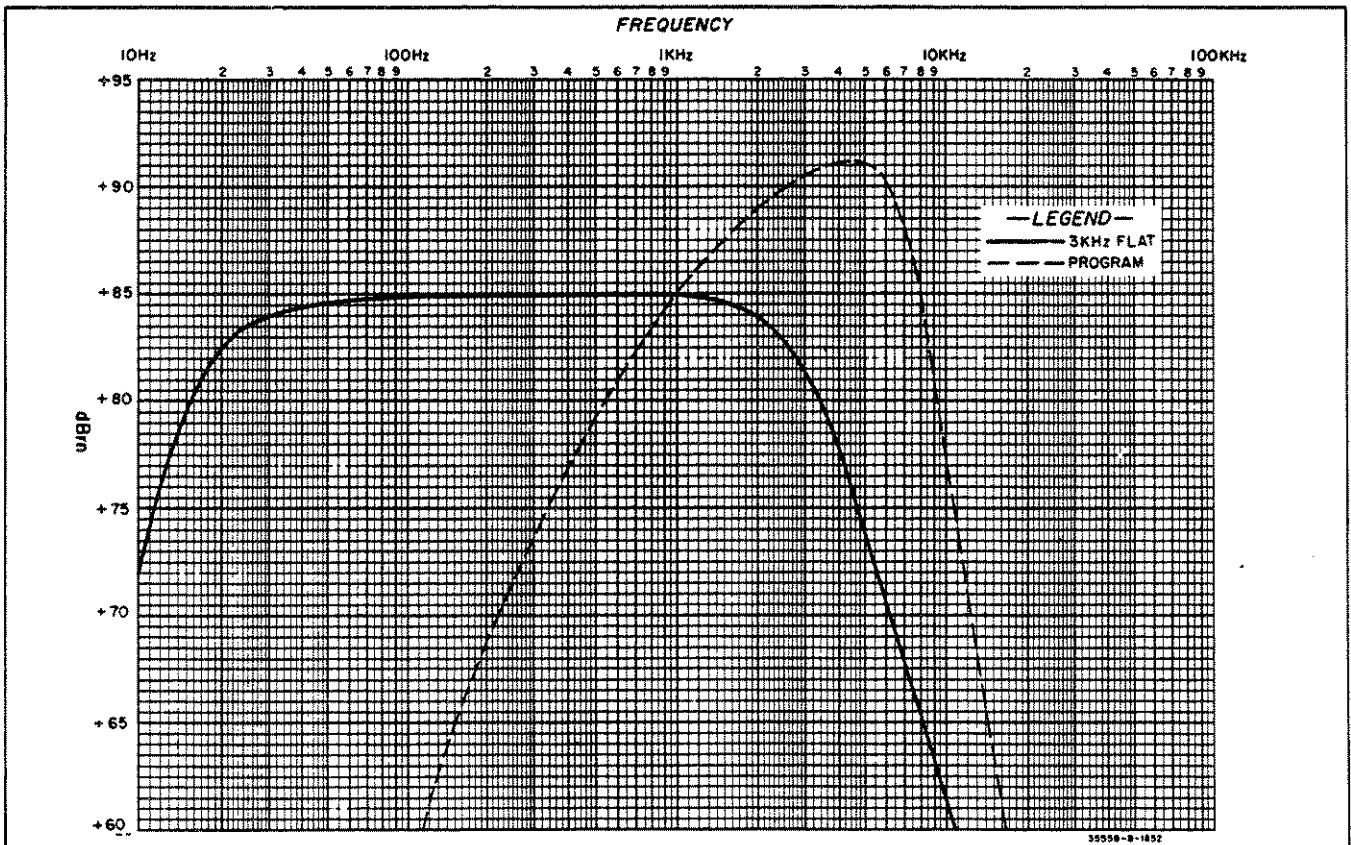


Figure 3-2. 3 kHz FLAT and Program Weighting Curves.

on a circuit. In the tone mode the noise weighting filters are bypassed. In the DAMPED position, the sample period is extended to increase readability of the display when noise is present.

**3-29. Noise Weighting.** The RECEIVE NOISE WEIGHTING switch selects one of four weighting filters for noise measurements. The weighting filters are: C message, 3 kHz Flat, 15 kHz Flat, and Program.

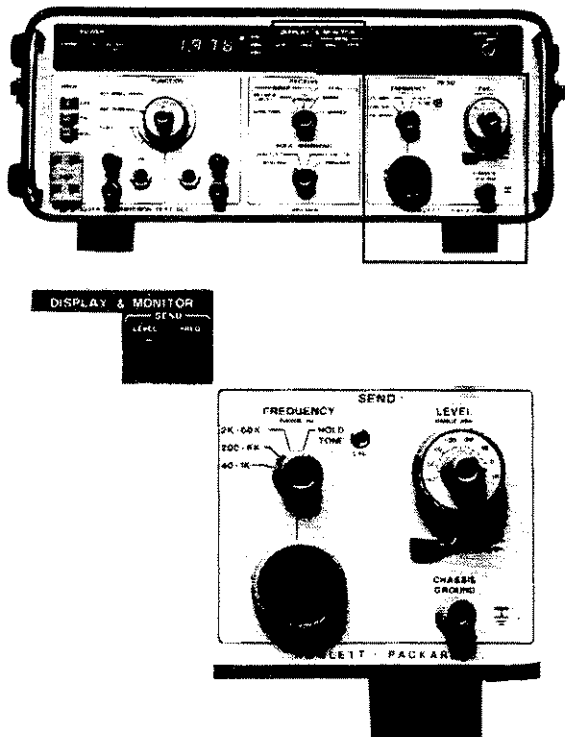
**3-30. C Message.** The C message filter has a frequency response which simulates the effects of noise on the human ear. This weighting is also used to evaluate the effects of noise on voice-grade data circuits. The frequency response of this filter is shown in Figure 3-1.

**3-31. 3 kHz Flat.** The 3 kHz Flat weighting filter is used on voice frequency circuits when investigating low-frequency noise, such as power induction. The frequency response of this filter is shown in Figure 3-2.

**3-32. 15 kHz Flat.** The 15 kHz Flat filter is used for unweighted measurements of noise on radio and television studio-transmitter and studio-remote audio links. The frequency response of this filter is shown in Figure 3-1.

**3-33. Program.** The Program filter is used for weighted measurements of noise on radio and television studio-transmitter and studio-remote audio links. The frequency response of this filter is shown in Figure 3-2.

**3-34. Display Monitor Receive.** The DISPLAY & MONITOR RECEIVE pushbuttons select the display function desired for the received signal. Two functions, level or frequency, are available. Both level and frequency are fully autoranging. For a complete description of the display and monitoring operation, refer to Paragraph 3-40.



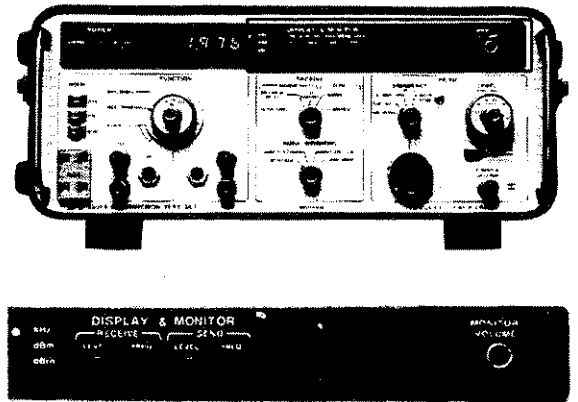
**3-35. Send.**

**3-36.** The send function of the Test Set provides the operator with a calibrated test signal at the output jack. The test signal can be variable in frequency from 40 Hz to 60 kHz, or a steady tone of 1004 Hz. The amplitude of the test signal is variable from -60 dBm to +10 dBm. Clipping may occur at levels above +10 dBm. Both frequency and amplitude can be monitored.

**3-37. Frequency.** The send frequency is controlled by the SEND FREQUENCY switch and the frequency vernier control. There are three overlapping range positions, and one steady tone position. The range positions are 40 Hz to 1 kHz, 200 Hz to 6 kHz, and 2 kHz to 60 kHz. The hold tone position provides a 1004 Hz tone which the operator may calibrate by means of a front panel screwdriver adjustment. The frequency vernier is a dual (coarse and fine) frequency control.

**3-38. Level.** The send level is controlled by the SEND LEVEL switch and the level vernier. There are seven range positions on the range switch: -60 to -50, -50 to -40, -40 to -30, -30 to -20, -20 to -10, -10 to 0, 0 to +10. The range of the level vernier is greater than 10 dBm.

**3-39. Display Monitor Send.** The DISPLAY & MONITOR SEND pushbuttons select the display function desired for the send signal. Two functions, level or frequency, are available. Both level and frequency are fully autoranging. For a complete description of the display and monitoring operation, refer to Paragraph 3-40.



**3-40. Display-Monitor.**

**3-41.** The display monitor function of the Test Set is controlled by the DISPLAY & MONITOR RECEIVE/SEND pushbuttons and MONITOR VOLUME vernier. It features a digital LED display for visual indications of frequency and level measurements, and a speaker for audio aid in identifying transmission line noise.

**3-42. Display.** The display provides digitally controlled LED readout of both the send frequency and level, and the receive frequency and level. Send and receive frequency

indications are displayed in four digits expressed in kHz units. Send level measurements and receive tone level measurements are displayed in three digits expressed in dBm. Receive noise level measurements are displayed in two digits expressed in dBm.

3-43. For frequency measurements below 10 kHz, the resolution is 1 Hz. For frequency measurements above 10 kHz, the resolution is 10 Hz. Tone level measurements are displayed with a 0.1 dB resolution. Noise level measurements are displayed with a 1.0 dB resolution.

3-44. Sample rate for frequency measurements and tone level measurements is 10/sec in NORMAL position and 2/sec in DAMPED. The sample rate for noise measurements is 2/sec.

3-45. Ranging in both level and frequency measurements is fully automatic. If an out-of-range condition in input level occurs, it is indicated by blanking of the display digits and a flashing plus or minus sign. The flashing plus sign indicates the instrument input signal is too large. The flashing minus sign indicates the instrument input signal is too small. Table 3-1 lists the minimum and maximum input levels and their respective operating modes. Both frequency and level

**Table 3-1. Input Levels.**

Operating Mode	Minimum Level	Maximum Level
Receive noise with tone	10 dBm	85 dBm
Receive message circuit noise	0 dBm	85 dBm
Receive noise to ground	40 dBm	125 dBm
Receive tone, send level and all frequency measurements	-70 dBm	+15 dBm

**Table 3-2. Dial and Hold Operation.**

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Press the HOLD OFF pushbutton.
3.	Connect a linemans handset (butt-in) to the DIAL terminals.
4.	Set the FUNCTION switch to REC BRDG or REC TERM for the black labeled terminals.
5.	Set the IMP switch to the desired impedance.
6.	Connect the line to the 310 jack or TIP RING terminals labeled in black.
7.	Press the HOLD DIAL pushbutton and dial with the handset (butt-in).*
8.	Press the HOLD ON pushbutton to maintain connection during test.

\*HOLD may be used only on "wet" lines. Also, when used on fringe lines, readings may be in error on some instruments. See Appendix B.

ranging occurs in either frequency measurements or level measurements. Consequently, blanking of frequency digits will occur if the level of the input signal is out-of-range.

3-46. **Monitor.** The audio monitor provides the operator audio indications of input signals. A monitor volume control is available for regulation of the audio signal. *Care should be taken not to use the audio facility at maximum volume for extended lengths of time while operating in the battery mode. This causes a large drain on the battery.* If radio frequency interference (broadcast music coming from the speaker) is a problem, refer to Appendix B.

3-46A. **Monitor 241 Jacks.** An external speaker or headphones can be plugged into the Monitor 241 jacks. An external speaker would be connected to the tip and sleeve of the jack. If the top jack is used, the internal speaker is disconnected. If the bottom jack is used, the internal speaker continues to operate along with the external speaker.

**3-47. OPERATION.**

3-48. Tables 3-2 through 3-7 list the step-by-step procedures for dial and hold operation, making level and noise measurements, operating the Test Set send unit, and making balance and transmission loss measurements. For a detailed description of each of the controls used in these procedures, refer to Paragraph 3-9. For power and warm-up information, refer to Paragraph 3-6.

**Table 3-3. Receive Tone Level and Frequency Measurements.**

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Set the FUNCTION switch to REC BRDG or REC TERM for desired input terminals.
3.	Set the IMP switch for the desired input impedance.
4.	Set the RECEIVE NOISE/TONE switch to the NORMAL position.
5.	Select the DISPLAY - MONITOR RECEIVE mode (LEVEL or FREQ) desired.
6.	Connect the line to be measured to the input terminals chosen in Step 2.
7.	If the display is too noisy to read, set the RECEIVE NOISE/TONE switch to DAMPED.



**Table 3-4. Message Circuit Noise and Noise with Tone Measurements.**

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Set the FUNCTION switch to REC BRDG or REC TERM for desired input terminals.
3.	Set the IMP switch for the desired input impedance.
4.	Select the RECEIVE NOISE/TONE mode desired (MESSAGE CIRCUIT or WITH TONE).
5.	Select the desired weighting filter.
6.	Press the DISPLAY-MONITOR RECEIVE LEVEL pushbutton.
7.	Connect the line to be measured to the input terminals chosen in Step 2.

**Table 3-5. Noise-to-Ground Measurements.**

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Set the FUNCTION switch to REC BRDG for the desired input terminals.
3.	Set the IMP switch to the desired input impedance.
4.	Set the RECEIVE NOISE/TONE switch to the TO GROUND position.
5.	Set the NOISE WEIGHTING switch for the desired weighting filter position.
6.	Press the DISPLAY-MONITOR RECEIVE LEVEL pushbutton.
7.	Connect a ground lead from the front panel CHASSIS GROUND terminal to earth or system ground.
8.	Connect the line to be measured to the input terminals chosen in Step 2.

**Table 3-6. Send Unit Operation.**

Step	Procedures
1.	Turn the Test Set POWER on.
2.	Press the DISPLAY-MONITOR SEND LEVEL pushbutton.
3.	Set the SEND LEVEL RANGE dBm switch and vernier to the desired signal level as indicated on the display.
4.	Press the DISPLAY-MONITOR SEND FREQ. pushbutton.
5.	Set the SEND FREQUENCY switch and the vernier to the desired frequency as indicated on the display.
6.	Set the IMP switch to the desired output impedance.
7.	Set the FUNCTION switch to the SEND position for the desired output terminal.
8.	Connect the line or circuit under test to the output terminals chosen in Step 6.

**Table 3-7. Balance Measurements.**

Step	Procedures
1.	Perform the message circuit noise measurement as described in Table 3-4.
2.	Perform the noise-to-ground measurement as described in Table 3-5.
3.	<p>Compute the line balance in dB using the results of the above checks and the following formula:</p> $\text{Balance (dB)} = N_g - N_{mc}$ <p>Where: <math>N_{mc}</math> = Message circuit noise  <math>N_g</math> = Noise-to-ground</p> <p>Example:  <math>N_{mc}</math> = 26 dBm  <math>N_g</math> = 90 dBm  Balance = 90 - 26 = 64 dB</p>



Do not apply ringing voltage to the 3551A while making REC TERM measurements.

