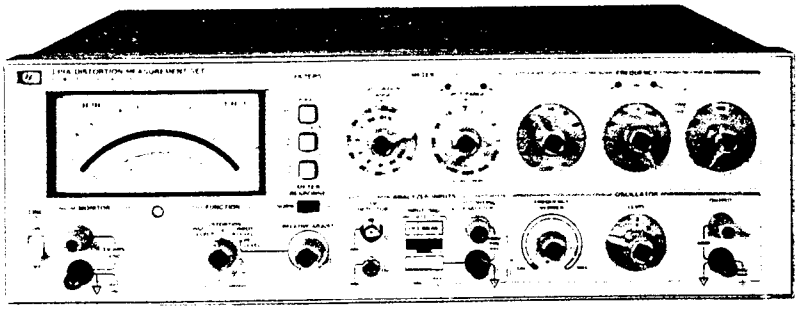
OPERATING AND SERVICE MANUAL

DISTORTION MEASUREMENT SET

339A



HEWLETT PACKARD

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HEWLETT PACKARD

SAFETY SUMMARY

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Hewlett-Packard Company assumes no liability for the customer's failure to comply with these requirements. This is a Safety Class 1 instrument.

GROUND THE INSTRUMENT

To minimize shock hazard, the instrument chassis and cabinet must be connected to an electrical ground. The instrument is equipped with a three-conductor ac power cable. The power cable must either be plugged into an approved three-contact electrical outlet or used with a three-contact to two-contact adapter with the grounding wire (green) firmly connected to an electrical ground (safety ground) at the power outlet. The power jack and mating plug of the power cable meet International Electrotechnical Commission (IEC) safety standards.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes. Operation of any electrical instrument in such an environment constitutes a definite safety hazard.

KEEP AWAY FROM LIVE CIRCUITS

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made by qualified maintenance personnel. Do not replace components with power cable connected. Under certain conditions, dangerous voltages may exist even with the power cable removed. To avoid injuries, always disconnect power and discharge circuits before touching them.

DO NOT SERVICE OR ADJUST ALONE

Do not attempt internal service or adjustment unless another person, capable of rendering first aid and resuscitation, is present.

DO NOT SUBSTITUTE PARTS OR MODIFY INSTRUMENT

Because of the danger of introducing additional hazards, do not install substitute parts or perform any unauthorized modification to the instrument. Return the instrument to a Hewlett-Packard Sales and Service Office for service and repair to ensure that safety features are maintained.

DANGEROUS PROCEDURE WARNINGS

Warnings, such as the example below, precede potentially dangerous procedures throughout this manual. Instructions contained in the warnings must be followed.

WARNING

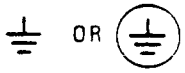
Dangerous voltages, capable of causing death, are present in this instrument. Use extreme caution when handling, testing, and adjusting.

SAFETY SYMBOLS

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

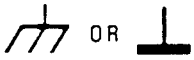
Instruction manual symbol: the product will be marked with this symbol when it is necessary for the user to refer to the instruction manual in order to protect against damage to the instrument.

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).

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.

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. This Operating and Service Manual contains information necessary to install, operate, test, adjust, and service the Hewlett-Packard Model 339A Distortion Measurement Set.

1-3. This section of the manual contains the performance specifications and general operating characteristics of the Model 339A. Also listed are available options and accessories, and instrument and manual identification information.

1-4. SPECIFICATIONS.

1-5. Operating Specifications for the Model 339A are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Table 1-2 lists general operating characteristics of the instrument. These characteristics are not specifications but are typical operating characteristics included as additional information for the user.

1-6. INSTRUMENT AND MANUAL IDENTIFICATION.

1-7. Instrument identification by serial number is located on the rear panel. 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.) The prefix is the same for all identical instruments and changes only when a major instrument change is made. The suffix, however, is assigned sequentially and is unique to each instrument.

1-8. This manual applies to instruments with serial numbers indicated on the title page. If changes have been made in the instrument since the manual was printed, a yellow "Manual Changes" supplement supplied with the manual will define these changes and explain how to adapt the manual to the newer instruments. In addition, backdating information contained in Section VII adapts the manual to instruments with serial numbers lower than those listed on the title page.

1-9. Part numbers for the manual and the microfiche copy of the manual are also listed on the title page.

1-10. DESCRIPTION.

1-11. The Model 339A Distortion Measurement Set combines a low distortion signal source, a high resolution distortion analyzer, an rms responding voltmeter and a VU (volume units) meter in one unit.

1-12. The signal source used in the Model 339A is a "bridged-T" oscillator which provides a low distortion sine-wave signal from 10 Hz to 110 kHz. The output amplitude is variable from 1 mV rms to 3 V rms into a 600 ohm load and is maintained by an amplitude control circuit which minimizes amplitude variations even when changing frequency ranges.

1-13. The distortion analyzer section of the 339A contains a tracking notch filter which is tuned to the oscillator frequency. The analyzer measures total harmonic distortion (THD) from 100% full-scale to .01% full-scale in nine ranges and features both automatic "Set Level" and automatic "Nulling" to greatly simplify operation. The Auto Set Level feature automatically sets the reference level over a 10 dB range. If the input signal is outside this range, a LED on the front panel indicates whether the INPUT RANGE control setting must be increased or decreased to be within the "pull-in" range of the Auto Set Level. The Auto Nulling feature is fully automatic when the 339A internal oscillator is used as the signal source. When an external oscillator is used as the signal source, an LED on the front panel indicates which direction the FREQUENCY controls must be set to be within the Auto Nulling range. Distortion characteristics of the input signal can be monitored at the MONITOR OUTPUT terminals with external equipment (oscilloscope, voltmeter, spectrum analyzer, etc.) to provide additional analysis of the distortion products.

1-14. The Model 339A is equippped with an amplitude modulation (AM) detector which has a frequency response from 550 kHz to 1.6 MHz. The AM detector permits the measurement of modulation distortion.

1-15. The 339A contains three active filters, one high-pass and two low-pass, which enables the user to eliminate unwanted frequencies and noise to permit higher resolution measurements.

1-16. The ac voltmeter section of the 339A measures the rms value of input voltage from 1 mV full-scale to 300 V full-scale in twelve ranges. In the VU meter mode, the

meter response characteristics are changed to those of a volume units meter.

1-17. OPTIONS.

1-18. The following options are available for use with the Model 339A:

Option 907: Front Handle Kit

Option 908: Rack Mounting Kit
Option 909: Front Handle and Rack Mounting Kit
Option 910: Additional Operating and Service Manual

1-19. Recommended Test Equipment.

1-20. Equipment required to maintain the Model 339A is listed in Table 1-3. Other equipment may be substituted if it meets the critical requirements listed in the table.

Table 1-1. Specifications.

DISTORTION

Fundamental Frequency Range:

10 Hz to 110 kHz continuous frequency coverage in 4 decade ranges with 2-digit resolution. Distortion analyzer and oscillator are simultaneously tuned.

Distortion Measurement Range:

0.01% full scale to 100% full scale (-80 dB to 0 dB) in 9 ranges.

Detection and Meter Indication:

True rms detection for waveforms with crest factor ≤ 3. Meter reads dB and % THD (Total Harmonic Distortion). Meter response can be changed from NORMAL to VU ballistics with a front panel switch.

Distortion Measurement Accuracy:

20 Hz to 20 kHz	±1 dB
10 Hz to 50 kHz	+1, -2 dB
50 kHz to 110 kHz	+1.5, -4 dB

NOTE

The above specifications apply for harmonics < 330 kHz.

Fundamental Rejection:

10 Hz to 20 kHz	> 100 dB
20 kHz to 50 kHz	> 90 dB
50 kHz to 110 kHz	> 86 dB

Distortion Introduced by Instrument (Input > 1 V rms)

10 Hz to 20 kHz	< -95 dB
20 kHz to 30 kHz	< -90 dB
30 kHz to 50 kHz	< -85 dB
50 kHz to 110 kHz	< -70 dB

Residual Noise (Fundamental frequency setting < 20 kHz, 80 kHz filter in, source resistance ≤ 1 kΩ shielded):

< -92 dB referenced to 1 V.

Input Level for Distortion Measurements:

30 mV to 300 V rms
(100 mV range minimum)

Input Impedance:

100 kΩ ±1.0% shunted by < 100 pF input High to Low.

DC Isolation:

Input low may be connected to chassis ground or floated 30 V to reduce the effects of ground loops on the measurement.

Auto Set Level:

No set level adjustment required. Distortion measurements are made directly over 10 dB range selected by input range switch. Two LED annunciators provide a fast visual indication to change input range for valid distortion measurement. Correct range is indicated when both annunciators are extinguished.

Auto Null:

Using internal oscillators: No manual frequency tuning necessary when using internal oscillator as signal source. Oscillator frequency controls simultaneously tune the analyzer.

Using external frequency source: Two LED annunciators provide a quick visual indication for the operator to increase or decrease the analyzer frequency controls. When the analyzer is rough tuned to within one least significant digit of the fundamental frequency, the indicator lights are extinguished and the 339A auto-null circuitry takes over to provide a fast accurate null without tedious operator tuning.

Input Filters (usable on all functions):

Low Pass

30 kHz – 3 dB point at 30 kHz, + 2.6 kHz, – 3 kHz. Provides band limiting required by FCC for proof-of-performance broadcast testing.

80 kHz – 3 dB point at 80 kHz, + 7 kHz, – 7.9 kHz. Normally used with fundamental frequencies < 20 kHz to reduce the effect of higher frequency noise present in the measured signal.

High Pass

400 Hz – 3 dB point at 400 Hz, + 35 Hz, – 40 Hz. Normally used with fundamental frequencies > 1 kHz to reduce the effect of hum components in the input signal.

Monitor Output:

Provides scaled presentation of input signal after

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

fundamental is removed for further analysis using oscilloscope or low frequency spectrum analyzer.

Output Voltage: 1 V rms ±5% open circuit for full scale meter indication, proportional to meter deflection.

Output Resistance: 1 kΩ ±5%.

VOLTMETER

Voltage Range:

1 mV rms full scale to 300 V rms full scale (−60 dB to +50 dB full scale, meter calibrated in dBV and dBm into 600 Ω)

Frequency Range:

10 Hz to 110 kHz

Accuracy (% of range setting)

20 Hz to 20 kHz ± 2%
10 Hz to 110 kHz ± 4%

Detection and Meter Indication

True rms detection for waveforms with crest factor ≤ 3. Meter reads true rms volts, dB V, and dBm into 600Ω.

Input Impedance:

100 kΩ ± 1.0% shunted by <100 pF Input High to Low.

Monitor Output:

Provides scaled presentation of input signal for further analysis using oscilloscope or low frequency spectrum analyzer.

Output Voltage: 1 V rms ±5% open circuit for full scale meter indication, proportional to meter deflection.

Output Resistance: 1 kΩ ± 5%.

RELATIVE INPUT LEVEL

Provides a ratio measurement relative to an operator selected reference level with readout directly in dB V or dBm (600 Ω).

Voltage range, frequency range, accuracy specifications, and monitor are the same as in VOLTMETER mode. (Accuracy is relative to 0 dB set level input.)

OSCILLATOR

Frequency Range:

10 Hz to 110 kHz in 4 overlapping decade ranges with 2 digit resolution. Frequency vernier provides continuous frequency tuning between 2nd digit switch settings.

Output Level:

Variable from < 1 mV to > 3 V rms into 600 Ω with 10 dB/step LEVEL control and 10 dB VERNIER adjustment.

OSC LEVEL position on function switch allows a quick check of oscillator level without disconnecting leads to device under test.

OFF position on Oscillator LEVEL control provides fast signal-to-noise measurement capability. Oscillator output terminals remain terminated in 600Ω.

Frequency Accuracy:

± 2% of selected frequency (with FREQUENCY VERNIER in CAL position).

Level Flatness:

20 Hz to 20 kHz ± 0.1 dB
10 Hz to 110 kHz ± 0.2 db

Distortion (≥ 600 Ω load, ≤ 3 V output):

10 Hz to 20 kHz < -95 dB (0.0018%) THD
20 kHz to 30 kHz < -85 dB (0.0056%) THD
30 kHz to 50 kHz < -80 dB (0.01%) THD
50 kHz to 110 kHz < -70 dB (0.032%) THD

Output Resistance:

600Ω ± 5%

AM DETECTOR

Frequency Range:

Carrier frequencies: 550 kHz to 1.6 MHz.
Modulation frequencies: 20 Hz to 20 kHz.

Distortion introduced by AM Detector (with 30 kHz filter switched IN):

Up to 85% Modulation: < -36 dB (1.6%) THD
85% to 95% Modulation: < -30 dB (3%) THD

Input Level

Maximum: 60 V peak
Modulation signal level:
2.0 V rms minimum
10 V rms maximum

Monitor Output (with modulated RF carrier applied to AM Detector input):

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

Distortion mode: Provides scaled presentation of demodulated input signal after fundamental is removed.	Voltmeter and Relative Input mode: Provides scaled presentation of demodulated input signal. Output Voltage and Output Resistance are the same as in Distortion mode.

Table 1-2. Typical Operating Characteristics.

GENERAL

Operating Environment:

Temperature: 0°C to 50°C.
Humidity Range: < 95%, 0°C to 40°C.

Storage Temperature:

−40°C to +65°C.

Power:

100/120/220/240, +5%, -10%, 40 to 66 Hz, 200 mA max.

Weight:

Net 8.2 kg (18 lbs.); shipping 11.3 kg (25 lbs.).

Dimensions:

426 mm wide x 146 mm high x 442 mm deep (16.75" wide x 5.75" high x 17.4" deep).

Table 1-3. Recommended Test Equipments.

Instrument	Critical Specification	Recommended Model	Use
AC Calibrator	Frequency: 10 Hz - 110 kHz Output Level: 1 mV - 300 V rms Level Accuracy: ± .2% Output Impedance: ≤ 50 Ω	-hp- Model 745A AC Calibrator -hp- Model 746A High Voltage Amplifier	PAT
True RMS Voltmeter	Frequency Range: 10 Hz - 110 kHz Voltage Range: 1 mV - 10 V rms Measurement Accuracy: ± .5% Measurement Resolution: .1% of full-scale Crest Factor: ≥ 4	-hp- Model 3403C True RMS Voltmeter	PT
Pulse Generator	Pulse Output Amplitude: 10 V p-p Pulse Width: Variable, 1 msec − 10 μsec Repetition Rate: 100 Hz − 10 kHz	-hp- Model 8011A Pulse Generator	P
Oscilloscope	Bandwidth: DC - 2 MHz Sweep Time: .1 μs - .5 sec/div Sensitivity: .1 V/div.	-hp- Model 1221A Oscilloscope	PT

Table 1-3. Recommended Test Equipments (Cont'd).

Instrument	Critical Specification	Recommended Model	Use
Frequency Counter	Frequency Range: 10 Hz - 110 kHz Frequency Resolution: .1% of reading	-hp- Model 5300A Counter Mainframe -hp- Model 5302A Counter Module	P
Spectrum Analyzer	Frequency Range: 10 Hz - 330 kHz Frequency Resolution: .1 Hz Input Amplitude: 1 V Dynamic Range: 50 dB Measurement Resolution: ± .1 dB Minimum Bandwidth: 3 Hz	-hp- Model 3044A Spectrum Analyzer	PA
Tuneable Notch Filter	Frequency Range: 10 Hz - 110 kHz Notch Depth: ⩾ -80 dB	-hp- Model 339A Distortion Measurement Set	P
Low Distortion Oscillator	Frequency Range: 10 Hz - 110 kHz Output Level: 3 V rms into 600 Ω THD: > -95 dB (10 Hz - 20 kHz) > -85 dB (20 kHz - 30 kHz) > -80 dB (30 kHz - 50 kHz) > -70 dB (50 kHz - 110 kHz)	-hp- Model 239A Oscillator	PAT
DC Digital Voltmeter	Input Range: 4 V dc Measurement Accuracy: ± .1% Resolution: .01% of full-scale	-hp- Model 3465A Digital Voltmeter	AT
Resistors	600 Ω Resistive Load	-hp- Accessory No. 11095A	PA
	600 Ω 1% Metal Film	-hp- Part No. 0698-5405	
	60 kΩ 1% Metal Film	-hp- Part No. 0698-5973	P
	100 kΩ .1% Metal Film	-hp- Part No. 0698-4158	
	1 kΩ 1% Metal Film	-hp- Part No. 0757-0280	

P = Performance Test

A = Adjustment Procedures

T = Troubleshooting

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section of the manual contains information and instructions necessary to install the Model 339A Distortion Measurement Set. Also included are initial inspection procedures, power and grounding requirements, environmental information, and packaging instructions.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected, both mechanically and electrically, before shipment. It should be free of mars and scratches and in perfect electrical order. The instrument should be inspected upon receipt for damage that might have occured in transit. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has been mechanically and electrically inspected. Procedures for testing the electrical performance of the Model 339A are given in Section IV of this manual. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the Performance Tests, notify the nearest Hewlett-Packard Office. (A list of the -hp- Sales and Service Offices is presented at the back of this manual.) If the shipping container is damaged, or the cushioning material shows signs of stress, notify the carrier as well as the Hewlett-Packard Office. Save the shipping materials for the carriers inspection.

2-5. PREPARATION FOR USE.

2-6. Power Requirements.

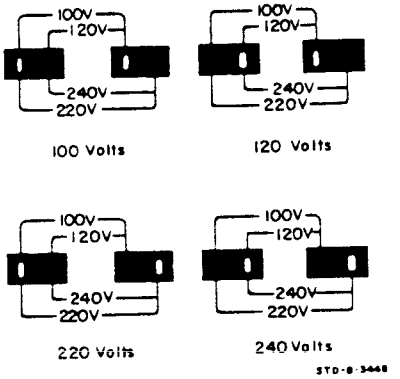
2-7. The Model 339A requires a power source of 100, 120, 220, or 240 V ac (+5% - 10%), 48 Hz to 66 Hz single phase. Maximum power consumption is 48 VA.

2-8. Line Voltage Selection.

2-9. Before connecting ac power to the Model 339A make sure the rear panel line selector switches are set to correspond to the available power line voltage and that the proper fuse is installed, as shown in Figure 2-1. The instrument is shipped from the factory with the line voltage and fuse selected for 120 V ac operation.

2-10. Power Cable.

2-11. Figure 2-2 illustrates the standard configurations used for -hp- power cables. The number directly below each drawing is the -hp- part number for a power cable equipped with a connector of that configuration. If the



NOMINAL VOLTAGE	OPERATING RANGE - 10%, + 5% of nominal	FUSE
100 volts	90 to 105 volts	0.25 A
120 volts	108 to 126 volts	
220 volts	198 to 231 volts	
240 volts	216 to 252 volts	

Figure 2-1. Line Voltage Selection.

appropriate power cable is not included with the instrument, notify the nearest -hp- Sales and Service Office and the proper cable will be provided.

2-12. Grounding Requirements.

2-13. To protect operating personnel, the National Electrical Manufacturer's Association (NEMA) recommends that the instrument cabinet and front panel be grounded. The Model 339A is equipped with a three

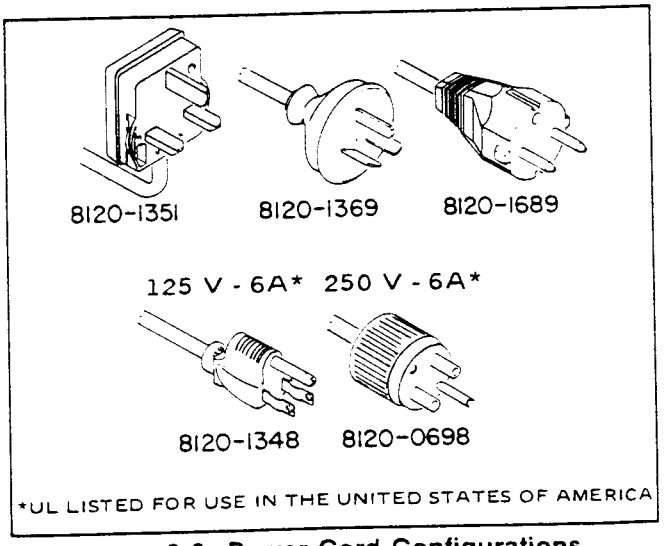


Figure 2-2. Power Cord Configurations.

conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument.

2-14. Bench Use.

2-15. The Model 339A is shipped with plastic feet and tilt stands installed and is ready for use as a bench instrument. The plastic feet are shaped to permit "stacking" with other full-module Hewlett-Packard instruments. The tilt stands permit the operator to elevate the front of the instrument for operating and viewing convenience.

2-16. Rack Mounting.

2-17. The Model 339A may be rack mounted by adding rack mounting kit Option 908 or Option 909. Option 908 contains the basic hardware and instructions for rack mounting; Option 909 adds front handles to the basic rack mount kit. The rack mount kits are designed to permit the instrument to be installed in a standard 19 inch rack.

2-18. ENVIRONMENTAL REQUIREMENTS.

WARNING

To prevent electrical shock or fire hazard, do not expose the instrument to rain or moisture.

2-19. Operating and Storage Temperature.

2-20. In order to meet the specifications listed in Table 1-1, the instrument should be operated within an ambient temperature range of 0°C to +50°C (+32°F to +122°F).

2-21. The instrument may be stored or shipped where the ambient temperature range is within −40°C to +65°C (−40°F to +149°F). However, the instrument should not be stored or shipped where temperature fluctuations cause condensation within the instrument.

2-22. Humidity.

2-23. The instrument may be operated in environments with relative humidity of up to 95%. However, the instrument must be protected from temperature extremes which cause condensation within the instrument.

2-24. Altitude.

2-25. The instrument may be operated at altitudes up to 4572 meters (15,000 feet).

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 it in an inner container.

b. Place packing around all sides of the instrument and protect the front panel with cardboard strips or plastic foam.

c. Place the instrument and inner container in a heavy carton and seal with strong tape or metal bands.

d. Mark the shipping container "DELICATE INSTRUMENT", "FRAGILE", etc.

SECTION III
OPERATION

3-1. INTRODUCTION.

3-2. This section contains information and instructions necessary for operation of the Model 339A Distortion Measurement Set. Included is a description of operating characteristics, a description of operating controls and indicators, and functional checks to be performed by the operator.

3-3. OPERATING CHARACTERISTICS.

3-4. General.

3-5. The Model 339A is designed to measure Total Harmonic distortion (THD) of signals having a fundamental frequency between 10 Hz and 110 kHz. the analyzer section of this instrument measures total harmonic distortion levels from 100% (0 dB) full-scale to .01% (-80 dB) full-scale in nine ranges as selected by the DISTORTION RANGE control. to simplify operation, the analyzer section features both automatic "set level" and automatic "nulling".

3-6. The Auto Set Level feature automatically sets the measurement reference level over a 10 dB V range. If the input signal is outside this range, an LED on the front panel indicates whether the INPUT RANGE control setting must be increased or decreased to be within the "pull-in" range of the Auto Set Level.

3-7. The Auto Nulling feature is fully automatic when the 339A internal oscillator is used as the signal source. When using an external signal source, an LED on the front panel indicates which direction the FREQUENCY controls must be rotated to be within the Auto Nulling range.

3-8. The Model 339A includes an AM detector which has a carrier frequency range of 550 kHz to 1.6 MHz. The AM detector permits the measurement of THD of a modulation signal.

3-9. The signal source used in the Model 339A is a "bridged T" oscillator which provides a low distortion sine-wave signal from 10 Hz to 110 kHz. The operating frequencies of the oscillator and the analyzer notch filter are set simultaneously. The output level of the oscillator is variable from 1 mV rms full-scale to 3 V rms full-scale into a 600 Ω load.

3-10. The ac voltmeter section of the Model 339A measures the true rms value of input voltages from 1 mV full-scale to 300 V full-scale in twelve ranges. Frequency response of the meter section is 10 Hz to 110 kHz.

3-11. True RMS VS Average Responding Detection.

3-12. Since the 339A employs a true rms converter to detect the measurement signal, it is less susceptible to errors than average responding devices. Most average responding meters are calibrated to indicate the rms value of a pure sine-wave. When reading a pure sine-wave, both the true rms and average responding meters will give the correct indication. However, when reading complex signals the average responding meter may be in error. The amount or error depends upon the particular signal being measured.

As an example; when measuring a square-wave, the true rms meter will give the correct indication of the rms value. The average responding meter however, will read 11% high. The average responding meter is also affected by signals with harmonic content. The amount of error introduced by an average responding meter due to harmonics is dependent upon the relative amplitude, phase, and order of the harmonic. The third harmonic usually causes the greatest amount of error. For example, when measuring a signal with third harmonic content, an average responding meter can be in error by +5% to -20% depending upon the amplitude and phase of the harmonic, relative to the fundamental frequency. Due to the errors inherent in average responding meters, a distortion analyzer which employs this type of detector will also be subject to the same measurement errors. These errors can cause indicated distortion readings to be as much as 1.3 dB below the actual rms value for certain combinations of second and third harmonics. The Model 339A is not affected by the errors associated with average responding detectors and will provide more accurate measurement indications.

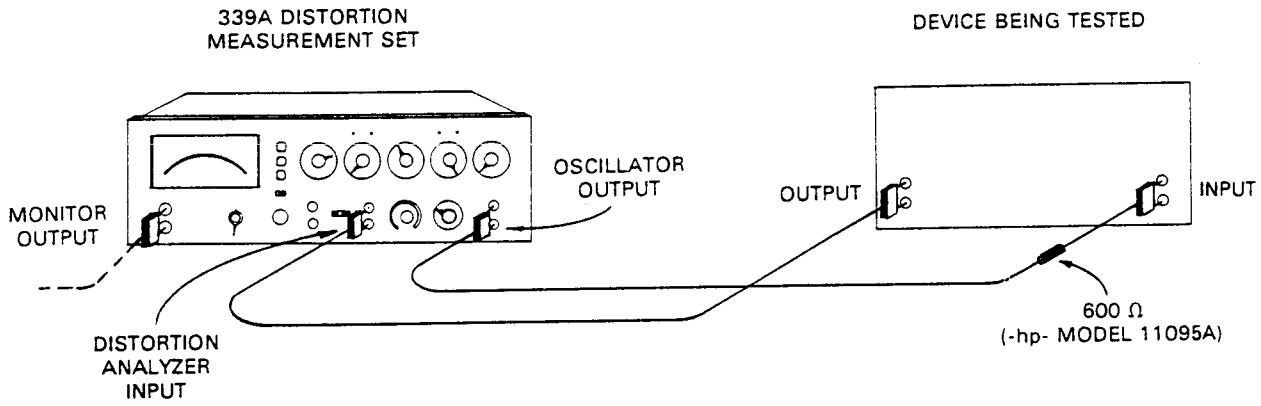
3-13. Turn-On and Warm-Up.

3-14. Before connecting ac power to the 339A, be certain the rear panel voltage selector switches are set to correspond to the voltage of the available power line and that the proper fuse is installed for the voltage selected. For rated measurement accuracy, the 339A should be allowed to "warm-up" for at least 15 minutes.

3-15. DISTORTION MEASUREMENT.

3-16. Distortion Measurement Using the 339A Internal Oscillator.

3-17. The Model 339A Distortion Measurment Set is designed to provide complete capability for measuring Total Harmonic Distortion by combining an automatic, high resolution distortion analyzer and a low distortion signal source. Figure 3-2 illustrates the fundamental application of the Model 339A. The figure shows the equipment configuration and includes an operating procedure for making THD measurements.



PRELIMINARY ADJUSTMENTS.

a. Set the OSCILLATOR LEVEL control to OFF.

b. Set the METER RESPONSE switch to NORMal.

c. Set the ANALYZER INPUT/GND SELECT switch to DIStortion ANalyzer. (Low input connected to chassis ground or floated as desired.)

d. Set FILTER switches as desired.

e. Connect the 339A DISTORTION MEASUREMENT SET and the device to be tested as shown.

OSCILLATOR ADJUSTMENT.

f. Set the FUNCTION switch to OSCillator LEVEL and adjust the OSCILLATOR LEVEL and LEVEL vernier controls for the desired signal level as indicated on the meter. (Change the METER INPUT RANGE switch as necesary to obtain the proper meter range.)

g. Set the FREQUENCY controls and FREQUENCY VERNIER for the desired output frequency. (Use a frequency counter if frequency is critical.)

ANALYZER ADJUSTMENT.

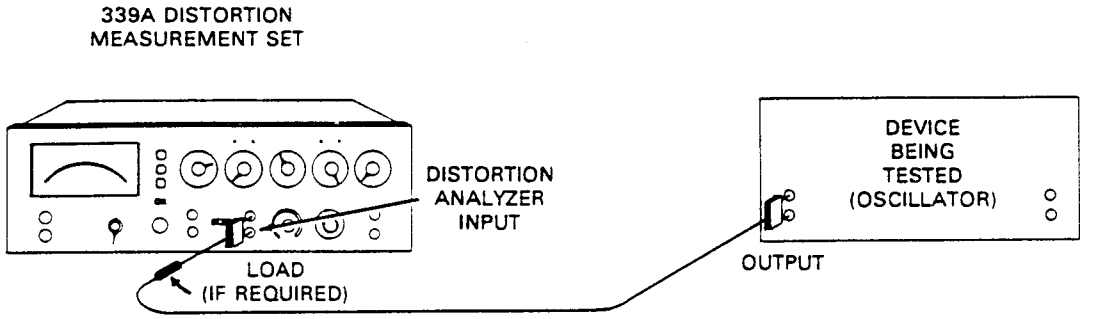
h. Set the FUNCTION switch to DISTORTION.

i. Select the proper input range by turning the METER INPUT RANGE control in the direction indicated by the INPUT RANGE indicator lights. The proper input range has been selected when the INPUT RANGE control is set to the lowest range which extinguishes *both* indicator lights.

j. Adjust the DISTORTION RANGE control to obtain an "on-scale" meter indication as near full-scale as possible.

k. Read the amount of total harmonic distortion (THD) in dB by adding the dB figure on the DISTORTION RANGE control and the dB reading of the meter, or the amount of THD in per-cent is indicated by the meter reading (second or third scale) relative to the full-scale per-cent figure on the DISTORTION RANGE control.

Figure 3-2. Distortion Measurement Using 339A Internal Oscillator.



PRELIMINARY ADJUSTMENTS.

a. Set the METER RESPONSE switch to NORMAL.

b. Set the ANALYZER INPUT/GND SELECT switch to DIStortion ANalyzer. (Low input connected to chassis ground or floated as desired.)

c. Set the FILTER switches as desired.

d. Connect the 339A DISTORTION MEASUREMENT SET and the device to be tested as shown.

ANALYZER ADJUSTMENTS.

e. Set the FUNCTION switch to DISTORTION.

f. Select the proper input range by turning the METER INPUT RANGE control in the direction indicated by the INPUT RANGE indicator lights. The proper input range has been selected when the INPUT RANGE control is set to the lowest range which extinguishes *both* indicator lights.

g. Slowly adjust the FREQUENCY controls in the direction indicated by the FREQUENCY indicator lights. The proper frequency range has been selected when *both* indicator lights are extinguished.

h. Adjust the DISTORTION RANGE control to obtain an "on-scale" meter indication as near full-scale as possible.

i. Read the amount of total harmonic distortion (THD) in dB by adding the dB figure on the DISTORTION RANGE control and the dB reading of the meter, or the amount of THD in per-cent is indicated by the meter reading (second or third scale) relative to the full-scale per-cent figure on the DISTORTION RANGE control.

Figure 3-3. Distortion Measurement of an External Source.

3-18. Distortion Measurement of an External Source.

Figure 3-3 shows another measurement application. In this case the Model 339A is used to measure the THD of a signal source. The figure includes an illustration of the necesary equipment connections and an operating procedure for making the measurement.

3-20. AM DETECTOR.

3-21. The Model 339A includes an AM DETECTOR to permit the user to measure the total harmonic distortion of a modulation signal on an RF carrier. Equipment connection and measurement procedures are similar to those outlined in Figure 3-3 except the input is connected to the AM DETECTOR input.

3-22. VOLTMETER OPERATION.

3-23. The following procedures outline the operating procedures for the various voltmeter functions.

3-24. Normal Voltmeter Operation.

3-25. To use the Model 339A as a normal, true rms voltmeter, proceed as follows:

a. Set the FUNCTION switch to INPUT LEVEL.

b. Set the METER RESPONSE switch to NORMAL.

c. Set the INPUT/GND SELECT switch to DIStortion ANalyzer (low input connected to chassis ground or floating as desired).

d. Set the FILTER switches off (out).

e. Connect the signal to be measured to the DISTORTION ANALYZER input connectors.

f. Adjust the INPUT RANGE control in the direction indicated by the INPUT RANGE indicator lights until an "on-scale" meter indication, as near full-scale as possible, is obtained. (Both indicator lights will be off.)

3-26. RELATIVE LEVEL OPERATION.

3-27. The RELATIVE LEVEL FUNCTION permits the user to adjust the meter gain of the 339A to set a convenient reference level on the meter (usually 0 dB). This function is convenient for measuring signal levels relative to a reference level. To use the RELative LEVEL FUNCTION, proceed as follows:

a. Set the FUNCTION switch to RELative LEVEL.

b. Set the METER RESPONSE switch to NORMal.

c. Set the INPUT/GND SELECT switch to DIStortion ANalyzer. (Low input connected to chassis ground or floating as desired.)

d. Set the FILTER switches off (out).

e. Connect the reference signal to the DISTORTION ANALYZER input connectors.

f. Adjust the INPUT RANGE control in the direction indicated by the INPUT RANGE indicator lights until an "on-scale" meter indication is obtained.

g. Use the RELATIVE ADJUST control to set the meter to the desired reference level.

h. Measure other input levels relative to the reference just established. Do not change the RELATIVE ADJUST control.

3-28. Oscillator Level Operation.

3-29. In the OSCillator LEVEL function, the analyzer inputs and the MONITOR output is disabled and the 339A meter circuit is used to monitor the output level of the oscillator. To measure the oscillator output level, perform the following:

a. Set the FUNCTION switch to OSCillator LEVEL.

b. Set the METER RESPONSE switch to NORMAL.

c. Set the FILTER switches to off (out).

d. Adjust the INPUT RANGE control as necessary to obtain an "on-scale" meter indication as near full-scale as possible.

e. The meter reading, relative to the meter range selected by the INPUT RANGE control indicates the output level of the oscillator.

3-30. To adjust the oscillator output to a particular level, perform the following:

a. Set the FUNCTION switch to OSCillator LEVEL.

b. Set the METER RESPONSE switch to NORMAL.

c. Set the FILTER switches to off (out).

d. Set the INPUT RANGE control to the appropriate meter range for the oscillator output level desired.

e. Adjust the OSCILLATOR LEVEL control and LEVEL vernier until the desired output level is indicated on the meter.

3-31. VU MEASUREMENTS.

3-32. To measure volume units (VU), the meter response characteristics are changed to those of a VU meter by switching the METER RESPONSE switch to the VU position. VU measurements can be made in the INPUT LEVEL or RELative LEVEL functions. Measurement results are normally read on the dBm 600 ohms meter scale. Operating procedures for making VU measurements are the same as those listed for Normal Voltmeter Operation or Relative Level Operation.

3-33. Filters.

3-34. Three 60 dB/decade active filters, one high-pass and two low-pass, are included to permit the user to eliminate unwanted frequencies and noise. These filters may be selected individually or in any combination by means of the front panel FILTER switch. The frequencies labeled beside each switch indicate the 3 dB "roll-off" point of that particular filter.

3-35. Input Ground Select.

3-36. The ANALYZER Low input reference is selected by the INPUT/GND SELECT switch. When using the DISTORTION ANALYZER input, the input low is connected to chassis ground (center switch position) or allowed to float (right switch position). When using the AM DETECTOR input (left switch position) the input low is connected to chassis ground.

CAUTION

To prevent damage to the analyzer input circuits, do not float the low input terminal more than ± 30 V dc relative to earth ground.

3-37. Monitor Output.

3-38. The MONITOR output provides a means of driving external equipment to permit a more detailed analysis of the signal being measured. Instruments, such as an oscilloscope, wave analyzer, or spectrum annalyzer can be used to determine the nature of the total harmonic distortion being measured. The monitor output level is 1 V rms for full-scale meter deflection. The MONITOR output is disabled when using the OSCillator LEVEL FUNCTION.

3-39. OSCILLATOR OPERATION.

3-40. Frequency Selection.

3-41. The oscillator frequency is determined by the setting of the FREQUENCY and FREQUENCY VERNIER controls. The units and tenths controls determine the first and second digits of the desired frequency. These numbers are then multiplied by the range selected on the multiplier control. As an example: to set the oscillator to a frequency of 5.6 kHz; set the units control to 5, the tenths control to .6, and the multiplier to X1K. (The FREQUENCY VERNIER should be set to the CAL position.) The FREQUENCY VERNIER provides continuous frequency tuning between steps of the tenths control to permit continuous frequency selection from 10 Hz to 110 kHz.

3-42. Output Level.

3-43. The oscillator output level is controlled by the OSCILLATOR LEVEL control and LEVEL vernier. The OSCILLATOR LEVEL control selects output levels from 3 mV rms full-scale to 3 V rms full-scale in 10 dB V steps (600 ohm load). The level vernier varies the output level from greater than 3 V rms to less than 1 mV rms (600 ohm load).

3-44. OPERATIONAL VERIFICATION CHECKS.

3-45. The following procedures are designed to test the operational capabilities of the Model 339A. If so desired, these tests can be substituted for the performance tests outlined in Section IV for incoming inspection tests or to check operation after calibration. Keep in mind however, these tests check only the operational capabilities of the Models 339A. They *do not* check the performance accuracy. If the instrument fails any of the following tests, refer service to qualified service personnel.

3-46. Preliminary Procedure.

3-47. Before connecting power to the 339A, perform the following:

a. Be certain that the rear panel VOLTAGE SELECTOR switches are set to correspond to the available power line voltage and that the proper fuse is installed.

b. Connect power to the 339A and turn the LINE switch ON.

c. Set the FILTER switches off (out).

d. Set the METER RESPONSE switch to NORMAL.

3-48. OSCILLATOR.

3-49. This procedure checks the output level of the 339A oscillator for all frequency settings. Frequency accuracy is not checked. To check the oscillator proceed as follows:

a. Set the FUNCTION switch to OSCillator LEVEL.

b. Set the INPUT RANGE control to the 10 volt range.

c. Set the FREQUENCY controls fully counterclockwise.

d. Set the OSCILLATOR LEVEL control and level vernier fully clockwise. The meter should indicate more than 6 volts.

e. Set the level vernier fully counterclockwise. The meter should indicate less than 2 volts.

f. Set the INPUT RANGE control to the +10 dBm range and adjust the level vernier for a 0 dBm meter indication (blue scale).

g. While observing the meter, set the FREQUENCY controls to each dial position. (Allow time for the meter reading to stabilize at each setting.) The meter indication should not vary more than 0.6 dBm from the original setting.

h. Set the FREQUENCY controls for a frequency of 1 kHz.

i. Adjust the level vernier for a meter indication 0 dBm.

j. Simultaneously down-range the OSCILLATOR LEVEL and INPUT RANGE controls to the next lower range. The meter should indicate 0 dBm.

k. Repeat Steps i and j for each position of the OSCILLATOR LEVEL control.

3-50. AC VOLTMETER.

3-51. The following procedure checks the ac voltmeter functions and ranges. Perform the following steps:

a. Set the FILTER switches off (out), the METER RESPONSE switch to NORMAL, and the INPUT/GND SELECT switch to the center position. (DIStortion ANalyzer with input low connected to chassis ground.)

b. Set the FUNCTION switch to INPUT LEVEL.

c. Set the INPUT RANGE control to the 10 volt range.

d. Set the FREQUENCY controls for a frequency of 1 kHz.

e. Set the OSCILLATOR LEVEL control to the 3 volt range.

f. Connect a cable from the OSCILLATOR OUTPUT terminals to the DISTORTION ANALYZER input terminals.

g. Adjust the OSCILLATOR LEVEL vernier for a meter indication of 6 volts.

h. While observing the meter, set the INPUT RANGE control to the 30, 100, and 300 volts ranges. The meter should indicate 6 volts on the respective ranges. The left hand INPUT RANGE indicator light should be lit on all three ranges.

i. Set the INPUT RANGE switch to the 3 volt range. Observe that the right hand INPUT RANGE indicator is lit.

j. Down-range the OSCILLATOR LEVEL control to the next lower range and adjust the level vernier for a meter indication -10 dB V.

k. Down-range the INPUT RANGE control to the next lower range. The meter should indicate 0 dB V ± .2 dB V.

l. Repeat Steps j and k until all input ranges except the .001 V range have been checked.

m. Set the INPUT RANGE control to the 10 volt range and the OSCILLATOR LEVEL control to the 3 volt range.

n. Adjust the level vernier for a meter indication of -12 dB V.

o. Set the FUNCTION switch to the RELATIVE LEVEL position.

p. Vary the RELATIVE ADJUST control to verify an adjustment range of greater-than 10 dB V.

3-52. Distortion Analyzer.

3-53. The following procedure checks the distortion analyzer ranges and distortion measurement capability. Perform the following steps:

a. Set the FILTER switches off (out), the METER RESPONSE switch to NORMAL, and the INPUT/GND SELECT switch to the center position (DIStortion ANalyzer with input low connected to chassis ground).

b. Set the DISTORTION RANGE control to 0 dB.

c. Set the INPUT RANGE control to the 1 volt range.

d. Set the FREQUENCY controls to a frequency of 1 kHz.

e. Set the OSCILLATOR LEVEL control to the 3 volt range.

f. Connect a cable between the OSCILLATOR OUTPUT terminals and the DISTORTION ANALYZER input terminals.

g. Set the FUNCTION switch to the DISTORTION position.

h. Adjust the OSCILLATOR LEVEL vernier for a meter indication of -15 dB V.

i. Down-range the DISTORTION RANGE control to the next lower range. The meter should indicate approximately -5 dB V.

j. Repeat Steps h and i until all distortion ranges have been checked.

3-54. Filters.

3-55. The following procedure checks the "roll-off" of the filters.

a. Set the FUNCTION switch to OSCILLATOR LEVEL.

b. Set the INPUT RANGE control to the 3 volt range.

c. Set the OSCILLATOR LEVEL control to the 3 volt range and adjust the level vernier for a meter indication of 0 dB V.

d. Set the FREQUENCY controls for a frequency of 400 Hz.

e. Set the 400 Hz FILTER switch on (in). The meter should indicate -3 dB V ± 1 dB. Return the filter switch to off (out).

f. Set the FREQUENCY controls for a frequency of 30 kHz. Readjust the level vernier for a meter indication 0 dB V if necessary.

g. Set the 30 kHz filter switch on (in). The meter

should indicate -3 dB V ± 2 dB. Return the filter switch to off (out).

h. Set the FREQUENCY controls for a frequency of 80 kHz. Readjust the level vernier for a meter indication of 0 dB V if necessary.

i. Set the 80 kHz filter switch on (in). The meter should indicate -3 dB V ± 2 dB. Return the filter switch to off (out).

3-56. OPERATOR'S MAINTENANCE.

3-57. Fuse Replacement.

3-58. The ac line fuse is located on the rear panel of the instrument. Before checking or replacing the fuse, disconnect the ac line cord from the instrument. The fuse used in the Model 339A is a 250 mA, normal-blow fuse.

WARNING

For continued protection against fire hazard, replace only with the same type and rating of fuse as specified for the line voltage being used.

3-59. Adjustment of Meter Mechanical Zero.

3-60. The meter is properly zero-set when the pointer rests over the zero calibration mark with the instrument in its normal operating environment and turned off. Zero-set the meter as follows to obtain maximum accuracy and mechanical stability:

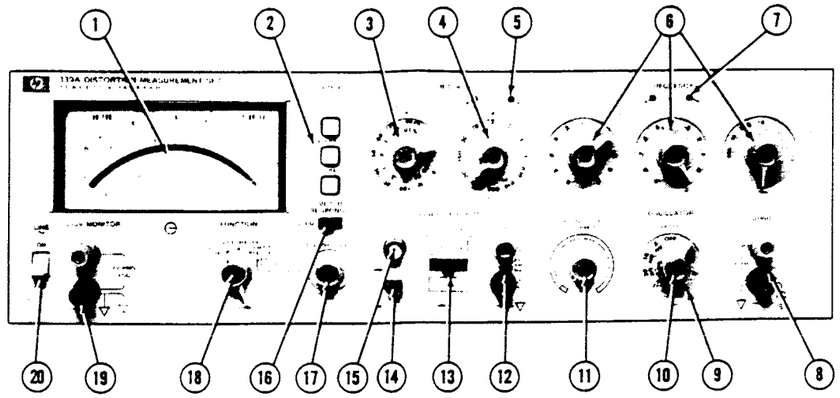
a. Turn instrument on and alow it to operate for at least 20 minutes to let meter movement reach normal operating temperature.

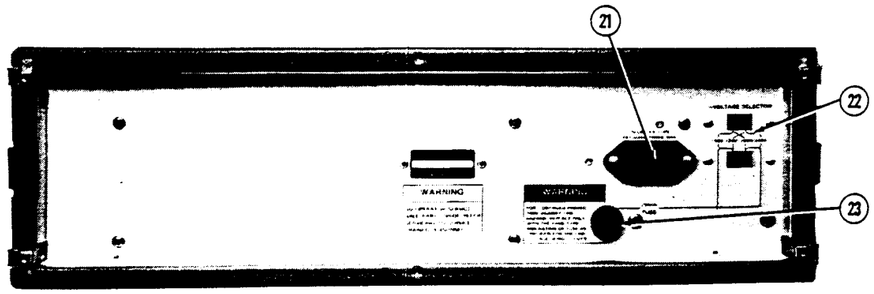
b. Turn instrument off and allow 30 seconds for all capacitors to discharge.

c. Rotate zero adjustment screw clockwise until pointer is left of zero and moving upscale.

d. Continue rotating screw clockwise; stop when pointer is exactly at zero.

e. When pointer is exactly over zero, rotate adjustment screw slightly counterclockwise to relieve tension on pointer suspension. If pointer moves off zero, repeat Steps c through e, but make counterclockwise rotation less.





1. Meter indicates voltage level, distortion in dB or percent, or VU (volume units) in dB.

2. Filters permit the user to eliminate unwanted frequencies and noise from the measurement. The filters include a 400 Hz high-pass filter which is normally used to reject power-line related noise, a 30 kHz low-pass filter for use in making "proof of performance" measurements at AM broadcast stations, and an 80 kHz low-pass filter to eliminate high frequency noise.

3. DISTORTION RANGE control selects the gain of the distortion measurement circuits to the proper sensitivity for measuring the applied signal.

4. INPUT RANGE control sets the input range of the distortion and meter circuits to the proper sensitivity for measuring the applied signal.

5. Input Range indicators indicate the direction the INPUT RANGE control must be turned to select the correct range for the signal applied.

6. FREQUENCY controls determine the fundamental rejection frequency of the analyzer and the output frequency of the oscillator.

7. Frequency indicators indicate the direction the FREQUENCY controls must be turned to bring the analyzer circuits within "pull-in range" of the fundamental frequency of the applied signal. This applies only when using an external signal source.

8. OSCILLATOR OUTPUT terminals. Output impedance is 600 Ω.

9. OSCILLATOR LEVEL control changes the output level in 10 dB V steps from 3 mV rms to 3 V rms into 600 Ω. The LEVEL control also includes an OFF position which disconnects the oscillator output and terminates the output terminals with a 600 Ω resistive load.

10. Oscillator LEVEL Vernier permits the output level to be varied below the level selected by the LEVEL control. This makes the oscillator output level continuously variable from less than 1 mV to greater-than 3 rms into 600 Ω.

11. OSCILLATOR FREQUENCY VERNIER. Frequency range of the vernier permits the oscillator output frequency to be increased above the frequency selected by the FREQUENCY controls. Frequency range of the vernier is approximately equal to one step on the center frequency control.

12. DISTORTION ANALYZER (and voltmeter) terminals provide connection for analyzer and voltmeter inputs.

13. ANALYZER (and voltmeter) INPUT/GND SELECT switch selects DIStortion ANalyzer input with either circuit or chassis ground or AM DETECTOR input with chassis ground only.

14. AM DETECTOR input terminal provides connection for amplitude modulated RF signals.

15. Ground Terminal provides connection to 339A Chassis.

16. METER RESPONSE switch selects normal or VU (volume units) meter response.

17. RELATIVE ADJUST permits the user to set a convenient reference level on the meter when using the voltmeter RELative LEVEL FUNCTION.

18. FUNCTION control selects analyzer or voltmeter functions.

19. MONITOR terminals permit the signal applied to the meter circuitry to be monitored. The MONITOR output is 1 V rms for a full-scale meter deflection.

With an audio signal applied to the DISTORTION ANALYZER input the MONITOR output will be:

DISTORTION FUNCTION - Distortion products of the applied signal after the fundamental has been removed.

INPUT LEVEL - And RELative LEVEL FUNCTIONS. Scaled presentation of the applied signal.

With a modulated RF signal applied to the AM DETECTOR input the MONITOR output will provide:

DISTORTION FUNCTION - Scaled presentation of the demodulated input signal with the fundamental removed.

INPUT LEVEL and RELative LEVEL FUNCTIONS - Scaled presentation of the demodulated input signal.

The MONITOR terminals are disabled when using the OSCillator LEVEL FUNCTION.

20. LINE switch applies ac power to the instrument.

21. AC LINE connector provides connection for ac power.

22. AC VOLTAGE SELECTOR switches set the instrument to operate from 100 V, 120 V, 220 V, or 240 V ac power source.

23. FUSE protects the instrument circuits from excessive current.

Figure 3-1. Control, Connector and Indicator Descriptions.