

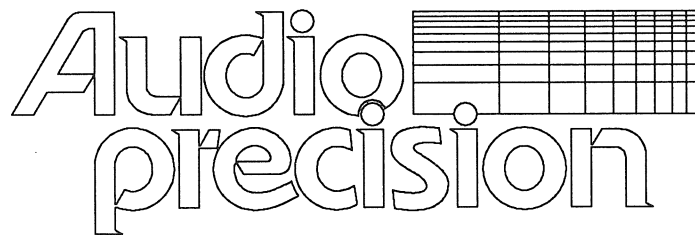
# Audio precision

## ATS-1 AUDIO TEST SYSTEM USER'S MANUAL



Issue 1  
Firmware Version 2.0  
May, 1993





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ISSUE 1, FIRMWARE VERSION 2.0

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# 1. SAFETY SUMMARY

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Please review the following safety information before operating:

All Audio Precision instruments are designed to be used with an approved three-conductor power cord and an ac (mains) power source with safety grounding. **NEVER** operate this instrument if the safety ground connection is unavailable or has been compromised.

For continued fire hazard protection, the main power fuse must be replaced only with one having the correct rating (see the "Changing Line Voltage Selection" section of the SET-UP AND CHECK-OUT chapter).

There are no operator serviceable parts inside this instrument. **DO NOT** attempt to service unless properly qualified.



## 2. INTRODUCTION

Audio Precision's ATS-1 is a comprehensive two-channel audio test set. It includes the measurement functions of level (two channels simultaneously), noise and signal-to-noise ratio (wideband, weighted, or selective), THD+N (total harmonic distortion plus noise), SINAD (ratio of {signal + noise + distortion} to {noise + distortion}), phase (interchannel or input-to-output phase shift through a device), SMPTE/DIN intermodulation distortion (option), real-time two-channel amplitude ratio (interchannel balance or device gain/loss), wow and flutter, real-time frequency-selective crosstalk, ac mains check (voltage, frequency, and distortion of the ac power line), and ac resistance of the input of the device connected to the generator output.

The ATS-1 may be operated manually from the front panels, or may be programmed via the IEEE-488 computer port. This User's Manual describes manual operation. See the companion Programmer's Manual for complete documentation on controlling the ATS-1 via IEEE-488.

Generally, three measurements are simultaneously displayed in PANELS mode. The ATS-1 can also sweep across any specified frequency range and display measurements in graphic form on the LCD

display. Graph top and bottom values may be user-set as desired, and may be changed after a sweep with the data dynamically re-scaling. A graphic cursor provides numeric readout of any point on the graph. High-resolution graphs, fast screen dumps, tabular data from a sweep or from self test, bar-graphs, and panels may all be printed to an attached Epson-compatible parallel-connected printer.

The ATS-1 is self-contained, requiring no external computer to operate. All measurements are displayed on a fluorescent back-lighted LCD (liquid crystal display). Signals within the audible range may be audibly monitored via the built-in loud-speaker or headphones. Amplitude and level measurements may be displayed in user-selectable units from the list of Volts, dBm (user-specified impedance reference), dBu, dBV, dBr (dB relative to a stored measured value), dBg (dB relative to the present generator output amplitude), and Watts (user-specified impedance reference). Distortion may be expressed in % or dB, and the absolute value of THD+N may further be displayed in most of the amplitude units listed above. Units selected are remembered for each measurement function and will be automatically displayed when that function is next selected.

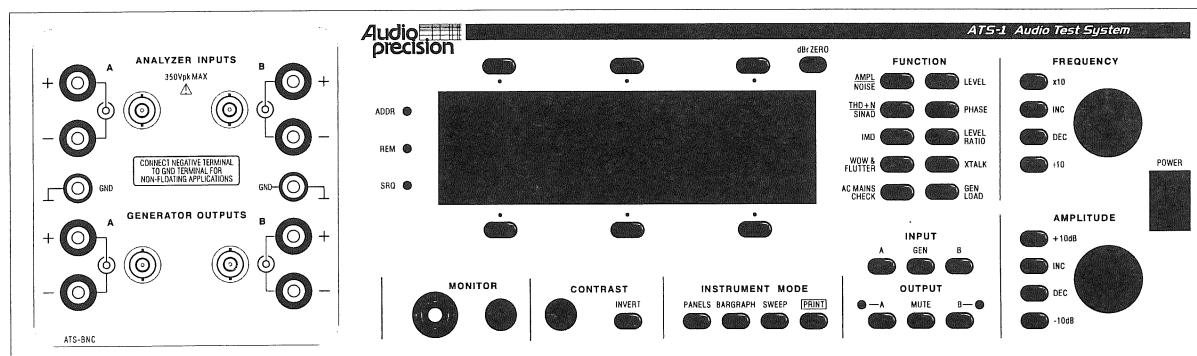


Figure 2-1 ATS-1 Front Panel

Signal generation capability includes low-distortion sine and square waveforms plus an intermodulation test signal if the intermodulation distortion option is present.

The ATS-1 includes standard 22 Hz-22 kHz audio bandpass, 400 Hz highpass, 30 kHz and 80 kHz lowpass, tunable 1/3 octave bandpass, A-weighting, and CCIR weighting filters plus sockets for two optional filters. Filters selected in each measurement function are remembered and automatically selected again when that function is next selected.

An IEEE-488 port provides computer control over all settings and functions. Two IEEE-488 command sets are available. One complies with the latest IEEE-488.2 standards; the other emulates the command set of the Hewlett-Packard 8903A and 8903B instruments.



# 3. SET-UP, CHECK-OUT, AND CHANGING CONFIGURATIONS

## 3.1. Changing Line Voltage Selection

The power (ac mains) receptacle and voltage-change and fuse block are located on the rear of the instrument. Check to see that the line voltage is correctly set for the voltage in use in your area. The voltage setting can be read on the small circuit board visible in the fuse/voltage change block. If the indicator is not at the correct setting for your area, slide the plastic cover aside and remove the fuse. Remove the circuit board with pliers. Rotate and invert the circuit board as necessary to make the desired voltage readable when the board is re-inserted. Re-insert the board. If the operating voltage was changed from one of the 100/120 Volt ranges to one of the 220/240 Volt ranges, replace the fuse with the proper value as shown in the table below and on the rear of the ATS-1. Replace the plastic cover, connect a power cable and turn the unit on.

Voltage	Fuse
100/120V	0.5A, 250V, 3AG
220/240V	0.25A, 250V, 3AG

## 3.2. Functional Self Test

At any time, you may initiate a functional self-test of the ATS-1. Preferably, this self test should only be run when internal temperatures have stabilized after a warm-up period. The functional self test mode is entered through the AC MAINS CHECK function (see Figure 3-3). In this function, the lower left corner of the display in PANELS mode shows SELF TEST. Pressing the lower left soft button enters self test mode. Figure 3-4 shows the self-test screen before the actual test sequence has been initiated. Note the instruction to remove any cable connections from the generator outputs; a voltage of 26 Volts will be present at these connectors during portions of the self test which could dam-

age external devices. Furthermore, noise or nonlinearities in the input circuitry of an external device could cause self test to fail limits.

After removing any cables connected to the generator, press either the lower left soft key now labeled START or (if an Epson-compatible printer is connected to the rear-panel printer port) the lower center soft key labeled PRINT. In either case, the system will go into an automatic sequence of functional checks, with each measurement being internally compared to specifications; see Figure 3-5 for an example. If a printer is connected and the self test was started with the center PRINT key, the test results including test number, description, upper and lower limits, measured result, and a PASS or FAIL statement will print for each step. The step number and name of the test are displayed across the center of the display. The self test may be interrupted by pressing any button except INVERT. If any limit is exceeded, the test will display the out-of-spec reading and pause until the CONTINUE button is pressed; see Figure 3-6 for an example failure display. At the end of the series of tests, a final screen will display with a passed indication if all steps of all tests passed. A failed indication results if any one or more steps failed. See Figure 3-7 for an example of the "passed" condition. To exit from self test mode, press the QUIT button.

The self test sequence is as follows:

### Generator Frequency Accuracy

- 1.0 Generator Frequency 100 Hz
- 1.1 Generator Frequency 1 kHz
- 1.2 Generator Frequency 10 kHz
- 1.3 Generator Frequency 100 kHz

### Amplitude Accuracy

- 2.0 Generator Amplitude 26.0 V
- 2.1 Generator Amplitude 15.0 V
- 2.2 Generator Amplitude 5.0 V
- 2.3 Generator Amplitude 2.0 V

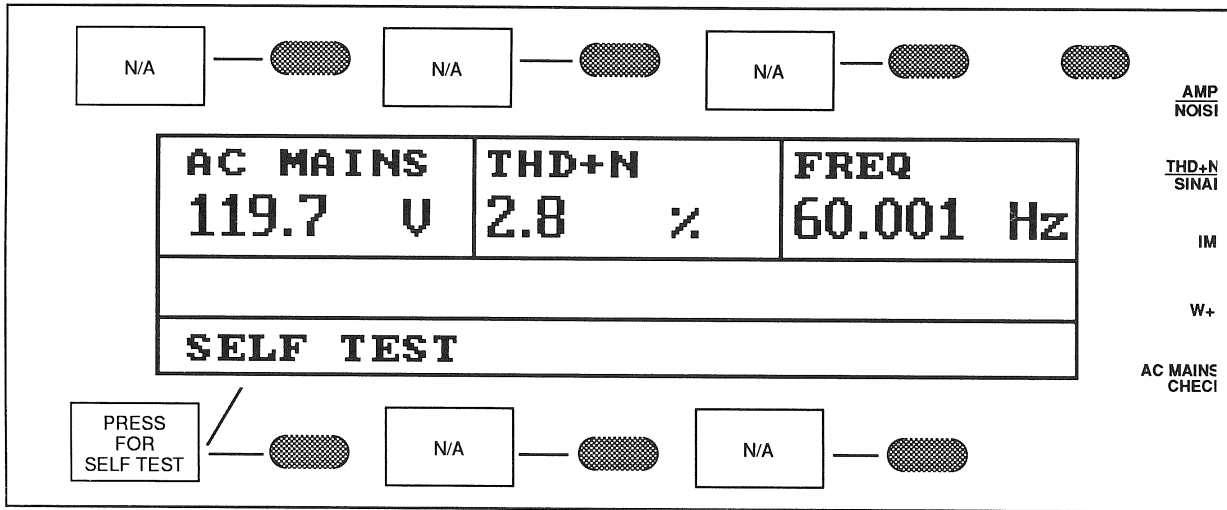


Figure 3-2 Typical Display, AC MAINS CHECK Function

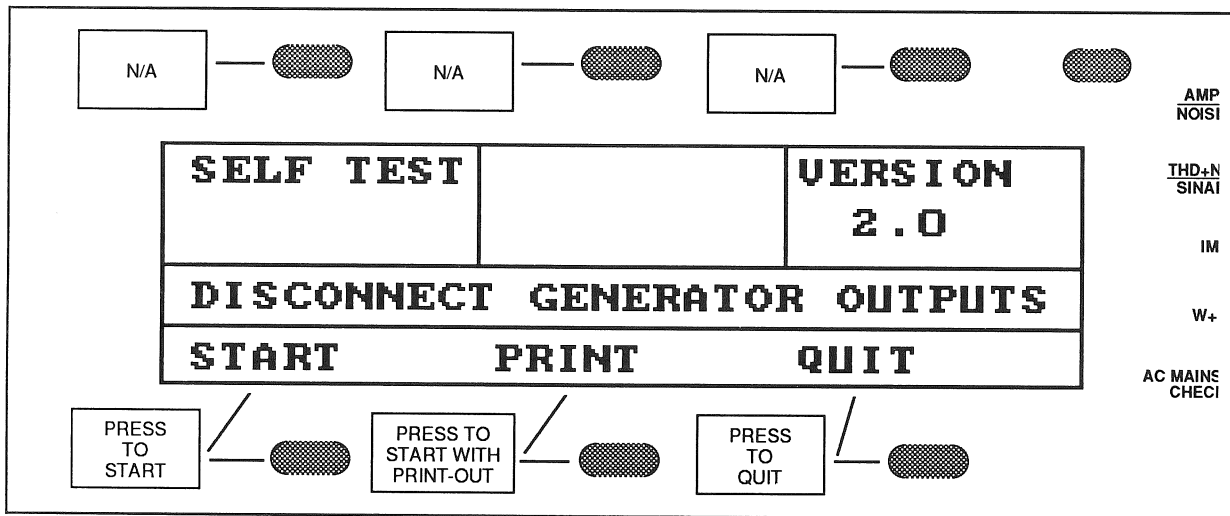


Figure 3-3 Typical Display, Self Test Function Before Starting Self Test

2.3	Generator Amplitude	2.0 V
2.4	Generator Amplitude	1.5 V
2.5	Generator Amplitude	0.5 V
2.6	Generator Amplitude	0.2 V
2.7	Generator Amplitude	150 mV
2.8	Generator Amplitude	50 mV
2.9	Generator Amplitude	10 mV

**System Flatness (Both Channels)**

3.0	10 Hz
3.1	20 Hz
3.2	20 kHz
3.3	50 kHz
3.4	100 kHz
3.5	120 kHz
3.6	Input Atten Compensation @ 20 kHz
3.7	Gen Squarewave signal
3.8	Gen IMD signal (with IMD option only)

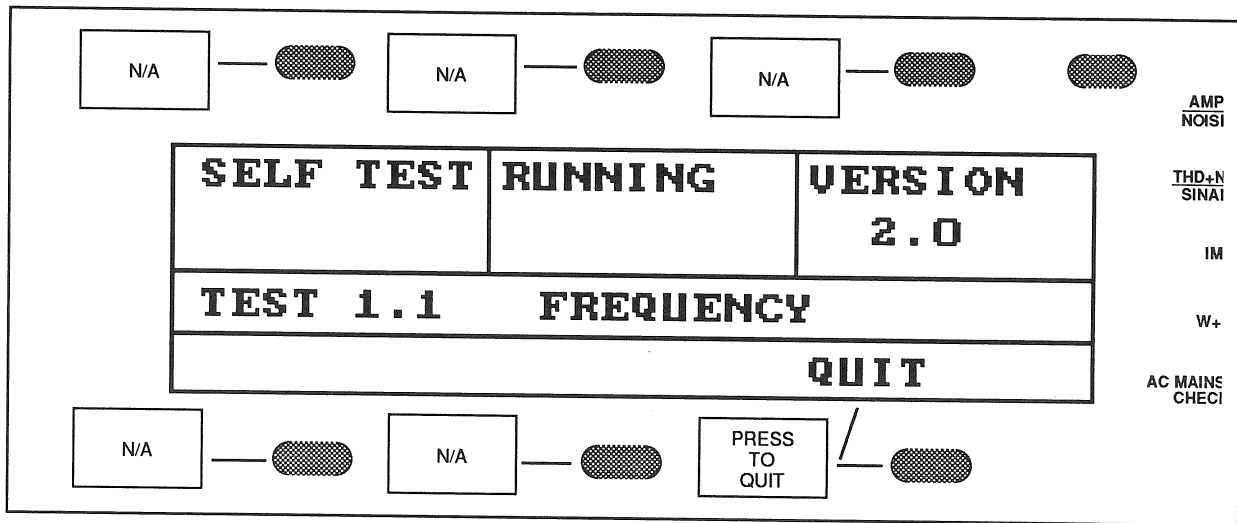


Figure 3-4 Typical Display, Self Test Function with Test Running

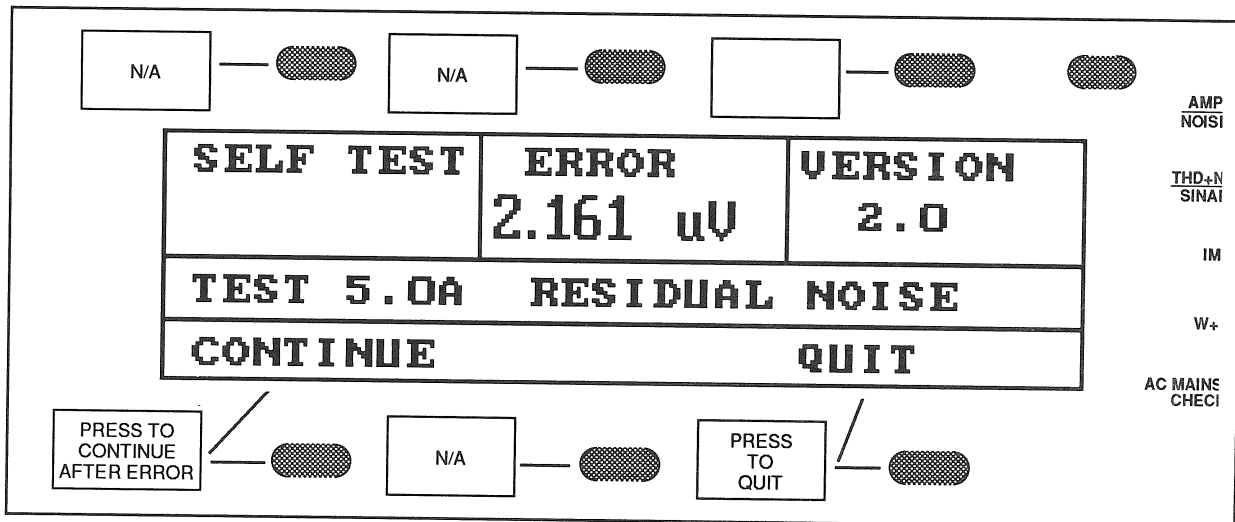


Figure 3-5 Typical Display, Self Test Mode Paused to Display Error

**Bandwidth Limiting Filter Response**

- 4.0 400 Hz HP
- 4.1 80 kHz LP
- 4.2 30 kHz LP
- 4.3 22 Hz-22 kHz BP @ 22.4 Hz
- 4.4 22 Hz-22 kHz BP @ 31.5 Hz
- 4.5 22 Hz-22 kHz BP @ 16 kHz
- 4.6 22 Hz-22 kHz BP @ 22.4 kHz
- 4.7 1 kHz SELECTIVE mode BP @ 1 kHz
- 4.8 1 kHz SELECTIVE mode BP @ 2 kHz

**Weighting Filter Response**

- 5.0 A-weighting @ 100 Hz
- 5.1 A-weighting @ 1 kHz
- 5.2 A-weighting @ 10 kHz
- 5.3 CCIR weighting @ 100 Hz
- 5.4 CCIR weighting @ 1 kHz
- 5.5 CCIR weighting @ 6.3 kHz
- 5.6 CCIR weighting @ 12.5 kHz
- 5.7 CCIR q-peak detector @ 1 kHz
- 5.8 CCIR-ARM detector @ 2 kHz

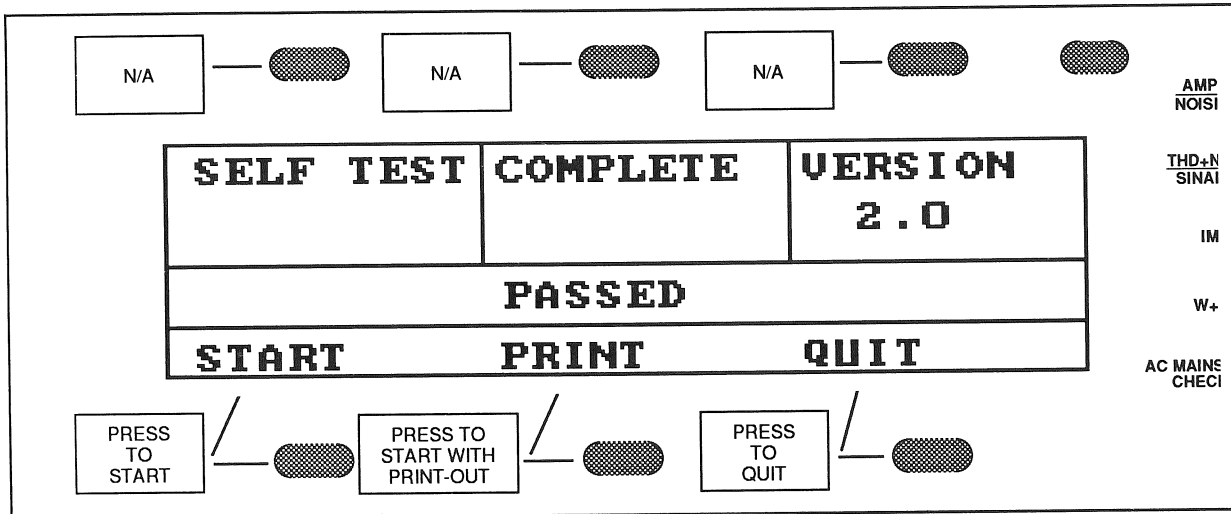


Figure 3-6 Typical Display, End of Self Test Where All Tests Passed

**Residual Distortion @ 2 Volts**

- 6.0 20 Hz THD+N, channel A
- 6.1 1 kHz THD+N, channel A
- 6.2 20 kHz THD+N, channel A
- 6.3 50 kHz THD+N, channel A
- 6.4 20 Hz THD+N, channel B
- 6.5 1 kHz THD+N, channel B
- 6.6 20 kHz THD+N, channel B
- 6.7 50 kHz THD+N, channel B
- 6.8 IMD (with IMD option only)

**Residual Noise, 22 Hz-22 kHz BW**

- 7.0 Chan A
- 7.1 Chan B

**Phase**

- 8.0 20 Hz
- 8.1 1 kHz
- 8.2 20 kHz

**Wow & Flutter**

- 9.0 1.0%

**3.3. Changing Configurations**

*NOTE: Refer all servicing to qualified personnel.*

**3.3.1. Changing Between Rack Mount and Benchtop Configurations**

**3.3.1.1. Installation of Rack Mount Hardware**

Note: Conversion from bench top to rack mount configuration does not require the removal of the covers.

1. Remove the handle, handle brackets, bracket spacers (2) and the trim panel from the right side of the instrument (see Figure 3-7).
2. Remove the trim panel and the four adhesive-backed feet from the left side of the instrument.
3. Remove the four feet and bail from the bottom of the instrument.
4. Align the rack mount spacer to the right side of the instrument. (The spacer fits into the recess formed by the the covers. Three holes in the spacer align with three matching holes in the chassis; see Figure 3-8. Do not insert screws at this time).

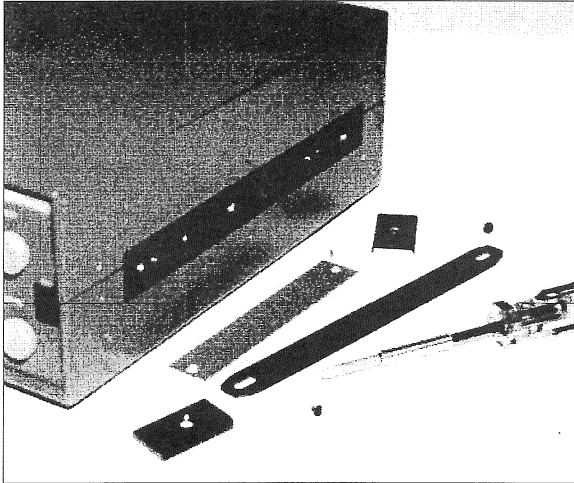


Figure 3-7 Handle Parts After Removal

### 3.3.1.2. For Fixed Rack Mount

5F. Align the right hand rack handle (a painted, formed steel plate 16 inches long) over the spacer mentioned in step 4. The spacer is now sandwiched between the instrument chassis and the rack handle. See 3-9.

6F. Fasten the rack handle and spacer to the chassis with three #10-32 screws.

7F. Repeat steps 4, 5F and 6F on the left side of the instrument.

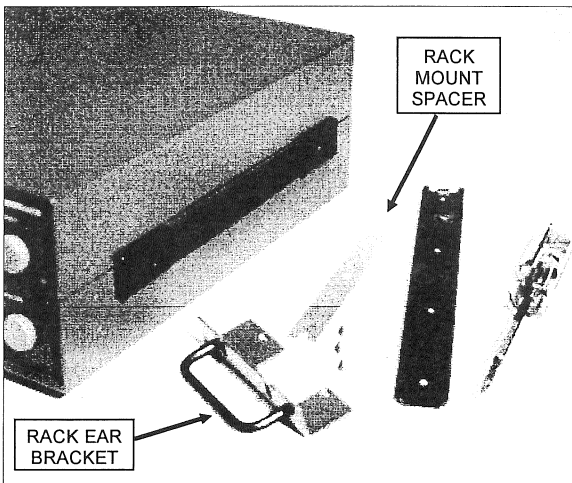


Figure 3-8 Slide Rack Mounting Kit, Right End

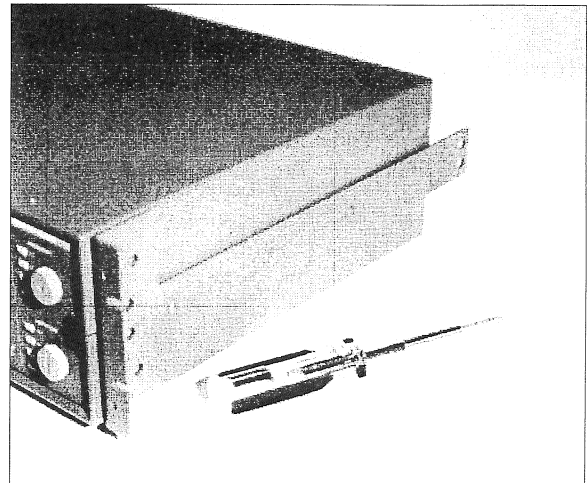


Figure 3-9 Fixed Rack Mounting Hardware in Place

### 3.3.1.3. For Slide Track Rack Mount

The slide rack mount capability is compatible with the Chassis Trak<sup>®</sup> Model C-300-S-114 (14" rack depths), C-300-S-116 (16"), and C-300-S-118 (18") rack mounts available from General Devices, Inc. Note that the top and bottom covers may be removed from a slide rack-mounted ATS-1 without removing the unit from the rack or slides.

5S. Remove the eight #6-32 flat head screws securing the top and bottom covers to the front end of the chassis. There are two screws on the right and left side on each of the top and bottom covers, near the front four corners of the case (see figure 3-10).

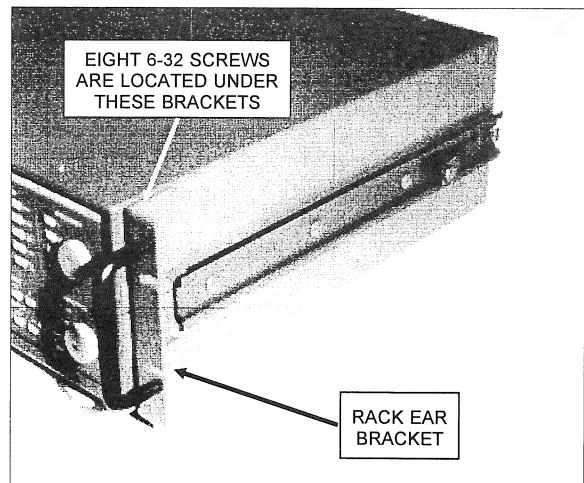


Figure 3-10 Slide Rack Mounting Hardware in Place

6S. Align and secure (with three #10-32 screws) the fixed portion of the Chassis Trak rack mount kit to the chassis, sandwiching the spacer between. See Figure 3-10.

7S. Note that the right-hand and left-hand rack ear brackets are not identical. The cut-out portion of the proper rack ear bracket clears the fixed slide mounted in the previous step. Secure the right-hand rack ear bracket (See Figure 3-10) with the two #6-32 flat head screws.

8S. Align the spacer as outlined in step 4.

9S. Repeat steps 6S, 7S and 8S on the left side.

### 3.3.2. Opening the ATS-1 Case

1. Remove four screws from the right side, four screws from the left side, and six screws from the top or bottom of the cover (14 screws total).

2. Lift the cover directly off the instrument.

### 3.3.3. Changing to Alternate Connector Panels

The ATS-1 may be factory-configured with any of five connector audio styles; floating BNC, XLR (Cannon), WE310 tip-ring-sleeve, 1/4" stereo tip-ring-sleeve, and Siemens. To later change to another connector panel with a different connector configuration:

1. Remove the top and bottom covers as described earlier.

2. Disconnect two cable(s) from the analyzer input connectors on the panel to the analyzer circuit board on the top side of the chassis. Clip cable ties as necessary to free these cables.

3. Disconnect two cable(s) from the generator output connectors on the panel to the generator circuit board on the bottom side of the chassis. Clip cable ties as necessary to free these cables.

4. Remove the four #6-32 nuts which secure the connector panel to the chassis.

9. Mount the new cable connector panel using four #6-32 nuts.

10. Connect the generator output channel A cable to the generator A channel connector on the bottom circuit board. The wire with white insulation must go to the pin marked + on the circuit board.

11. Connect the generator output channel B cable to the generator B channel connector on the bottom circuit board. The wire with white insulation must go to the pin marked + on the circuit board.

12. Connect the analyzer input channel A cable to the analyzer A channel connector on the top circuit board. The wire with white insulation must go to the pin marked + on the circuit board.

13. Connect the analyzer input channel B cable to the analyzer B channel connector on the top circuit board. The wire with white insulation must go to the pin marked + on the circuit board.

14. Loop and dress the excess cable length neatly near the edge of the circuit board and secure them to the chassis with cable ties.

15. Replace the top and bottom covers.

Test the new configuration by connecting A output to A input and B output to B input with external cables which do not have a polarity inversion (conductors transposed) between the two ends. Select LEVEL function with PHASE displayed in the upper right display. With both generator outputs on and a 1 kHz 1 Volt signal, the measured voltages should agree within the instrument specification and the phase should read nearly zero degrees for all four possible input configuration selections; A-B, A-G, B-1, and B-G.

### 3.3.4. Swapping Connector Panel and Loudspeaker Between Front and Rear

The ATS-1 is shipped with the monitor loudspeaker installed on the rear panel and the input/output connector panel installed on the front. It is sometimes more desirable, especially in rack-

mounted production test systems, to have the input/output connectors at the rear. To interchange the loudspeaker and connector panels, perform the following steps:

1. Remove the top and bottom covers as described earlier.
2. Disconnect two cable(s) from the analyzer input connectors on the panel to the analyzer circuit board on the top side of the chassis. Clip cable ties as necessary to free these cables.
3. Disconnect two cable(s) from the generator output connectors on the panel to the generator circuit board on the bottom side of the chassis. Clip cable ties as necessary to free these cables.
4. Remove the four #6-32 nuts which secure the connector panel to the chassis.
5. Disconnect the cable from the loudspeaker to the circuit board connector on the bottom side of the chassis at the *rear* edge of the circuit board.
6. Remove the four #6-32 nuts which secure the loudspeaker panel to the chassis. Remove the loudspeaker panel.
7. Mount the loudspeaker panel to the front panel with four #6-32 nuts.
8. Connect the loudspeaker cable to the alternative two-pin circuit board connector on the bottom side of the chassis at the *front* edge of the circuit board.
9. Mount the cable connector panel to the rear of the chassis using four #6-32 nuts.
10. Connect the generator output channel A cable to the generator A channel connector on the bottom circuit board. The wire with white insulation must go to the pin marked + on the circuit board.
11. Connect the generator output channel B cable to the generator B channel connector on the bottom circuit board. The wire with white insulation must go to the pin marked + on the circuit board.

12. Connect the analyzer input channel A cable to the analyzer A channel connector on the top circuit board. The wire with white insulation must go to the pin marked + on the circuit board.

13. Connect the analyzer input channel B cable to the analyzer B channel connector on the top circuit board. The wire with white insulation must go to the pin marked + on the circuit board.

14. Dress the cables neatly at the edge of the chassis and secure them with cable ties.

15. Replace the top and bottom covers.

Test the new configuration by connecting A output to A input and B output to B input with external cables which do not have a polarity inversion (conductors transposed) between the two ends. Select LEVEL function with PHASE displayed in the upper right display. With both generator outputs on and a 1 kHz 1 Volt signal, the measured voltages should agree within the instrument specification and the phase should read nearly zero degrees for all four possible input configuration selections; A-B, A-G, B-1, and B-G.

### 3.3.5. Option Filter Installation

If your ATS-1 was ordered with optional filters, they will have been installed in the FILTER 1 or FILTER 2 sockets at the factory and documentation will have provided with the instrument to indicate

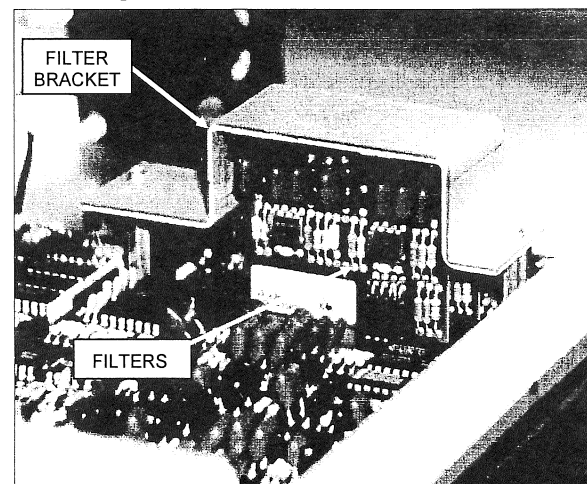


Figure 3-11 Filters and Filter Hold-Down Bracket

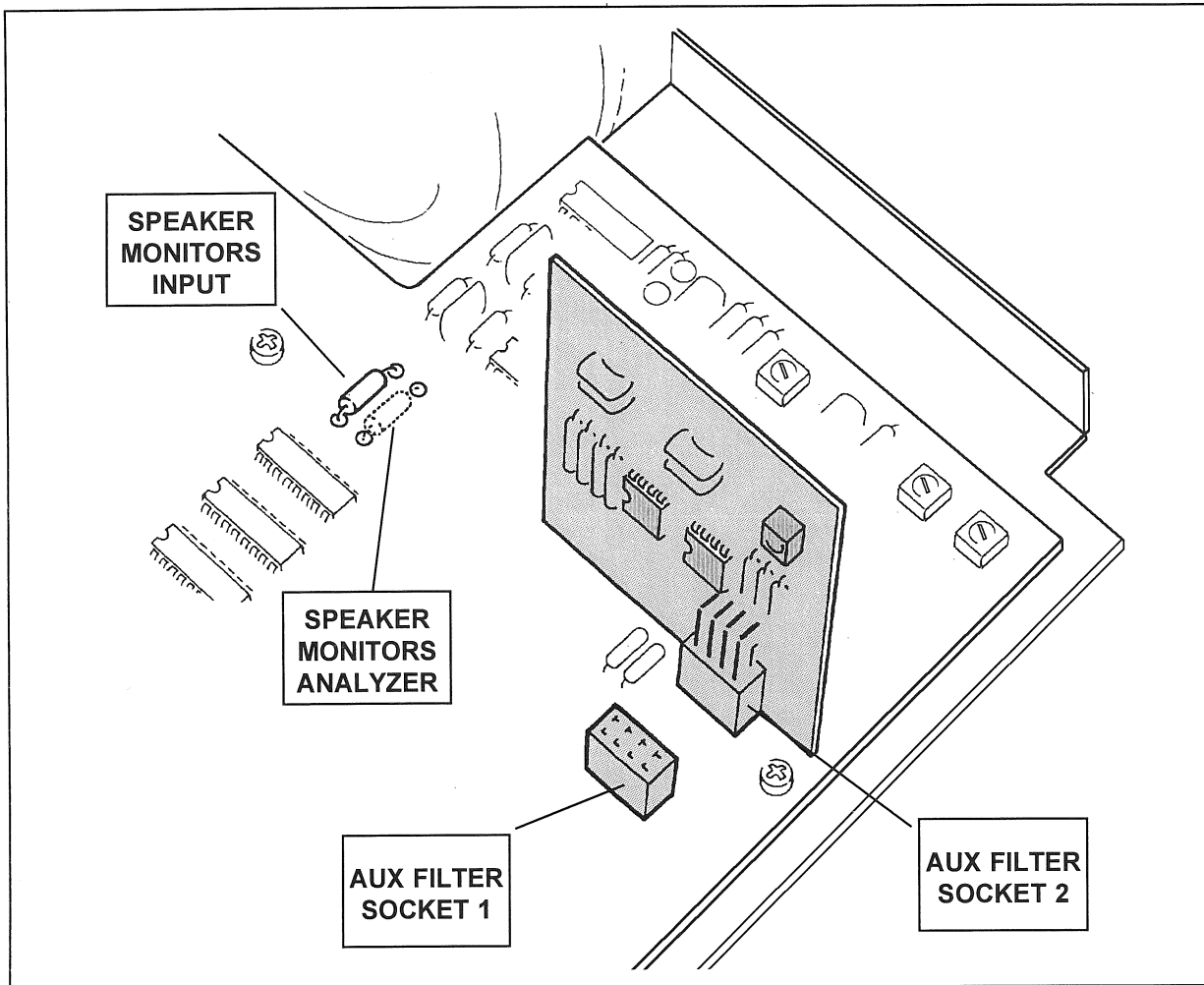


Figure 3-12 Auxiliary Filter Socket Locations and Monitor Loudspeaker Jumper Locations

what filter is in which socket. If you purchase option filters later to install yourself, the installation process is as follows:

1. Remove the top cover as described earlier.
2. The two sockets for option filters are located near the right rear of the main analyzer circuit board (see Figure 3-12). They are clearly labeled FILTER1 and FILTER2 on the circuit board. Remove the two screws which secure the filter hold-down bracket, and remove the hold-down bracket. See Figure 3-11.
3. Plug the filter(s) into whichever socket is desired. Replace the filter hold-down bracket and fasten it with the two screws.
4. Replace the top cover.
5. Re-connect power to the unit and turn it on. Select AMPLITUDE function, INPUT A GEN, and use PANELS mode with analyzer setup parameters displayed to select the newly-installed filter(s). Verify their correct function by measuring their frequency response.



5. Re-connect power to the unit and turn it on. Select AMPLITUDE function, INPUT A GEN, and use PANELS mode with analyzer setup parameters displayed to select the newly-installed filter(s). Verify their correct function by measuring their frequency response.

### 3.3.6. Monitor Loudspeaker Signal

You may wish to change the location of an internal jumper which controls whether the built-in loudspeaker monitors the input signal (normal factory-shipped setting) or the “analyzer” signal, following all filters (same as rear panel ANALYZER BNC connector). As shipped from the factory, the built-in monitor loudspeaker or headphone jack normally monitors the selected analyzer input signal, following input autoranging but before all filtering. For some applications, it may be more desirable to monitor the “ANALYZER” signal. This is the final processed signal in the instrument, following the bandreject or bandpass filter and any high-pass, low-pass, weighting, or optional filters selected (see the instrument block diagram in the DIAGRAMS chapter). To change the monitor signal:

1. Remove the top cover as described above.
2. Unsolder and remove the internal jumper shown in Figure 3-12 from its factory-installed position and re-install it in the alternate location as shown in the drawing.
3. Replace the top cover.



## 4. A QUICK INTRODUCTION TO OPERATION OF THE ATS-1

Basic operation of the ATS-1 is simple; press a function button and read the display. NOISE function is obtained by pressing the AMPL/NOISE button a second time. Automatic signal-to-noise ratio mode is selected by choosing the dB unit (top left soft key) while in NOISE function. SINAD function is obtained by pressing the THD+N/SINAD button a second time.

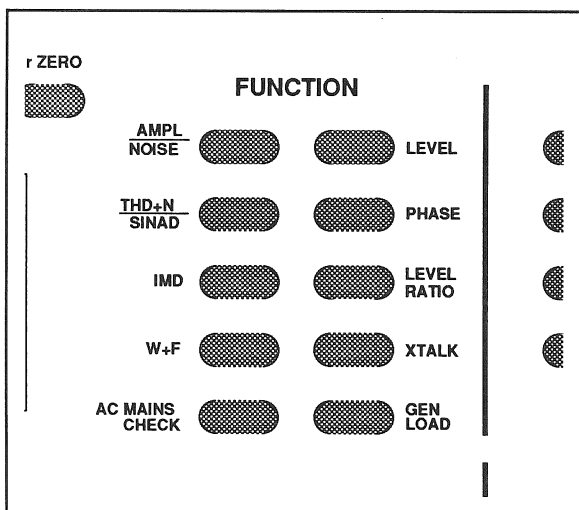


Figure 4-1 Measurement Function Keys; Press Twice for Second Function

The OUTPUT A and B buttons select which GENERATOR OUTPUT channel connectors will be driven, with the MUTE button turning off both

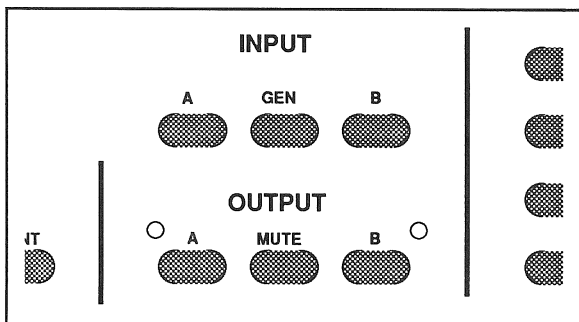


Figure 4-2 Input and Output Channel Selection Keys

channels simultaneously. The INPUT A and B buttons select which ANALYZER INPUT channel connector will be measured by the primary (wide dynamic range) voltmeter; the INPUT GEN button permits the signal at either generator output connector to be measured via internal cable.

The FREQUENCY and AMPLITUDE buttons and knobs normally control generator frequency and amplitude. The FREQUENCY controls also select the range for a sweep in sweep setup mode. Following a sweep, they scan a cursor through graphed data to provide numeric readout of any point. They also permit manually tuning the analyzer selective (1/3 octave) bandpass filter in manual selective analysis mode or the bandreject filter in THD+N or

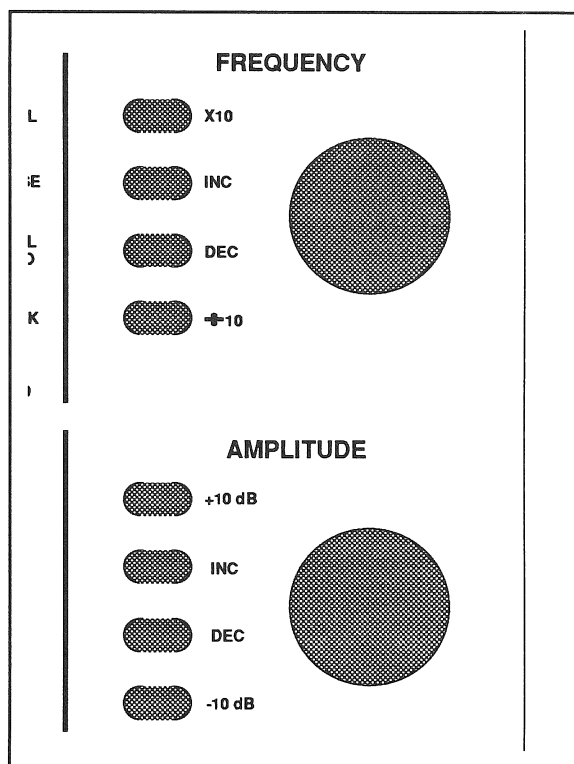


Figure 4-3 Frequency and Amplitude Control Section

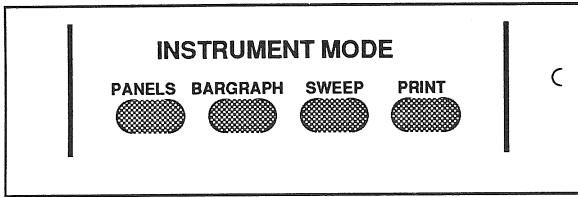


Figure 4-4 Instrument Mode Buttons Select Operational Mode, Display Format, Permit Setup, Cause Printout

SINAD FIX-TUNE mode. They permit setting an arbitrary FREQUENCY INC/DEC button step size from the screen obtained by pressing PANELS four times. The AMPLITUDE controls also permit setting the graph top and bottom points in sweep mode and end point calibration values of the bargraph in bargraph display mode when a soft button nearest the value to be changed has been pressed to highlight the value. With the set-up screen obtained by pressing PANELS four times, they can be used to enter an arbitrary amplitude step size for the AMPLITUDE INC/DEC buttons.

The INSTRUMENT MODE buttons control the type of operation, form of the display, give access to the generator and analyzer parameter selections, and permit printing display contents in several formats.

PANELS mode provides alpha-numeric display of one to three measurements and gives access to setup parameters in four formats as the button is successively pressed. When PANELS is first pressed, the major generator and analyzer settings are shown in addition to the measurements; major analyzer settings may be changed via the "soft" keys described below. Another press of the PANELS button provides display of generator settings only and permits changing them via soft keys. A third press of the PANELS button displays all analyzer settings and permits changing them. A fourth press of the PANELS button selects a screen which permits selecting the factory default values for the FREQUENCY and AMPLITUDE INC/DEC buttons, or entering user values for the step size produced by those buttons. This fourth PANEL also permits setting several IEEE-488 parameters including the instrument address and IEEE-488.2 command set versus H-P 8903B command set.

Six buttons, three above and three below the display, are "soft"; that is, they have different functions depending on the mode of the instrument.

All selected analyzer parameters (measurement units, filters, etc.) are independently remembered by the instrument for each function, and will be restored when that function is next selected. The "factory default" settings may be restored at any

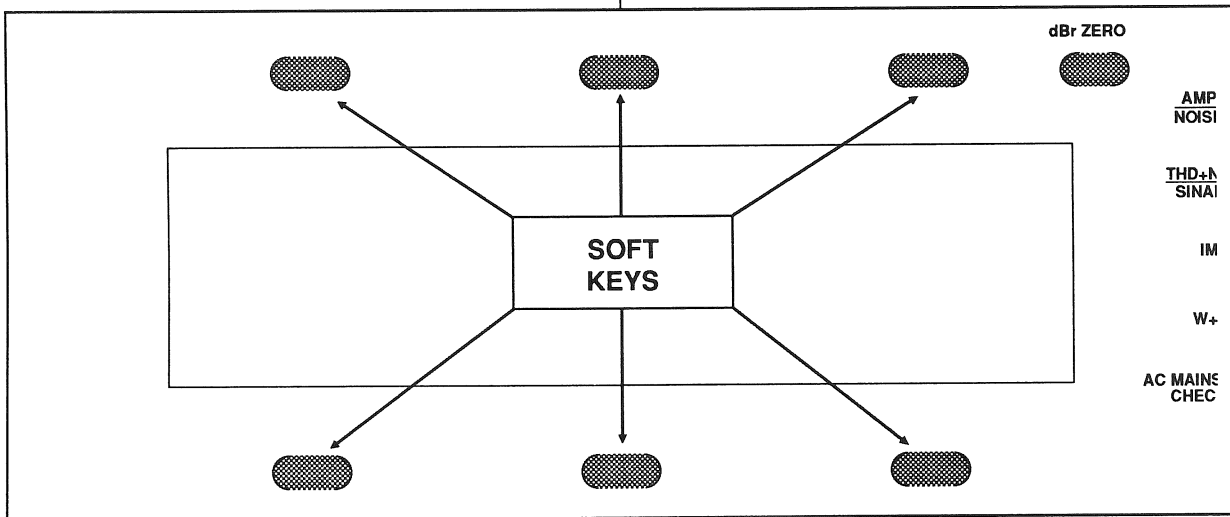


Figure 4-5 Soft Keys for Unit and Parameter Selection

time by turning off the ATS-1, then holding down the OUTPUT MUTE button while turning the power back on.

BARGRAPH mode displays the major measurement (both channels in LEVEL function) in analog fashion to simplify operations such as peaking, dipping, or observing trends. The bargraph display widens to indicate the maximum and minimum reading in addition to the present value.

SWEEP mode permits frequency sweeps across freely-selected ranges. Pressing the SWEEP button the first time selects sweep set-up mode. A second press of the SWEEP button initiates the test according to the presently-set values. A repeating sweep-erase cycle may be initiated by holding down the SWEEP button until the first measurement is displayed numerically at the left of the display. A sweep may be terminated by pressing the SWEEP button while a test is underway.

The SWEEP start and stop frequencies may be changed by selecting either value with the lower center and lower right soft keys, then using the FREQUENCY knob or buttons to set the desired value. Sweep resolution is selected by the upper center button, with choices of 3, 10, 30, 75, and 150 steps or 1/3 octave or EXTERNAL. Sweep speed may be selected from FAST, MEDIUM, and SLOW choices by the upper right button. FAST is appropriate for most electronic device testing. MEDIUM provides a dwell time of approximately 0.9 seconds at each frequency and is intended for testing devices with moderate time delay such as three-head tape recorders and satellite transmission links, or for creating test tapes or providing a source for a remote ATS-1. SLOW provides a dwell time of at least three seconds at each frequency so that a distant ATS-1 in EXTERNAL sweep mode has time to tune its selective filter to the incoming frequency. EXTERNAL is used for the analyzer to track signals such as test CDs, reference tapes, or a swept signal from a distant oscillator. GLIDE or STEP may be selected by the upper right soft key in EXTERNAL SWEEP mode, to match a continuously-changing "glide tone" or a series of fixed frequency steps. The generator does not sweep in EXTERNAL mode. The graph top and bottom values may be freely set by select-

ing either (or both) with the upper left or lower left soft keys, then using the AMPLITUDE buttons or knob to set a new value.

In all modes other than SWEEP, pressing the PRINT button causes the present display contents to be dumped to an attached Epson-compatible printer, along with major settings such as generator amplitude and filter selections. In SWEEP mode, pressing the PRINT button produces a print menu to allow selection of a high-resolution graphic printout (GRAPH), a fast screen dump (SCREEN), or tabular printout (TABLE), and to send individual line feeds or a form feed command to the printer with the LF/FF key. In SWEEP mode, pressing PRINT twice produces both the high resolution graphic and tabular printout.

To increase useful lifetime of the fluorescent backlighting of the LCD panel, the backlighting is automatically turned off whenever two hours pass without any button being pressed. The screen may be brought back to life by pressing any button.



## 5. DETAILED OPERATIONAL DESCRIPTION

### 5.1. Screen Saver

To extend the useful lifetime of the fluorescent backlighting of the screen, the backlight is turned off whenever two hours pass without any button being pressed. To turn the backlight on again, press any button. The first press of any button when the the backlighting is off will not execute the function of that button. For applications where the two hour period is inconveniently short, an eight hour period may be selected by holding down the BARGRAPH key while simultaneously pressing the INVERT key. The display backlight then turns off to indicate successful selection of the eight hour mode, and must be turned back on by pressing any key. Turning power off and back on returns the default two hour period.

### 5.2. Output Controls

The A and B OUTPUT buttons control the generator A and B output connectors. Both buttons have a "toggle" function; press to turn the specified channel ON, press again to turn OFF. For convenient noise and signal-to-noise ratio measurement, the generator output connectors are automatically reverse-terminated with the selected source resistance when OFF. The yellow indicators next to each button indicate when each corresponding channel is ON. The MUTE button turns OFF whichever channels are ON (both simultaneously if both were ON). When the MUTE button is pressed again, it restores the channel OFF/ON conditions present when it was previously pressed. Note that both output channels will

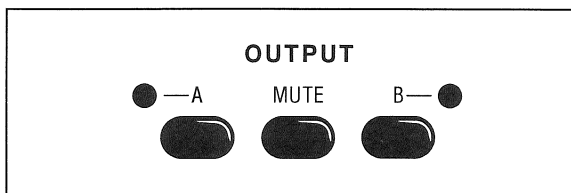


Figure 5-1 Output Controls

be automatically turned OFF when NOISE function is selected. The output is automatically cycled off and on when the signal-to-noise ratio mode (dB unit) of NOISE function is selected. The appropriate output channel will be turned OFF when XTALK or GEN LOAD function is selected.

### 5.3. Input Controls

The A and B INPUT buttons select which front-panel input connector is connected to which analyzer channel within the instrument. The analyzer contains two voltmeters. The primary voltmeter is normally displayed in the top left portion of the LCD display. The secondary voltmeter is normally displayed in the top center portion of the LCD display. Pressing the A button causes the A ANALYZER INPUT connector to be connected to the primary voltmeter; pressing the B button connects the B ANALYZER INPUT to the primary voltmeter. The LCD display will indicate above each reading which channel it is reading; for example, THD+N A or LEVEL B. In LEVEL, LEVEL RATIO, and XTALK functions, the primary voltmeter measures the signal at the selected input channel while the secondary voltmeter measures the signal at the alternate or reference (opposite) input channel. In most other functions, the selected input channel drives both primary and secondary meters with the primary meter channel being further processed by filters, discriminator (W+F mode), or demodulator (IMD mode). The monitor loudspeaker monitors the selected input channel except in LEVEL, LEVEL RATIO, PHASE, or XTALK modes where it measures the

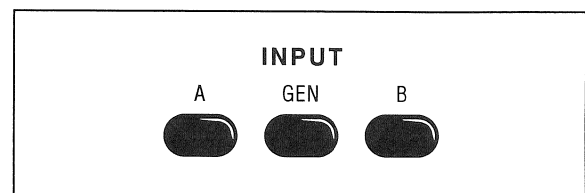


Figure 5-2 Input Controls

opposite (reference) channel. An internal jumper can be moved so that the loudspeaker monitors the final processed signal, following all filters.

If the INPUT GEN button is pressed following the INPUT A button, the primary voltmeter will be connected directly across the generator A output via an internal cable, instead of connecting to the A front panel input connector. Similarly, pressing the GEN button following the B button causes the primary voltmeter to measure the generator B output connector via internal cable instead of the front-panel-applied signal. The LCD display will indicate when it is measuring the generator via the internal cable; for example, LEVEL GA or THD+N GB. In LEVEL function, pressing the INPUT GEN button a second time then also switches the alternate channel to the generator connection, and the display will indicate LEVEL GA and LEVEL GB.

## 5.4. Instrument Mode Controls

The four INSTRUMENT MODE buttons select major instrument operational and display modes. PANELS mode provides numeric measurement display, access to setup parameters of analyzer and generator, and access to IEEE-488 setup parameters. BARGRAPH mode displays measurements in analog meter fashion. SWEEP mode provides setup and execution of frequency sweeps in most analyzer functions. PRINT mode provides hard copy print-out of the display in any mode, plus complete tabular listings of every data point in a sweep when desired.

PANELS mode, with its four subsidiary modes available by consecutive presses of the PANELS button, enables setup of generator and analyzer parameters and alphanumeric display of the selected measurement function. The first press of the PANELS

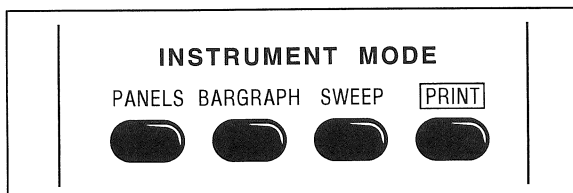


Figure 5-3 Instrument Mode Controls

button when leaving another mode displays the most important generator and analyzer parameters at the center and bottom of the display, in addition to the measurements at the top of the display. A second press of the PANELS button displays only generator setup parameters including output impedance selection and waveform selection. A third press of the PANELS button displays analyzer parameters and measurements and permits setting reference values for the dBm, dBr, and Watts units. A fourth press of the PANELS button displays a screen which permits user entry of arbitrary step size values for the FREQUENCY and AMPLITUDE INC and DEC buttons and selection of several IEEE-488 parameters including instrument address.

### 5.4.1. Setting Generator Parameters

Two consecutive presses of the PANELS button selects the generator setup mode. This mode uses all the display for generator parameters, to permit setting some of the less-often-changed generator conditions (see Figure 5-4). The top left or bottom left soft buttons permit selecting the generator waveform from the choices of SINE, SQR (square), and IMD (SMPTE/DIN intermodulation distortion test waveform, if the IMD option is installed). IMD waveform is automatically selected when IMD measurement function is chosen, without needing to go to GEN DISPLAY mode to make the IMD selection. When going to another measurement function from IMD, the generator waveform will then be automatically changed to sinewave.

The top right soft button, with IMD waveform selected, permits selecting the upper sinewave frequency of the IMD test signal. The bottom right soft button selects the lower sinewave frequency of the IMD test signal.

The bottom center soft button selects generator output impedance and balanced/unbalanced configuration from the choices of 50 Ohms balanced (40 Ohms if option EGZ is installed), 150 Ohms balanced (200 Ohms if option EGZ has been installed), 50 Ohms unbalanced (40 with EGZ), or 600 Ohms balanced. Note that the maximum available output amplitude is reduced by a factor of two with the unbalanced configuration.



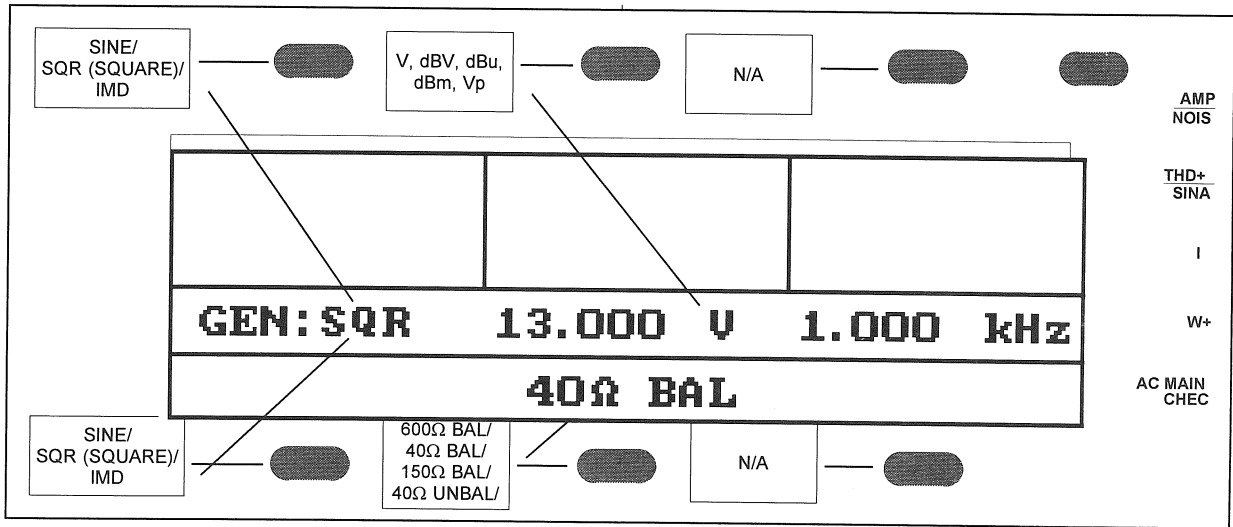


Figure 5-4 Setting Generator Parameters

The top center soft button selects generator amplitude units from the choices of V (Volts RMS), dBV, dBu, dBm (600 Ohm reference), and Vp (Volts peak). Volts, Volts peak, dBu, and dBV are voltage units; dBm are power units.

### 5.4.1.1. Generator Voltage Units—Open Circuit Voltage Calibration

When a voltage unit (Volts, Volts peak, dBu, dBV) is used, the generator AMPLITUDE controls specify the generator open-circuit voltage (sometimes called emf, or electro-motive force). Unless the external load impedance is infinite, the actual voltage delivered to the load will be less than this open circuit voltage since the selected generator source impedance and the external load impedance act as a voltage divider. For example, if the 50 Ohm source impedance is in use and the generator output is connected to the analyzer 100 kilohm input, the voltage across the load will be

$$\frac{100,000}{100,000 + 50} = 99.95\%$$

of the open circuit voltage. With the 50 Ohm source impedance in use, the voltage across the load will differ from the open-circuit voltage by no more than 0.1 dB if the load is approximately 5,000 Ohms or higher. For a 10,000 Ohm load (typical of bridging inputs on many professional audio devices), the loading of the 50 Ohm source will produce approximately an 0.05 dB error.

### 5.4.1.2. Generator dBm Units

The dBm units are available as generator and analyzer measurement units. The generator cannot directly control output power, but only generator open-circuit voltage. The value in dBm set by the user will be valid only into a 600 Ohm external load impedance. The ATS-1 microprocessor knows the value of generator source impedance presently selected on the generator and uses that value to compute what the open-circuit voltage must be set to in order to produce a voltage across 600 Ohms resulting in the specified dBm (power) level in the 600 Ohm load. If the source impedance is changed to another available value, the processor re-calculates and re-sets the open-circuit voltage so as to maintain the specified power in the load. For example, setting 0 dBm into a 600 Ohm load (0.7746 Volts across the load) from a 50 Ohm source load will produce a generator open-circuit voltage of

$$0.839V = 0.7746V \frac{600 + 50}{600}$$

Changing the source impedance to 600 Ohms causes the open-circuit voltage to go to

$$1.549V = 0.7746V \frac{600 + 600}{600}$$

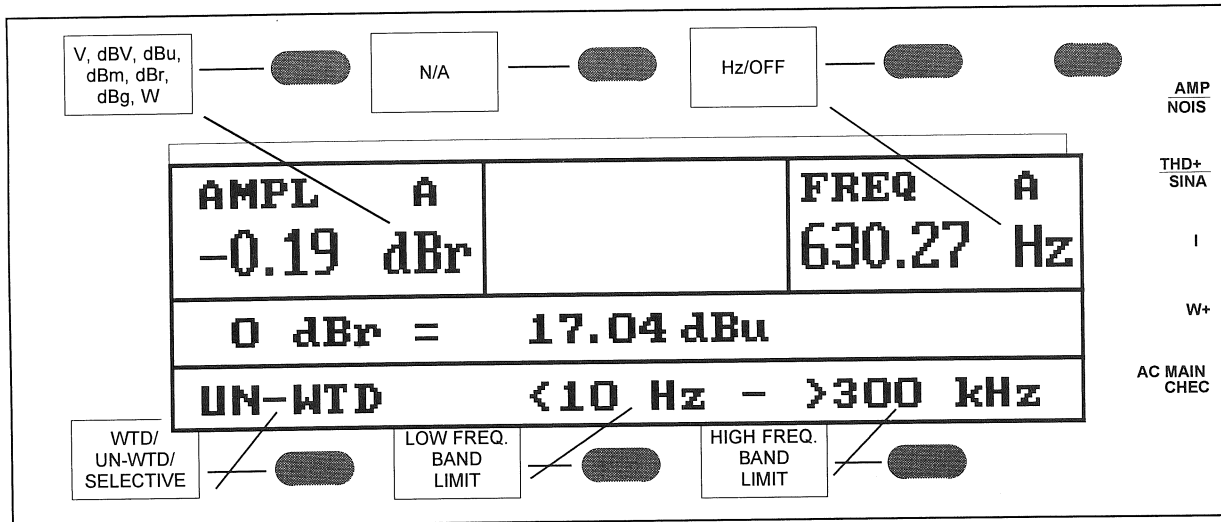


Figure 5-5 Setting Analyzer Parameters

### 5.4.1.3. Loading and One vs Two Channels

With the generator amplitude set in dBm, the microprocessor assumes that both generator output connectors A and B are loaded with 600 Ohms if both A and B generator outputs are on. Violating this assumption will result in an amplitude calibration error.

### 5.4.2. Setting Analyzer Parameters

Certain analyzer parameters may be set in either the first PANELS mode, obtained by the first operation of the PANELS button, or in the analyzer-only display mode obtained by three consecutive operations of the PANELS button (see Figure 5-5). The analyzer reference values for the dBm, dBr, and Watts units may be set only in the analyzer-only display obtained by three operations of the PANELS button. In AMPLitude and NOISE functions, WTD (weighted), UN-WTD (unweighted), and SELECTIVE filtering modes may be selected by the lower left soft button. THD+N function also has UN-WTD and WTD modes available. In WTD modes, the lower right soft button selects among the several weighting filters and detector responses available, and the lower center soft button permits selection of the lower band-limiting frequency. In UN-WTD modes, the lower center soft button controls the lower band limit and the lower right soft button con-

trols the upper band limit. In SELECTIVE mode of AMPL and NOISE functions, the upper right portion of the display becomes an indicator of the center frequency of a tunable 1/3 octave bandpass filter and the SWEEP mode and FREQUENCY buttons and knob control the center frequency of that filter.

In THD+N function, the upper right soft button permits selection of notch (bandreject) filter tuning mode from the choices of GEN-TRACK, AUTO-TUNE, or FIX-TUNE.

In SINAD function, the upper right soft key selects among GEN-TRACK, FIX-TUNE, and OFF modes. The lower center and lower right soft buttons control the lower and upper band-limiting filter selections. With OFF selected in the upper right display, the lower left soft button toggles the notch filter and generator frequency between 400 Hz and 1 kHz. The generator frequency may then be manually tuned away from the notch filter frequency if desired. In FIX-TUNE mode, the generator frequency remains at its last setting while the notch filter frequency may be freely tuned by use of the FREQUENCY buttons and knob. In GEN-TRACK mode, the FREQUENCY buttons and knob tune the generator frequency with the notch filter automatically tracking.

In PHASE function, the lower left soft button selects among three phase ranges. The lower right soft buttons selects between NOAVERAGE and AVERAGE modes.

In W+F function, the lower row of soft keys select between WTD and UN-WTD filtering, IEC (DIN) vs NAB vs JIS detector response, and PEAK vs 2-sigma processing.

### 5.4.3. Bargraph Display Mode

The BARGRAPH button uses the lower portion of the LCD for an analog bargraph display of the primary measured function (both channels in the case of LEVEL function). As measurements vary, the bargraph widens to show the minimum and maximum values reached since the last time the BARGRAPH button was pressed. This max/min hold can be re-set at any time by pressing the BARGRAPH button again. When the PRINT button is pressed in BARGRAPH mode, the resulting printout will not only give an analog indication of the maximum and minimum as wide portions of the bargraph, but also includes specifically labeled numerical maximum and minimum values.

BARGRAPH display mode also permits changing from the normal AUTORANGE mode to HOLD RANGE mode. This is useful not only to prevent "bouncing" of the bargraph display with consequent spoiling of the maximum and minimum hold feature, but also fixes the gain range to the rear auxiliary output connectors, the loudspeaker, and the headphone connector. The signal amplitude at these points will then vary directly with input signal amplitude, rather than abruptly changing when range switching takes place so as to remain relatively constant over a wide input signal range.

When BARGRAPH display mode is first selected in a new ATS-1 unit, the measurement unit at the two ends of the bargraph will be the same as the unit in the upper left numeric display field. If the upper left soft key is used to change to another unit while the bargraph is displayed, the bargraph units and upper left display units will both change. If the display mode is changed to PANELS with analyzer setup parameters displayed and the upper left soft key used for still further unit changes, the now-invis-

ible bargraph retains the unit selected when it was last visible. Going back to BARGRAPH mode will then show one unit in the upper left display field and a different unit at the two ends of the bargraph. The ATS-1 will remember these units independently for each measurement function.

The bargraph calibration is linear between the end point values, with small lines (tic marks) at each 10% increment of the bargraph span. In SINAD function, if the two ends of the bargraph are adjusted to exactly zero dB and 24 dB, the tic marks change. Twelve tic marks (two dB per mark) will then be shown below the bargraph. Above the bargraph, tic marks will be shown at 6 dB, 12 dB, 14 dB, and 18 dB. To change the end-point calibrations of the bargraph, press the soft button under the end to be changed. The calibration value will then be high-lighted in inverse video. The AMPLITUDE buttons and knob may then be used to set the bargraph end point to the value desired.

The step size of the INC/DEC and  $\pm 10$  dB amplitude control buttons used to control bargraph end points will vary with the measurement function selected. In Phase function, the  $\pm 10$  dB buttons cause 90 degree steps and the INC/DEC buttons make 10 degree steps. In AC MAINS CHECK function, the  $\pm 10$  dB buttons adjust the bargraph end points to exact multiples of 10.0 Volts, and the INC/DEC buttons select exact 1.00 Volt values. If the soft keys at both ends of the bargraph are pressed to high-light both end point calibration values, they can both be shifted simultaneously by the AMPLITUDE controls with the span between them remaining constant.

### 5.4.4. Sweep Mode

Pressing the SWEEP button (in the measurement functions of AMPL, NOISE, LEVEL, THD+N, PHASE, LEVEL RATIO, XTALK, or GEN LOAD) will produce a display similar to Figure 5-6. The right-hand portion of the display will be dedicated to a graphic presentation of principal measured parameter versus frequency. The frequency end points between which the sweep will take place are indicated below the graph area near the ends of the graph. Pressing the lower right or lower center soft key will select the upper or lower frequency value

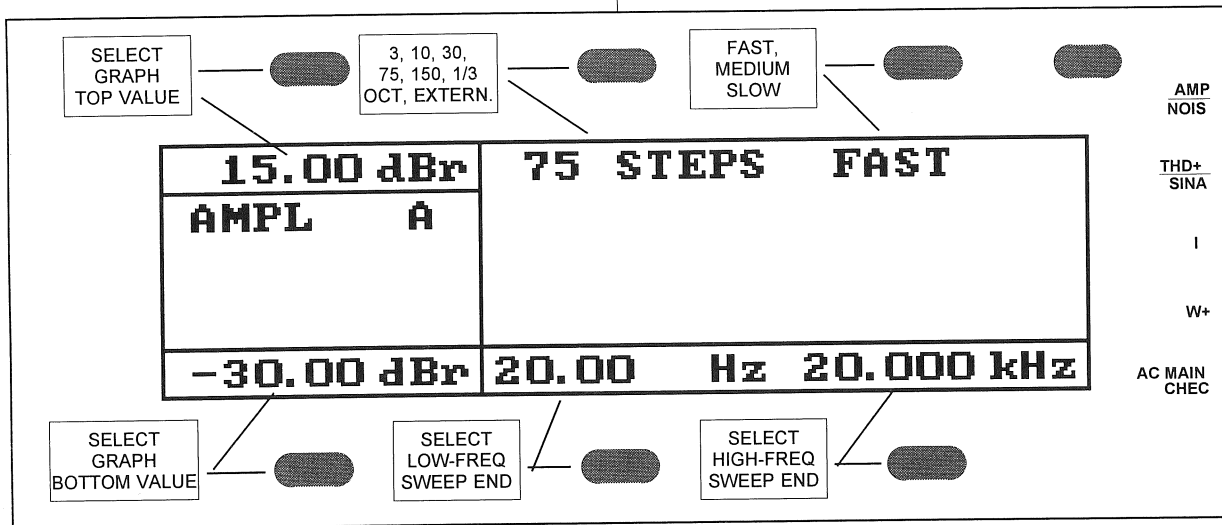


Figure 5-6 SWEEP Setup Mode Display

and indicate the selection in inverse video. The selected limit may then be changed by use of the FREQUENCY buttons and knob. Pressing the soft key again (or pressing the SWEEP button to start the sweep) ends the selection process. Horizontal calibration and the progression through sweep frequencies will always be logarithmic unless the ratio of sweep upper frequency to sweep lower frequency is 3:1 or less; in that case, the frequency sweep and calibration will be linear.

The graph top and bottom values are indicated at the top and bottom in the left end of the display. Pressing the upper left or lower left soft key will select the upper or lower value, with the selection again indicated in inverse video. The selected limit may then be changed by use of the AMPLITUDE buttons and knob, and the soft key pressed again (or the SWEEP button pressed) to end the selection process. If both the graph top and bottom values are selected simultaneously by their soft keys, the AMPLITUDE controls will move both with a fixed span between them. Vertical calibration is linear in all decibel units; that is, one dB occupies the same vertical span anywhere from top to bottom of the graph. Short horizontal tic marks indicate the dB values which are multiples of twenty dB, such as -20, 0, +40, etc. When phase is displayed, vertical calibration is always linear. With Volts, Watts,

Ohms, or percent units selected, vertical calibration will always be logarithmic unless the graph bottom is set to zero; in this case, calibration will be linear.

#### 5.4.4.1. Generator Sweep Resolution

Resolution of the sweep, or selection of generator-based sweep versus adaptation to an external sweeping signal, is controlled by the top center soft key. Successively pressing this button will cycle through values of "3", "10", "30", "75", "150", "1/3 OCT", and "EXTERNAL". All of the values from "3" through "1/3 OCT" will produce generator-based sweeps, with the generator making the selected number of steps progressively from the high-frequency value to the low-frequency value and thus graphically plotting from right to left. The "3", for example, indicates three steps between selected frequency end values. This will produce a four point sweep; the start frequency plus three steps. Similarly, "30" produces a 31-point graph, etc. The "150" value is not available in LEVEL function due to memory limitations, since both channels are plotted during a LEVEL function sweep. When "1/3 OCT" is selected, the sweep will consist of all standard ISO 1/3 octave values between the selected high and low frequencies. If the selected frequency end points are not standard ISO 1/3 octave values, the end points will also be used as test frequencies. For example, if the upper limit is 20 kHz (an ISO stand-

ard value), a 1/3 octave sweep will start with the values 20 kHz, 16 kHz, 12.5 kHz, etc. If the upper limit is 21.5 kHz (not a standard value), the sweep progression will be 21.5 kHz, 20 kHz, 16 kHz, 12.5 kHz, etc.

**5.4.4.2. Sweep Speed**

In all sweep modes except EXTERNAL, the upper-right soft key selects between the three device-under-test settling or delay times of FAST, MEDIUM, and SLOW. FAST is the appropriate selection whenever the generator and analyzer of an ATS-1 unit are testing a typical audio electronics device without significant delay through the device. Amplifiers, mixing consoles, equalizers, and three-head tape recorders with less than approximately 200 milliseconds time delay between record and reproduce heads are all examples of devices properly tested in FAST mode.

Satellite links and three-head tape recorders with a moderate delay between heads at the selected tape speed should be tested in MEDIUM speed. The MEDIUM selection inserts a time delay of approximately 0.9 second after the generator steps to each new frequency before the analyzer begins examining the data to see if it is settled. This delay time permits the portion of tape containing the new signal to

move from record to reproduce head, or a satellite-relayed signal to travel from the earth's surface to a synchronous satellite and to return.

The MEDIUM selection is also intended for use on an ATS-1 generator feeding an audio transmission link while the analyzer section of another ATS-1 makes EXTERNAL sweep measurements at the receiving end of the link.

SLOW inserts a minimum delay of three seconds after the generator steps to each new frequency before the analyzer begins examining the data, giving the "receiving" analyzer time enough to measure the incoming frequency, tune the selective filter to that frequency (if measuring in THD+N or XTALK functions), and obtain settled data to plot on the graph. SLOW may also be selected for use with tape recorders with very widely-spaced record and reproduce heads and operating at very slow tape speeds.

**5.4.4.3. External Sweeps**

When "EXTERNAL" is selected, the ATS-1 generator does not sweep. Instead, the analyzer expects an externally-applied sinewave signal (of sufficient amplitude to be measured by the frequency counter) to change either upwards or downwards in frequency. Most reference tapes and test CDs have ap-

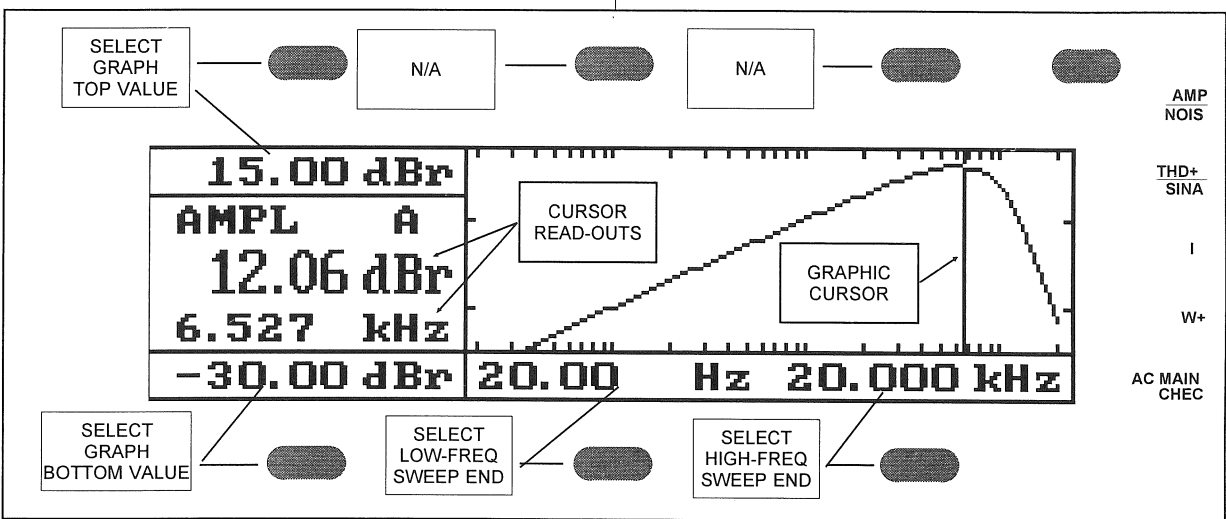


Figure 5-7 Graphic Cursor in SWEEP Mode

appropriate signal sequences to drive EXTERNAL mode. The signal may be either a continuously-changing "glide tone" or a series of tones or tracks which step across the audio spectrum. The appropriate analyzer function is selected by the upper right soft key from the choices GLIDE or STEP. If a glide tone is used, it must not sweep faster than five seconds per octave (50 seconds for a 20 Hz-20 kHz sweep). EXTERNAL mode will accept signals sweeping either upwards or downwards in frequency. A frequency counter measurement determines the horizontal value at which the measurement will be plotted. Whenever the incoming signal frequency changes by more than the 1/120th root of the selected frequency span from the previous measurement, another measurement will be made and plotted. This works out to approximately a 6% required change for the typical three-decade (20 Hz-20 kHz) span.

As noted earlier, the MEDIUM sweep speed should normally be selected for the generator sweep of one ATS-1 while a second ATS-1 measures amplitude or phase in EXTERNAL mode. SLOW must be used for the generator unit when THD+N is measured by another ATS-1 in EXTERNAL mode.

#### 5.4.4.4. Making the Sweep

When the sweep end points, resolution, and graph top and bottom values are set to the desired values, pressing the SWEEP button again will initiate the sweep and data acquisition. As each point is acquired, the frequency and measured parameter are displayed numerically at the left of the display. The measurements also plot onto the graph if they fall between the selected graph top and bottom values. At the end of the sweep, the generator frequency returns to its previously-set value as determined by the FREQUENCY knob and buttons. A sweep may be interrupted at any time by pressing the SWEEP button again. A continuously repeating sweep may be initiated by holding down the SWEEP button until the first acquired point is numerically displayed at the left of the screen. As the sweep repeats, the previously-stored data point at each frequency is replaced with the new value. A small gap in the graphed line shows where the replacement is taking place.

If desired, the graph top and bottom values or frequency end points may be changed following a sweep without needing to take data again. Any of these values may be selected by the nearest soft key and changed by use of the AMPLITUDE or FREQUENCY controls. The graph is dynamically redrawn as the values are changed.

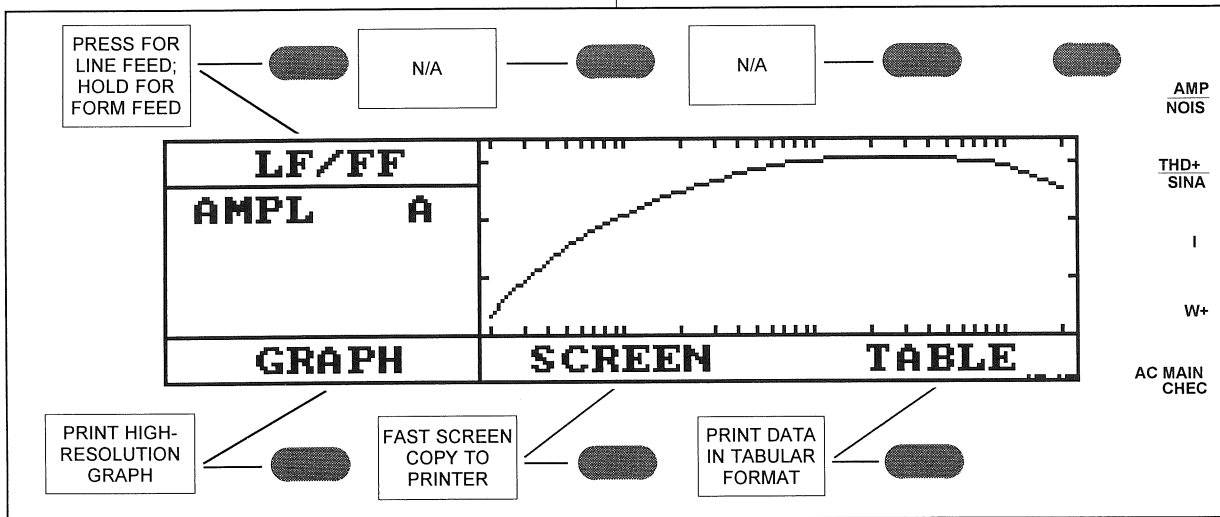


Figure 5-8 PRINT Mode Selections

### 5.4.4.5. Graphic Cursor

For a more precise read-out of any measurement point in a sweep, a graphic cursor may be used. Pressing any of the FREQUENCY buttons or turning the FREQUENCY knob causes a vertical line cursor to appear on the screen (see Figure 5-7). Be sure the graph frequency end points are not highlighted, or the FREQUENCY controls will change end points instead of controlling the cursor. The measured parameter and frequency of the data point at the cursor location are numerically displayed at the left of the screen. The cursor may be moved through the data one point at a time with the INC and DEC frequency buttons or the frequency knob. The x10 and ÷10 buttons move the cursor ten data points at a time. If dBr units are in use, the “dBr ZERO” button may be pressed while the cursor is in use and the dBr reference will be re-set to equal the value of the data point at the cursor location. This permits simple measurements of the difference in amplitude between any two points in a sweep.

### 5.4.5. Print Mode

Pressing the PRINT key once in PANELS or BARGRAPH mode provides a hard copy printout of the display to an Epson-compatible or IBM Graphics Printer-compatible dot-matrix printer, connected to the parallel printer port on the rear of the ATS-1. The printout also includes several key setup parameters including filter selections and generator waveform and amplitude.

In SWEEP mode, pressing the PRINT key displays a menu of choices: LF/FF at the upper left soft key, and GRAPH, SCREEN, and TABLE at the three lower soft keys. Pressing the lower left soft key, labeled GRAPH, produces a high-resolution 360 by 280 pixel printout of the data including grid lines, plus the key setup parameters. GRAPH mode printout takes from 30 to 45 seconds on most printers. Pressing the lower center soft key, labeled SCREEN, provides a “screen dump” printout of the display at the same resolution seen on screen, plus the same key setup parameters printed along with panel or bargraph printouts. SCREEN printout is fast, typically requiring less than 10 seconds on most printers. Pressing the lower right soft key, la-

beled TABLE, gives a tabular printout of every data point in the sweep but no graph. In any of the three printout modes, the graphic display changes to the inverse video selection while data is being sent to the printer. Thus, when the display returns to the original video presentation, data is all in the printer buffer and the next test can be made even though the printer is still printing. The screen automatically returns from the print menu to the normal sweep display after GRAPH, SCREEN or TABLE is pressed. If the PRINT key is pressed twice, both the high-resolution graphic and tabular printouts will result.

The upper left soft key, labeled LF/FF, sends a single line feed command to the printer when it is pressed briefly and released. If the key is held in for approximately one second, it sends a form feed command. The screen does not automatically return from the print menu to sweep mode after pressing LF/FF momentarily, allowing several line feed commands to be sent in succession without the need to select PRINT mode each time. To leave the print menu, press one of the other three mode buttons (PANELS, BARGRAPH, SWEEP).

The key permanently labeled PRINT is not used to obtain printout of a self test. To print the results of a self test, select AC MAINS function, followed by the SELF TEST function selected by the lower left soft key. Then, start the self test with the lower center soft key which will then be labeled PRINT, rather than starting the test with the lower left soft key labeled START.

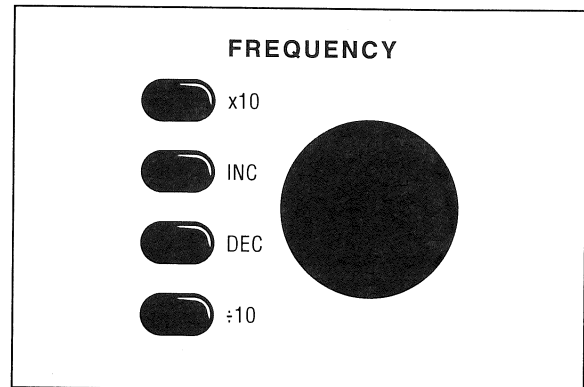


Figure 5-9 Frequency Control Section

### 5.5. Frequency Control Section

The knob and four buttons in the FREQUENCY block at the upper right of the panel control generator frequency, sweep start and stop frequencies during sweep setup mode, analyzer bandpass filter center frequency during selective analysis modes, and bandreject filter frequency in THD+N and SINAD FIX-TUNE mode (see Figure 5-9). The x10 and ÷10 buttons increase or decrease the frequency by a factor of 10 from the present value (unless this would exceed the available frequency range). The INC and DEC buttons may have different effects, depending upon whether the default ISO step sizes or user-selectable step sizes are in effect. With the default ISO steps, INC and DEC increase and decrease frequency according to the ISO standard 1/3 octave values, where the significant figures are:

- 1.00, 1.25, 1.60, 2.00, 2.50, 3.15, 4.00, 5.00, 6.30, 8.00, etc.

Alternately, the FREQUENCY INC and DEC buttons may be set by the user to use any frequency step size from 0.01 Hz to 20.0 kHz. To set the INC and DEC step sizes, press the PANELS button four times. The upper right section of the display will then be labeled **FREQ STEP** (see Figure 5-10). Pressing the upper right soft key will toggle between ISO and a numeric value in Hz or kHz. The ISO selection causes the 1/3 octave step sizes listed

above. If the numeric value is selected, the FREQUENCY buttons and knob may then be used to select any value from 0.01 Hz to 20 kHz. Press the PANELS button again to leave this setup panel and store the selected INC/DEC step size.

The frequency knob continuously controls frequency with fine resolution of 0.02%. One full rotation will change frequency by about 8%.

### 5.6. Amplitude Control Section

The knob and four buttons in the AMPLITUDE block at the lower right of the panel control the generator amplitude, graph top and bottom calibrations during sweep setup mode, and bargraph end-point calibration in bargraph mode. The +10 dB and -10 dB buttons add or subtract exactly ten decibels to or from the present value. When setting bargraph end points in AC MAINS CHECK function, they step through integer multiples of ten Volts. In PHASE function, they step through 90 degree values.

The INC and DEC buttons have three modes; the default 1.00 dB/ISO mode, user-settable voltage step sizes, and user-settable decibel step sizes. To select among these modes, press the PANELS button four times. The lower right section of the display will then be labeled **AMPL STEP** (see Figure 5-10).

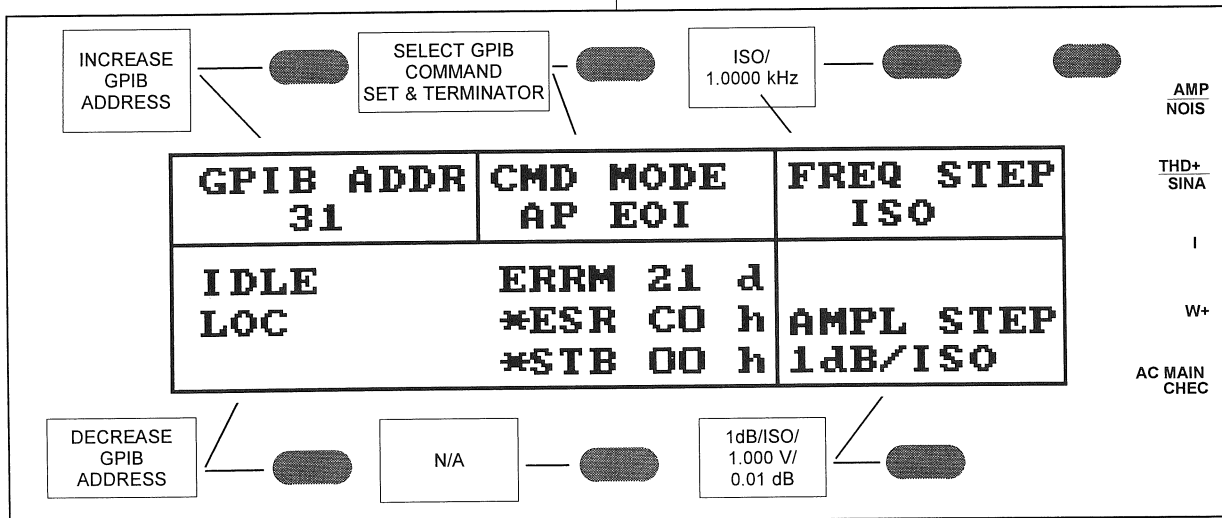


Figure 5-10 GPIB Parameters and Step Size Control Panel (Press PANELS Four Times)



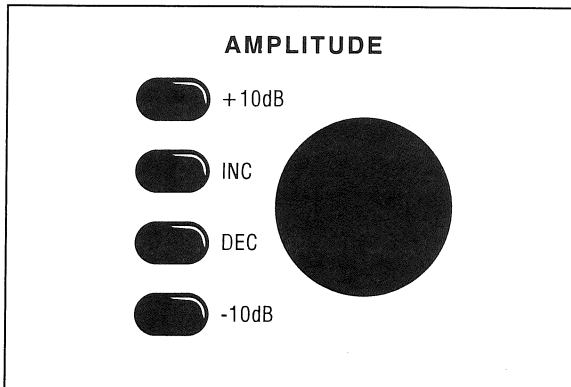


Figure 5-11 Amplitude Control Section

Pressing the lower right soft key will cycle among three values: "1dB/ISO", a numeric value in Volts, and a numeric value in dB. If either numeric value is selected, the AMPLITUDE buttons and knob may then be used to select any value across a wide range. With Volts units selected, any value from 1.000 microvolts to 2.000 Volts may be selected. With dB units selected, any value from 0.01 dB to 20.0 dB may be selected. Press the PANELS button again to leave this setup panel and store the selected INC/DEC mode and step size.

In the default (1dB/ISO) mode, amplitude step sizes produced by the INC and DEC buttons are different depending upon whether generator amplitude (or measurement unit when setting bargraph end points) has been selected in linear (Volts) or logarithmic (dB) units. With decibel units displayed, INC and DEC control the amplitude at exact one decibel steps (2.00 dB, 3.00 dB, etc.). With linear units displayed, INC and DEC will change the amplitude using the same set of significant figures described above for ISO standard values in frequency. When setting bargraph end points in AC MAINS CHECK function, INC and DEC provide integer multiples of one Volt. In PHASE function, they provide ten degree steps. The knob continuously controls amplitude with fine resolution of 0.0035 dB. One full rotation will change amplitude by about 17% or 1.4 dB.

When the step size was set by the user in Volts units, the INC and DEC buttons will change by the specified amount regardless of whether generator

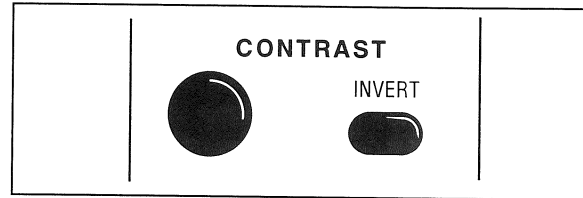


Figure 5-12 Display Contrast, Invert Controls

amplitude is displayed linearly (Volts) or in a dB unit. When the step size was set in dB units, the INC and DEC button will step by the specified dB amount regardless of generator amplitude display unit.

### 5.7. Contrast, Invert

The CONTRAST knob below the display adjusts the display contrast to optimize readability for almost any viewing angle. The INVERT button toggles between dark characters on a light background and light characters on a dark background.

### 5.8. Monitor

The MONITOR block, below the left end of the display, contains the volume control knob and a headphone connector. A loudspeaker normally audibly reproduces the selected input signal before processing. Its intended uses are monitoring signal presence in a channel and listening for voice announcements on test tapes. If headphones are plugged into the connector, the loudspeaker is disconnected. The MONITOR knob adjusts the loudness of the loudspeaker or headphone signal. If it is more desirable to audibly monitor the final processed signal (following notch or bandpass filter and any selected high-pass, low-pass, weighting, and op-

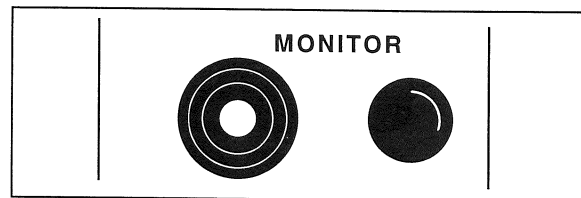


Figure 5-13 Loudspeaker and Headphone Monitor Section

tion filters), an internal jumper selects this signal instead of the input signal. See the FILTER INSTALLATION AND JUMPER SELECTION chapter for details.

## 5.9. Rear Auxiliary Signal Output Connectors

Three BNC connectors are located on the rear panel of the ATS-1. These connectors are labeled OSCILLOSCOPE TRIGGER, INPUT MONITOR, and ANALYZER MONITOR.

The OSCILLOSCOPE TRIGGER connector provides a constant amplitude 1.0 Volt RMS sinewave signal at the generator frequency in sinewave and squarewave modes. In IMD mode, the OSCILLOSCOPE TRIGGER signal is at the lower of the two intermodulation test signal frequencies in use. Source impedance is 680 Ohms  $\pm 10\%$ . The principal intended application for the OSCILLOSCOPE TRIGGER signal is to provide a stable trigger source for oscilloscope displays of the INPUT MONITOR and ANALYZER MONITOR output signals.

The INPUT MONITOR connector carries a near-constant amplitude replica of the signal present at the selected input channel. This is the signal being measured by the primary voltmeter and, in most functions, displayed in the upper left corner of the display. The amplitude of the signal at the INPUT MONITOR connector will remain in a 10-12 dB window between 2.8 Volt p-p and 0.7 Volt p-p over an input signal amplitude range of 140 Volts RMS through 25 mV RMS. Source impedance is 600 Ohms  $\pm 10\%$ . The principal intended application for the INPUT MONITOR connector is for monitoring the ATS-1 analyzer input signal on an oscilloscope or spectrum analyzer.

The ANALYZER MONITOR connector provides a replica of the fully-processed ac signal in the analyzer. This is the final ac signal in the instrument, just before presentation to the instrument detector and display. This signal thus has been processed by all selected filters; low-pass, high-pass, weighting, optional AUXiliary filters, the tunable bandpass or

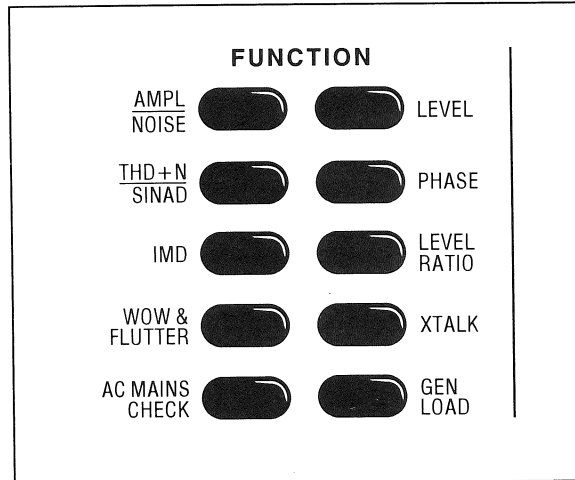


Figure 5-14 Measurement Function Selection Buttons

bandreject, and by the IMD demodulator in IMD analysis mode or the wow and flutter discriminator in W+F mode.

## 5.10. Functions

Twelve measurement functions are available by pressing the ten FUNCTION buttons. AMPLitude or NOISE are both selected by the AMPL/NOISE button; press once for AMPLitude, press again for NOISE. THD+N and SINAD are similarly selected by one button. Frequency or phase is measured in most functions and displayed at the upper right corner of the LCD, if the input signal amplitude is above approximately 8 mV (-40 dBu). If the amplitude is below that value, "Low" will be displayed instead of the frequency or phase reading.

### 5.10.1. Units

Most amplitude-measurement functions permit selection of measurement units by pressing the soft buttons above the display. The following units are available:

UNIT	REFERENCE
V (Volts)	basic unit
dB	signal level when generator output is cycled ON (NOISE function only)
dBV	0 dBV = 1.000 Volt
dBu	0 dBu = 0.7746 Volt
dBm	0 dBm = 1 milliwatt in 600 Ohms or a user-settable impedance value; this impedance value is displayed in PANELS mode, analyzer-only display, when dBm units are chosen
dBr	0 dBr = user-settable value or signal amplitude present when "dBr ZERO" button is pressed; this value is displayed in PANELS mode, analyzer-only display, when dBr units are chosen
dBg	0 dBg = presently set amplitude of the generator (Amplitude and Level measurement functions only)
W (Watts)	assumes 8 Ohm termination or a user-settable impedance value; this impedance value is displayed in PANELS mode, analyzer-only display, when Watts units are chosen

The dBg (dB relative to generator output) unit is selectable in Amplitude and Level functions. The reference is the presently-set generator open-circuit voltage (emf) when the chosen generator amplitude unit is V, Vp, dBV, or dBu. When dBm has been chosen as the generator amplitude unit, the reference for the analyzer dBg unit is the generator output voltage into an assumed 600 Ohm termination. The dBg measurement unit provides a direct readout of gain or loss through the device under test. With the generator output unit selected as V, Vp, dBV, or dBu, the gain value will be voltage gain. If the device has 600 Ohm input and output impedances and proper terminations and with dBm selected as the generator unit, the gain displayed will be power gain. Using the dBg unit and BARGRAPH display mode permits quick checks for compression, limiting, and saturation in a device as the generator amplitude is increased and decreased with the AMPLITUDE control buttons and knob. If the bargraph display is in dBg units while the upper-left numeric display is in an absolute unit such as dBu, it is easy to determine at what level the compression or satura-

tion begins. See the "Bargraph Display Mode" section on page 5-5 for instructions on how to set different units into the bargraph and the numeric display.

### 5.10.1.1. Why dBm?

In the early years of broadcasting and professional audio, audio circuits with matched terminations and maximum power transfer were the common case in studios and for audio transmission lines between facilities. Console and line amplifier output impedances, implemented with vacuum tube and transformer technology, were typically 600 Ohms. Equipment input impedances, again usually transformer-matched, were also typically 600 Ohms. Maximum power transfer takes place when the source and load impedances are matched. For such systems, the dBm unit (dB relative to one milliwatt) was appropriate since it is a power unit.

### 5.10.1.2. Audio Meters

However, actual power-measuring instruments are extremely rare in audio. Audio meters and distortions analyzers are *voltmeters*, measuring voltage across their input terminals. They do not know the power level, current value, nor source impedance across which they are measuring. Since the audio industry had "grown up" with 600 Ohm power-transfer systems in common use, audio test instrument manufacturers typically calibrated their voltmeters for this situation. Most audio test instruments and systems manufactured before approximately 1985 used only Volts and the dBm unit on their meter scales and switch labels. The dBm unit was calibrated with the assumption that the meter would always be connected across a 600 Ohm circuit when measuring dBm. Since the voltage across a 600 Ohm resistor is 0.7746 Volts when one milliwatt is being dissipated in that resistor, the meters were actually calibrated for a zero "dBm" indication with 0.7746 Volts applied. But, they were not measuring power; change the circuit impedance, and the meter is incorrect.

### 5.10.1.3. Voltage-Based Systems

Modern audio equipment normally has output impedances much lower than input impedances. Output impedance values from zero up to 50 Ohms are typical, and input impedances of 10 kilohms are typical. Such equipment, connected together, transfers negligible power due to the large impedance mismatch. However, nearly all the source voltage is transferred. As noted earlier, a 10 kilohm load reduces the open-circuit voltage from a 50 Ohm source by only 0.5%, or 0.05 dB. Thus, modern systems typically operate on a voltage transfer basis and the dBm, as a power unit, is not appropriate. A proper unit for voltage-based systems is the dBu (dB relative to 0.7746 Volts). The dBu is a voltage unit and requires no assumptions about current, power, or impedance. Those older audio meters calibrated in "dBm" are really dBu meters.

### 5.10.1.4. Old Habits Die Hard

Unfortunately, the "dBm" terminology has hung on long after its use is generally appropriate. Even some of the most-competent manufacturers of high-technology digital and analog professional audio equipment still use the dBm unit in their setup instructions. Users are told to apply an input signal of "+4 dBm" and then to adjust trim pots for an exact 0 VU indication on a 24-track digital audio tape recorder, for example. Yet, the line input impedances of that tape recorder are 10 kilohms. What the manufacturer clearly wants is a +4 dBu input level (1.22 Volts). If we truly applied +4 dBm to that 10,000 Ohm input, the resulting 5.0 Volts would probably not even be within the trim pot adjustment range for 0 VU. So, a good general rule when working with modern audio equipment unless you know it to be terminated in 600 Ohms is to read the manufacturer's "dBm" as "dBu". If in doubt about the actual termination value (and this is easily measured in GEN LOAD function), you won't go very far astray in using dBu with the ATS-1 generator's 50 Ohms source; 600 Ohms loads a 50 Ohm source by about 0.7 dB.

### 5.10.1.5. Setting References for dBr, dBm, Watts

#### dBr Reference

The dBr reference value may be entered from the panel by the user, or the value currently being measured may be chosen as the reference value by pressing the "dBr ZERO" button. To display the present dBr reference value, to change the units with which the dBr reference value is displayed, or to enter a new arbitrary reference value, select the dBr unit in any function where it is available. Select the analyzer-only display mode obtained by pressing the PANELS button three times, and the present value of dBr reference will be displayed at the center of the display. Use the lower center soft key to select units for the zero dBr reference. To change to an arbitrary value, the AMPLITUDE buttons and knob may be used to set any other value desired between one nanovolt and 500 Volts, or the decibel values corresponding to those values. For many purposes, it is convenient to establish a presently-measured amplitude value as the new dBr reference value. This is particularly convenient for gain and loss measurements, frequency response measurements, etc. In any function with an amplitude or level measurement displayed in dBr units, press the dBr ZERO button. The amplitude measurement will be stored as the new dBr reference, replacing any previous value whether manually entered by the user or by a previous press of the dBr ZERO button. The last dBr reference value will be remembered even when power is turned off.

#### dBm Reference

As noted above, an external value of circuit impedance must be known or assumed for use of the dBm or other power units. The default circuit impedance value for dBm units is 600 Ohms. To change to another impedance reference value for measurement in dBm units, select the dBm unit of any *measurement* function (*not* generator dBm units). Select the analyzer-only display mode obtained by pressing the PANELS button three times. The center of the display will show the present impedance reference for dBm units. Use the AMPLITUDE buttons and knob to select one of a number

of common impedance values for audio transmission lines; 900, 600, 300, 200, 150, 135, 75, or 50 Ohms. This value will be stored when the display mode is changed and will be remembered even when power is turned off. Note that the analyzer input impedance remains 100,000 Ohms at all times. The purpose of the selectable dBm reference is to provide correct dBm indications when the analyzer is bridged across a device or line of the specified impedance.

**Watts Reference**

An external value of circuit impedance, typically the resistance of a dummy load resistor, must be known or assumed for use of the Watt or other power units. The default load resistance value for Watts is eight Ohms. To change to another load resistance reference value, select the Watts unit of any *measurement* function. Select the analyzer-only display mode obtained by pressing the PANELS key three times. The center of the display will show the present reference for Watts units. Use the AMPLITUDE buttons and knob to select from a list of typical loudspeaker impedance values including 32, 16, 8, 4, 3.2, 2.6, 2.0, and 1.0 Ohms. This value will be stored when the display mode is changed and will be remembered even when power is turned off. The Watts and dBm reference values are independent of one another. Note that the analyzer input impedance remains 100,000 Ohms at all times. The purpose of the selectable Watts reference is to provide correct power indications when the analyzer is bridged across a loudspeaker or dummy load of the specified impedance.

**5.10.1.6. Percent and dB Units**

THD+N, SINAD, IMD, RATIO, and XTALK functions also make available the dB unit, and THD+N, IMD, and W+F modes have the % unit available. These are defined as follows:

Function	Unit	Definition
NOISE	dB	Ratio of signal amplitude measured with generator on to amplitude measured with generator off
THD+N	%	$100 * (\text{noise} + \text{distortion}) / (\text{signal} + \text{noise} + \text{dist.})$
THD+N	dB	$20 \log \{ (\text{noise} + \text{distortion}) / (\text{signal} + \text{noise} + \text{dist.}) \}$
SINAD	dB	$20 \log \{ (\text{signal} + \text{noise} + \text{dist.}) / (\text{noise} + \text{distortion}) \}$
IMD	%	$100 * (\text{distortion}) / (\text{hf signal})$
IMD	dB	$20 \log (\text{distortion}) / (\text{hf signal})$
RATIO	dB	$20 \log (\text{selected channel}) / (\text{alternate channel})$
XTALK	dB	$20 \log (\text{non-driven chan}) / (\text{driven chan})$
W+F	%	$100 * (\text{freq. deviation of flutter}) / (\text{measured frequency})$

**5.10.1.7. X/Y Units**

In RATIO function, the X/Y unit selection produces a “unitless” pure number display which is the ratio of amplitude reading on the selected channel to the alternate channel. This unit is intended for use in applications such as measuring transformer winding ratios.

**5.10.1.8. Speed Error Units (Delta%)**

In W+F function, frequency may be displayed in absolute (Hz and kHz) units or in delta% units. The delta% units are percentage deviation from the selected reference frequency (3.00 kHz or 3.15 kHz) and thus display speed error.

**5.10.2. Amplitude Function**

AMPLitude function measures the amplitude of the selected input channel and displays the result in the upper left corner of the LCD display. True RMS detection is used except in the CCIR-QPK and CCIR-ARM weighted modes as indicated below. Units are selectable by the soft button at the left above the display. Measured frequency is simultaneously displayed in the upper right corner of the display, except in SELECTIVE analysis mode when

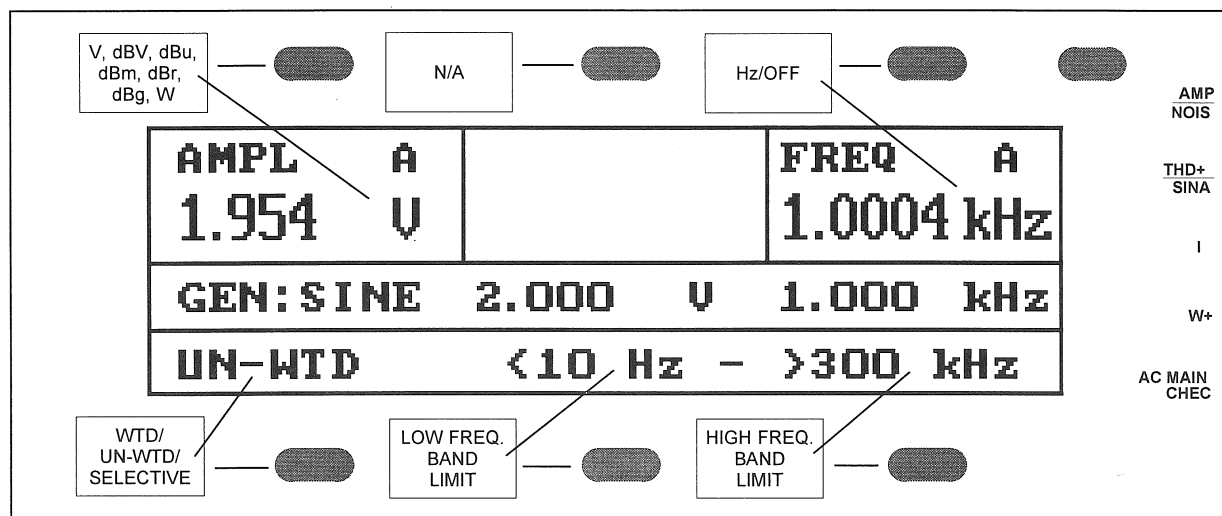


Figure 5-15 Typical Display, Amplitude Function

the upper right portion displays the center frequency of the 1/3 octave bandpass filter. Nothing is displayed at the top center.

Spectrum analysis sweeps can be made in SELECTIVE analysis mode. The 1/3 octave bandpass filter will be swept across the selected frequency range with the selected resolution.

In PANELS mode with the generator and analyzer or analyzer-only parameters displayed, the lower left soft button selects among UN-WTD (unweighted), WTD (weighted), and SELECTIVE modes. In UN-WTD mode, the lower center and lower right soft buttons permit selecting the lower and upper band limits (-3 dB points) to control analysis bandwidth according to the relevant specification and application. The lower right soft button selects among the following upper bandwidth limits; all use the RMS detector except for the 22 kHz-QPK choice which uses the quasi-peak detector per CCIR-468:

- 22 kHz
- 22 kHz-QPK
- 30 kHz
- 80 kHz
- >300 kHz

In WTD mode the lower right soft button selects among the available weighting filters and detector responses as follows:

IEC-A	A-weighting per IEC 179, RMS detection
CCIR-RMS	Weighting per CCIR-468, RMS detector
CCIR-QPK	Weighting per CCIR-468, Quasi-peak detector
CCIR-ARM	Weighting filter shape per CCIR-468, but with 0 dB gain point at 2 kHz rather than 1 kHz, average-responding detector per Dolby Bulletin 19/4
AUX1	Option filter socket 1 (RMS detection)
AUX2	Option filter socket 2 (RMS detection)

### 5.10.3. Noise Function and Signal-to-Noise Ratio

NOISE function is selected by pressing the AMPL/NOISE button a second time. NOISE and AMPLITUDE functions are virtually identical except for reading rate. In the NOISE function, the reading rate is slower to allow more integration time for the measurement. The amplitude measurement of the selected channel is displayed at the upper left

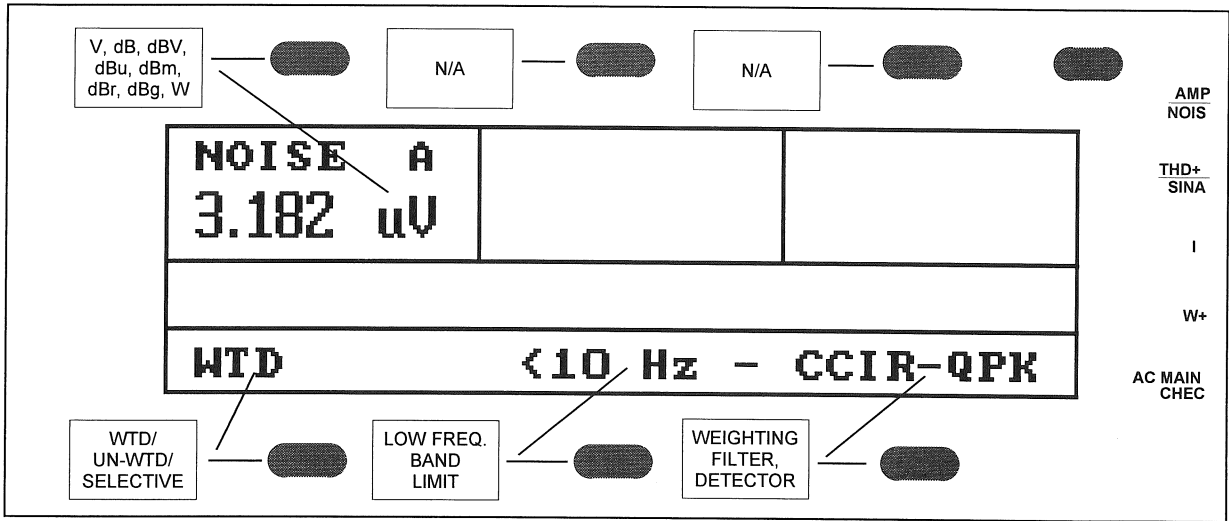


Figure 5-16 Typical Display, Noise Function

of the LCD; no other measurements are displayed in NOISE function. True RMS detection is used except in the CCIR-QPK and CCIR-ARM weighted modes. Units are selectable by the soft button at the left above the display.

The generator output is automatically turned off in NOISE function (although it can be manually turned on again if necessary). When the dB unit is selected (upper left soft key) in NOISE function, an automatic signal-to-noise ratio (S/N, SNR) mode is

initiated. The generator output is automatically cycled on and off. Output level from the device under test is measured under both conditions. The microprocessor in the ATS-1 computes the ratio of

$$\frac{\text{Level with signal}}{\text{Level without signal}}$$

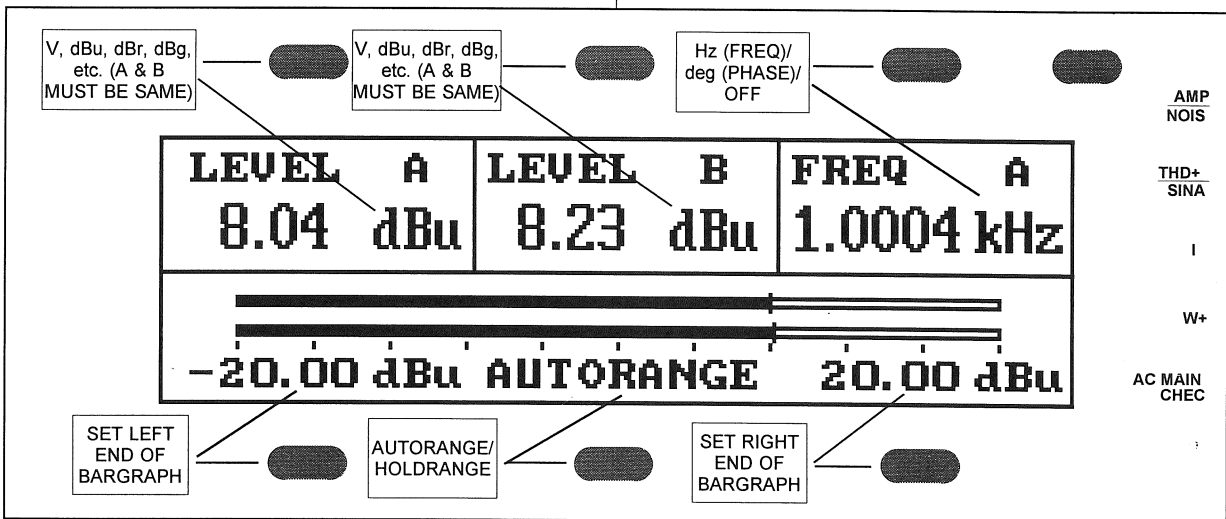


Figure 5-17 Typical Display, Level Function with Frequency Displayed, Bargraph Display Mode

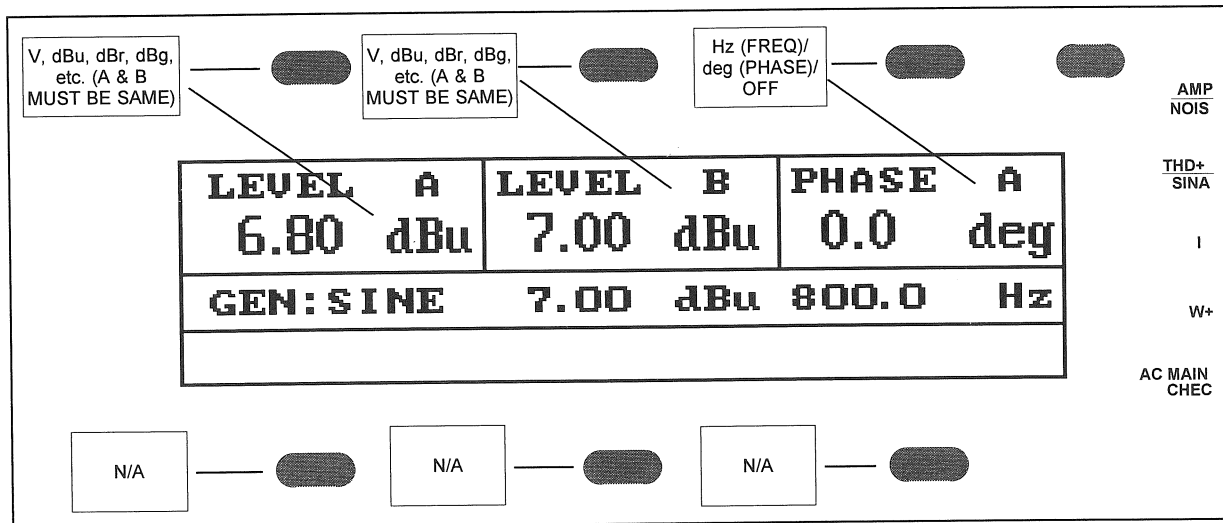


Figure 5-18 Typical Display, Level Function with Phase Displayed, PANELS Mode

and computes and displays the result in decibels. This automatic mode can be particularly convenient when making adjustments to the device under test to maximize S/N ratio.

In PANELS mode with generator and analyzer or analyzer only parameters displayed, the soft buttons under the display select among UN-WTD, WTD, and SELECTIVE modes and choose specific band-limiting or weighting filters and detectors as described above under AMPLITUDE function. Spectrum analysis sweeps can be made in SELECTIVE analysis mode. The 1/3 octave bandpass filter will be swept across the selected frequency range with the selected resolution.

Operating convenience for many users is enhanced by setting up NOISE and AMPLITUDE functions with different filter and detector selections so that noise can be measured to two different standards simply by pressing the AMPL/NOISE button twice. For example, AMPLITUDE function may be set up as UN-WTD with the 22 Hz-22 kHz bandpass selected (true RMS detection is automatically selected). NOISE function may be set up as WTD CCIR-QPK. Pressing the AMPL/NOISE button once will then produce the CCIR unweighted noise of the device; pressing the button again will provide the CCIR weighted noise.

#### 5.10.4. Level Function (2-Channel)

LEVEL function simultaneously measures the level (amplitude) of both input channels, using true RMS detection. LEVEL of the selected input channel is displayed at the upper left of the LCD; LEVEL of the alternate input channel is displayed at the upper center. Graphs made in SWEEP mode display the selected input channel with a solid line and the alternate input channel with a dotted line. When the cursor is used after a sweep, both the selected and alternate channel values at the cursor location are numerically displayed at the left of the display. Soft buttons above each of these display sections permit selection of measurement units. Both meters must use the same units. The upper right section of the display can show either frequency or phase, selectable by the soft button above. No filters are selectable in LEVEL function. LEVEL function is fully specified over the amplitude range between -38 dBu and +50 dBu (10 mV to 250 Volts), but may be used with increasing error and loss of measurement resolution below -38 dBu. Bargraph display in LEVEL function shows both channels in analog bargraph fashion. LEVEL function has the greatest amplitude accuracy of which the ATS-1 is capable when the signal amplitude is greater than -38 dBu.



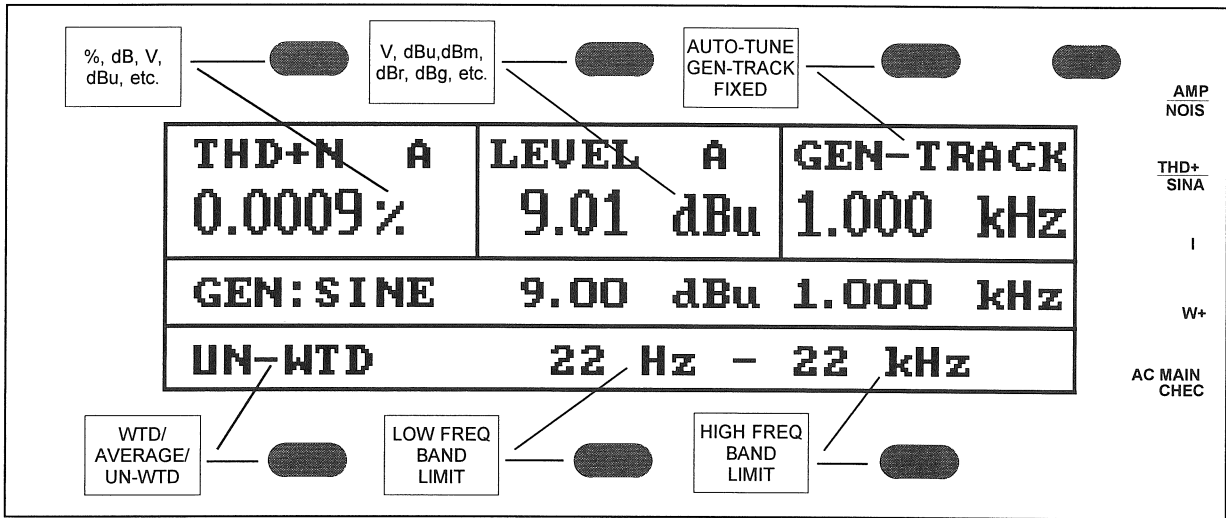


Figure 5-19 Typical Display, THD+N Function

### 5.10.5. THD+N Function (Total Harmonic Distortion + Noise)

THD+N function uses a notch (bandreject) filter to eliminate the fundamental frequency from the input signal, then measures (true RMS detection except in WTD CCIR-QPK or WTD CCIR-ARM modes) and displays the remaining signal as total harmonic distortion plus noise. Selection of THD+N measurement mode automatically selects the sine waveform of the ATS-1 generator. THD+N of the selected channel is displayed at the upper left of the display, level of that channel at the upper center of the display, and the frequency of that channel at the upper right. Units are selectable by the soft buttons above each section of the display.

In PANELS mode with analyzer setup parameters displayed, notch filter steering modes are selectable by the upper right soft button. Three choices are available for notch steering: AUTO-TUNE, GEN-TRACK, or FIX-TUNE. In AUTO-TUNE steering mode, the notch filter center frequency is automatically tuned to the signal frequency being measured by the frequency counter. Thus, in AUTO-TUNE mode the notch frequency will follow the frequency of an incoming signal from a tape, disc, or distant location in addition to the built-in generator. AUTO-TUNE is automatically selected during EXTERNAL sweeps of THD+N. AUTO-TUNE mode requires

that the signal amplitude be at least 20 mV (-30 dBu) for the frequency counter to function properly over its entire range. It is useable to below 10 mV. If the signal amplitude is below about 8 mV (-40 dBu), the upper left (THD+N) and upper right sections of the display will show "Low" instead of distortion and frequency measurements. AUTO-TUNE mode also requires that the signal be sufficiently "clean" (THD+N <10%) so that the frequency counter will function correctly.

GEN TRACK mode tunes the notch filter center frequency to the frequency of the internal generator. THD+N measurements are normally faster in this mode than in AUTO-TUNE steering mode. GEN-TRACK is the preferred mode when making stimulus-response measurements under potentially noisy conditions, where line interference or noise can cause the frequency counter to read incorrectly.

In FIX-TUNE mode, the notch filter center frequency may be set to any frequency in its range by use of the FREQUENCY knob and buttons. When FIX-TUNE is selected, the top right section of the display shows the filter frequency which may then be set to the desired value by use of the FREQUENCY buttons and knob. The primary application of FIX-TUNE mode is to enable quantization distortion measurements on low-amplitude signals

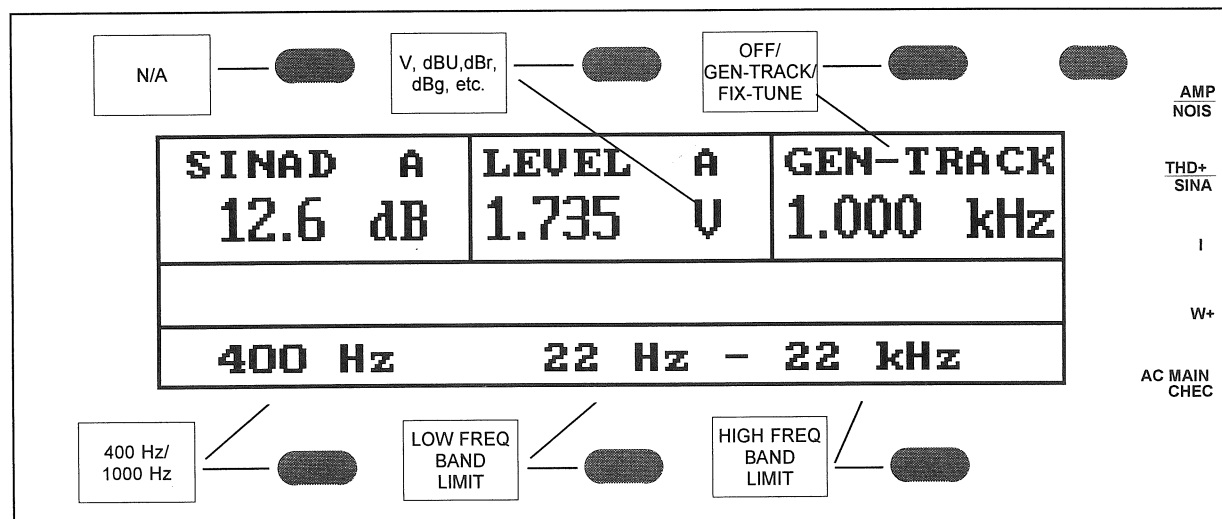


Figure 5-20 Typical Display, SINAD Function

from test compact discs, or k2/k3 (second and third harmonic distortion measurements) on tape machines in conjunction with optional bandpass filters.

THD+N measurements can be made on arbitrarily low amplitude signals in GEN-TRACK or FIX-TUNE modes. However, at amplitudes below about 10 mV (-38 dBu) the accuracy will suffer when THD+N is displayed in % or dB units, since the secondary voltmeter used to measure the input signal amplitude as the reference has limited dynamic range. Nulling time will also increase dramatically for inputs below 10-25 mV. In all other THD+N units (Volts, dBV, dBu, dBm, or dBr) the display is the absolute value of the noise and distortion signal and is independent of the secondary voltmeter reading.

In PANELS mode with analyzer setup parameters displayed, the bottom row of soft buttons may be used to select WTD, UN-WTD, and AVERAGE modes. WTD and UN-WTD modes function and have subsidiary filters as described above under AMPLITUDE function. Weighting filters are rarely used in conventional distortion measurements, but the A-weighting filter is specified in THD+N function for dynamic range tests of compact disc players, for example. Selection of the proper band-limiting filters is of critical importance in THD+N measurements. The dominant signal is often wideband

noise when measuring high-quality audio devices, so the specified band-limiting filter must be used if measurements are to correspond to manufacturer's specifications. On many audio devices it is illogical to make THD+N measurements at a fundamental frequency above 1/3 to 1/2 the value of the low-pass filter, since the harmonics above 3rd or 2nd would then be filtered off in the instrument. On digital audio devices, however, alias products of high-frequency signals may fold down into the audio band and will be properly measured in THD+N mode.

The AVERAGE mode of THD+N, selectable by the lower left soft key, was designed principally for distortion measurements on analog tape recorders. AVERAGE mode takes eight measurements during a one-second period and displays the computed average of those measurements. Thus, AVERAGE mode reduces the "digit bobble" caused by flutter and noise in tape recorders.

### 5.10.6. SINAD Function

SINAD is defined as the ratio of (Signal + Noise + Distortion)/(Noise + Distortion) in the output of an fm radio receiver. SINAD is thus similar to THD+N, except for the algebraic sign; for example, 12 dB SINAD corresponds to -12 dB THD+N. The SINAD technique is used in measurement of receiver sensitivity and interference rejection. SINAD

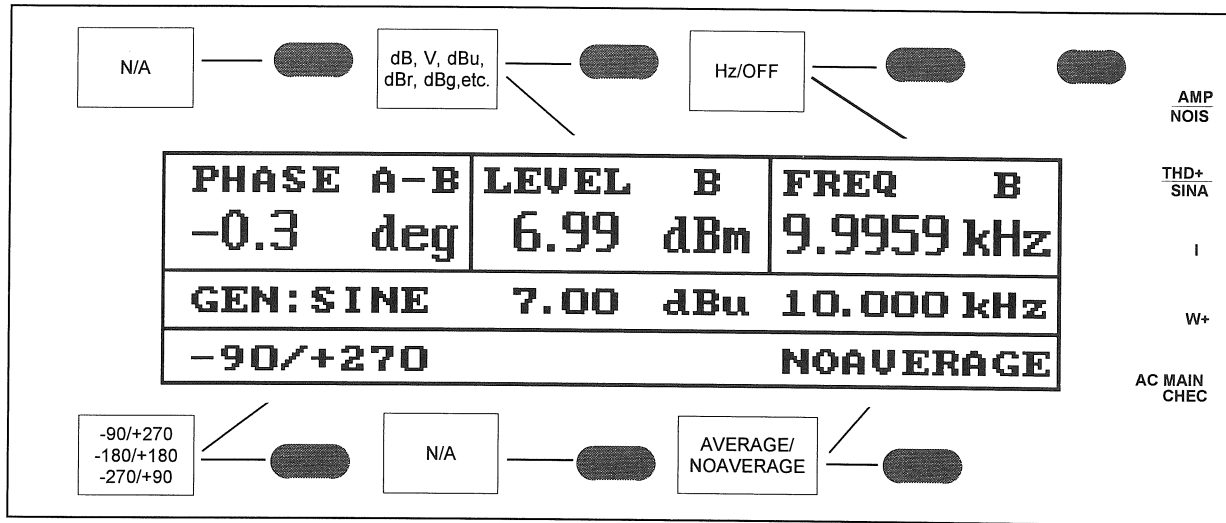


Figure 5-21 Typical Display, Phase Function

function is selected by pressing the THD+N/SINAD button a second time, and always uses true RMS detection. SINAD is displayed at the upper left of the display, level at the upper center, and notch filter tuning mode at the upper right. SINAD is always displayed in dB; units for the level display are selectable by the soft key immediately above. Band-limiting filters are selectable by the lower center and right soft buttons in PANELS mode with analyzer setup parameters displayed.

SINAD uses the bandreject filter, in one of three modes selected by the upper right soft key. The three SINAD notch filter tuning modes are OFF, GEN-TRACK, and FIX-TUNE. With OFF selected, the notch filter frequency is set to either 400 Hz or 1 kHz as toggled by the lower left soft button. The generator is initially tuned to the same frequency but may be manually tuned away if desired. The generator will be re-tuned to the displayed notch frequency each time the lower left soft key is pressed. With GEN-TRACK selected, the FREQUENCY buttons and knob tune the generator frequency and notch filter frequency (tracking one another) to any arbitrary frequency. In FIX-TUNE mode, the FREQUENCY buttons and knob control only the notch filter frequency. The generator frequency remains at its last setting in FIX-TUNE mode.

### 5.10.7. Phase Function

PHASE function displays the phase difference between the selected input channels. The result is displayed in the upper left portion of the LCD. Selection of PHASE measurement function automatically selects sine waveform from the ATS-1 generator. If INPUT A has been selected, the measurement and display will be the phase at input A using the input B signal as reference; the display will be labeled PHASE A-B. If INPUT B is selected, the display will be of phase at input B using the A signal as reference and the label will indicate PHASE B-A. If the INPUT GEN button is pressed following selection of input channel A or B, a cable from the corresponding generator output to the selected analyzer input is used instead of the front-panel ANALYZER INPUT connector. The phase indication will then be labeled PHASE A-G or PHASE B-G, depending on which channel is measuring the input connector and which channel is the reference (generator) channel. This permits measurement of the output-to-input phase shift of a device whose input is driven by the ATS-1 generator and whose output is connected to the analyzer.

In PANELS mode with the analyzer setup parameters displayed, the lower left soft button permits selection among the phase ranges -270/+90, -90/+270, or -180/+180. The -270/+90 and -90/+270

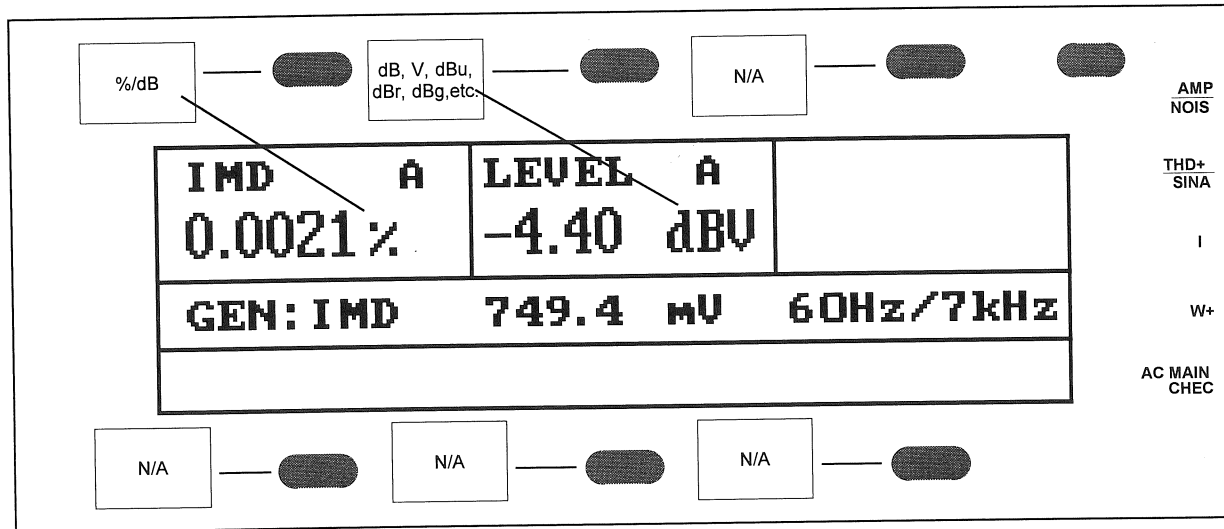


Figure 5-22 Typical Display, IMD (Intermodulation Distortion) Function

ranges are convenient when measuring devices or cables where the polarity is unknown. The lower right soft button selects between NOAVERAGE and AVERAGE modes. NOAVERAGE mode simply displays unprocessed phase readings at a rate of approximately three per second. AVERAGE mode displays a running average of the last eight readings to reduce the effects of jitter. It is particularly useful when adjusting azimuth in tape machines.

When setting bargraph end points in phase measurement function, press the soft key under the end of the bargraph to be changed. The numeric value will change to inverse video. Now, the  $\pm 10$  dB buttons of the AMPLITUDE controls will change the selected end-point value up or down in 90 degree steps and the INC/DEC buttons will change end points in 10 degree steps.

Both inputs must be at least 20 mV (-30 dBu) for specified accuracy, and have at least 40 dB signal-to-noise ratios. If the S/N ratio of either input is <40 dB, reading instability may result, particularly at low frequencies. If either input drops below about 8 mV (-40 dBu) or 10% of the selected fixed input range when the bargraph HOLD RANGE function is used, the phase display will show "Low".

### 5.10.8. IMD (Intermodulation Distortion) Function

IMD function, if the Intermodulation Distortion Option is installed, displays SMTPE/DIN intermodulation distortion of the selected channel at the upper left of the LCD display. Level of that channel is displayed at the upper center, with nothing displayed at the upper right. Units for the measurements are selectable by the soft buttons above the LCD. The IMD measurement function accepts signals with a low frequency tone between 40 Hz and 250 Hz, a high frequency tone between 3 kHz and 20 kHz, and a low-to-high tone amplitude ratio between 0:1 and 8:1. The IMD measurement technique demodulates the AM (amplitude modulation) products of the upper tone caused by the presence of the lower tone. The measurement is bandwidth-limited to approximately 20 Hz-700 Hz to minimize noise contributions, yet pass the 3rd order IM products at 500 Hz when the low frequency tone is 250 Hz. Intermodulation distortion can only be displayed in % of (or dB below) the high-frequency tone amplitude, so no absolute units are available for the IMD reading.

Selecting IMD function automatically selects the IMD signal waveform from the ATS-1 generator, although the waveform can then be manually changed in PANELS mode with the generator setup parameters displayed. When going from IMD function to

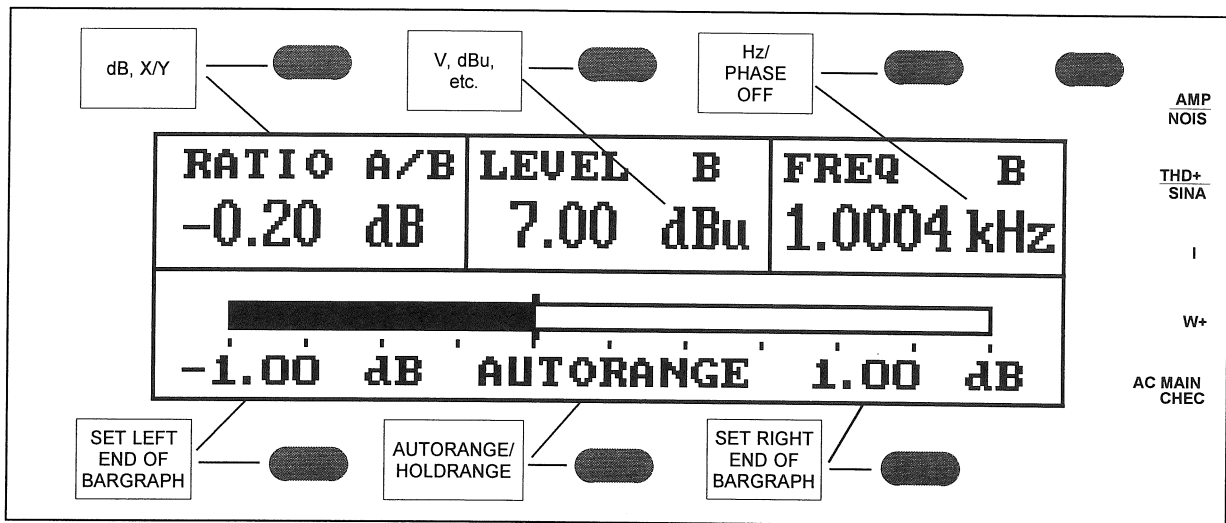


Figure 5-23 Typical Display, Level Ratio Function

any other function, the generator waveform will change to sinewave. In PANELS mode with only the generator setup parameters displayed, the soft buttons above and below the right corners of the LCD permit selection of the generator high and low frequency tones. The high frequency tone may be selected as either 7 kHz or 8 kHz. SWEEP mode is not available in IMD function since the standards define a fixed set of frequencies. The low frequency tone may be selected from the choices of 50 Hz, 60 Hz, 70 Hz, or 250 Hz. Although the SMPTE stand-

ard calls for a 60 Hz/7 kHz signal, experience suggests that the lower tone should not be a multiple of the ac mains frequency. 250 Hz/8 kHz is an acceptable combination under the DIN standard. The amplitude ratio of the low-frequency tone to the high-frequency tone is fixed at 4:1.

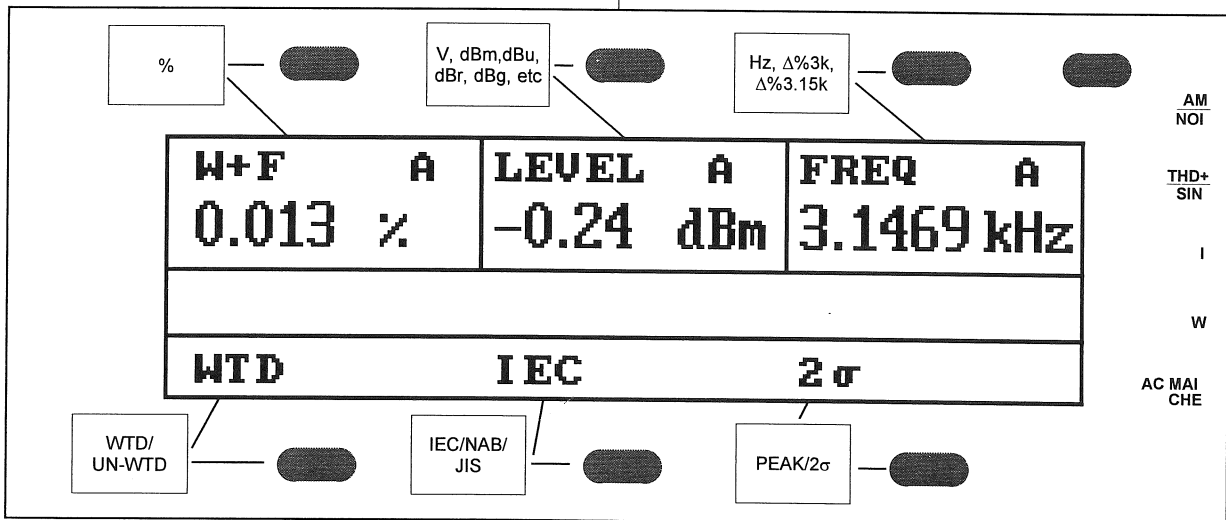


Figure 5-24 Typical Display, W+F (Wow and Flutter) Function

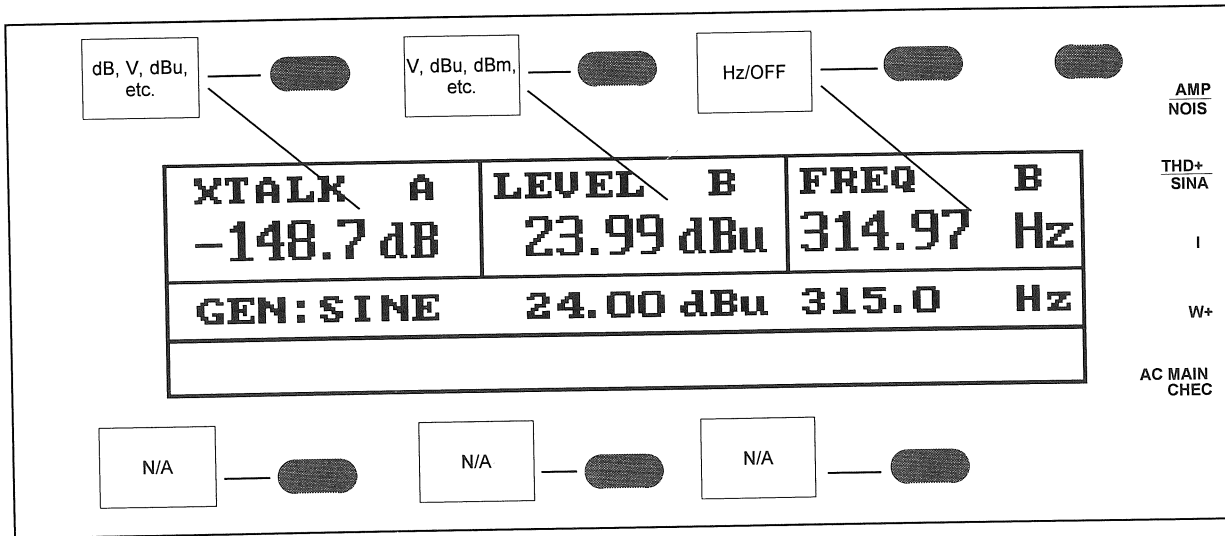


Figure 5-25 Typical Display, XTALK (Crosstalk/Stereo Separation) Function

### 5.10.9. Level Ratio Function

LEVEL RATIO function measures the true RMS amplitude of both input channels, computes the ratio of those two amplitudes, and displays that ratio at the upper left of the LCD display. The selected input channel is the numerator of the computed ratio, and the alternate channel is the denominator. The label of the display will indicate the channel assignments (RATIO A/B or RATIO B/A). Level of the alternate channel is displayed at the upper center, and frequency or phase at the upper right, selectable by the upper right soft button. Units for all measurements are selected by soft keys above the LCD display; the RATIO display unit may be dB or, with X/Y selected, the pure ratio number. No filters are selectable in LEVEL RATIO function. Selecting RATIO function automatically selects the sine waveform from the ATS-1 generator.

With both input connectors selected and a stereo signal applied, LEVEL RATIO function is a measurement of channel balance. If the INPUT GEN button is pressed to connect an analyzer input to generator output via the internal cable path, the display will indicate RATIO B/G or RATIO A/G and the display will indicate the voltage gain or loss through the external device.

### 5.10.10. W+F (Wow and Flutter) Function

W+F function measures wow and flutter of tape recorders and turntables to the IEC (DIN), NAB, or JIS standards at frequencies of 3 kHz or 3.15 kHz. SWEEP mode is not available in wow and flutter function. Wow and flutter is displayed at the upper left of the display, level of the measured signal at the upper center, and frequency of the measured signal at the upper right. Selection of W+F measurement function automatically selects the sine waveform from the System One generator. If the input frequency is not between 2.8 kHz and 3.35 kHz, the upper left display will indicate Hi Fr (high frequency) or Lo Fr (low frequency). The desired standard detector response is selected from the IEC (DIN), NAB, and JIS choices by the lower center soft key in PANELS mode with analyzer setup parameters displayed. Weighted versus unweighted measurements are selected by the lower left soft key. The lower right soft key selects between PEAK measurements updated three times per second, or a running calculation of the 2-sigma value. The 2-sigma value is the value exceeded no more than 5% of the time (the second-highest reading of a running 20-reading group).

Wow and flutter is normally measured while playing a reference tape or disc which was recorded on a very low flutter machine. Wow and flutter of 3-head tape recorders should not be measured during simultaneous record-reproduce mode, since this will result in spectral nulls which can give erroneously low readings. If a reference tape is not available, record a 3.00 kHz or 3.15 kHz signal on a tape, then rewind the tape and measure during reproduce mode.

When a reference tape or disc is being played for the wow and flutter measurement, the measured frequency becomes a measurement of the speed error of the recorder or turntable. The soft key above the upper right of the display permits changing the display between absolute frequency and speed error in percent relative to the reference frequency. The display is labeled "FREQ" in absolute frequency mode and "3.00 kHz" or "3.15 kHz" to indicate the reference frequency used in the relative (speed error) modes. The unit in relative modes is delta%.

**5.10.11. XTALK (Crosstalk) Function**

XTALK function measures the RMS level of the non-driven channel of a stereo pair or other two-channel system, using the tunable bandpass filter in order to make accurate measurements even below the wide-band noise level. Crosstalk is displayed in the upper left portion of the display, level of the

driven channel in the upper center portion, and the measured frequency of the driven channel in the upper right. Units for the measurements may be selected with the soft buttons above the display. Selecting XTALK measurement function automatically selects the sine waveform from the Portable One Plus generator, with the generator output channel which corresponds to the selected analyzer input channel turned OFF and the alternate generator channel turned ON. When the opposite analyzer channel is then selected by the INPUT button, the generator output channel to be driven will be correspondingly changed. The analyzer bandpass filter is automatically tuned to the signal frequency measured on the driven channel. If the signal on the driven channel is below 8 mV (-40 dBu), the counter cannot read the frequency accurately and the XTALK and FREQ displays will both indicate "Low". No fixed filters are selectable in XTALK function.

When the dB unit is selected for XTALK, the display is the computed, real-time dB difference in amplitude between the driven and non-driven channels. The other XTALK units (Volts, dBV, dBu, dBm, and dBr) display the absolute value of amplitude on the non-driven channel.

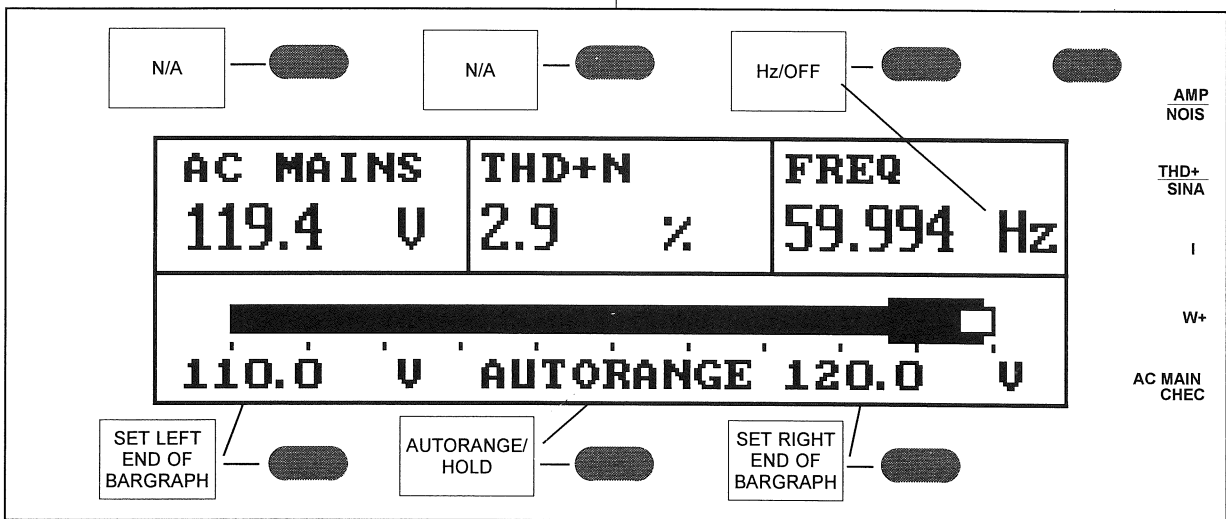


Figure 5-26 Typical Display, AC Mains Check Function

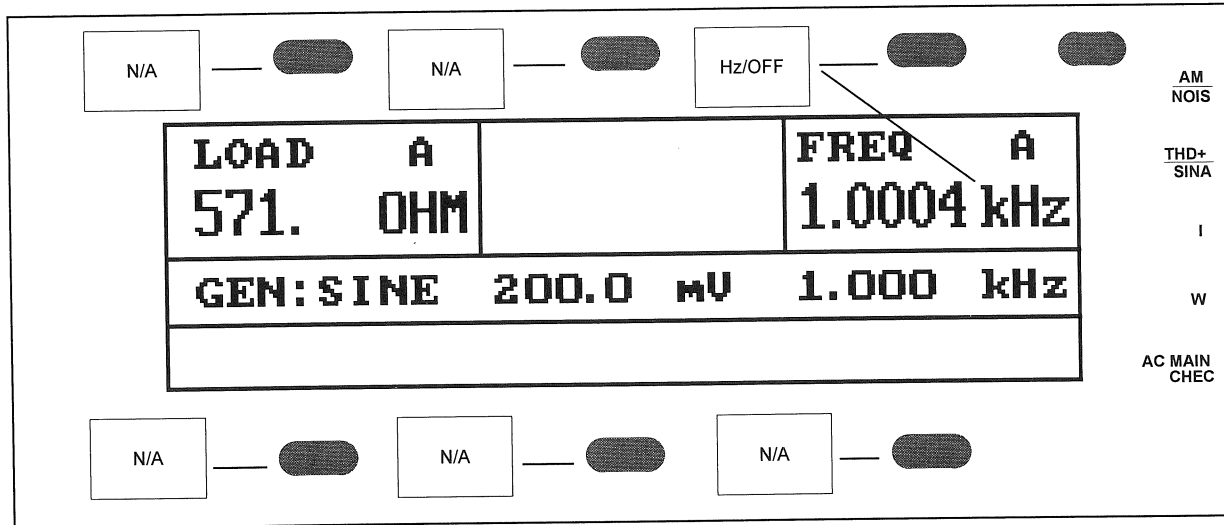


Figure 5-27 Typical Display, Gen Load (Device Input AC Resistance) Function

### 5.10.12. AC MAINS CHECK (Power Line Monitor) Function

AC MAINS CHECK function measures and displays three key parameters of the ac mains (power line) supplying the ATS-1. This provides this often-needed information without the difficulty and hazard of making up or using ac mains cables connected to the instrument input. The RMS voltage of the mains supply is displayed at the upper left of the display, THD+N (20 kHz bandwidth) at the display center, and power mains frequency at the upper right. SWEEP mode is not available in AC MAINS CHECK function. The signal at the rear-panel ANALYZER BNC connector in AC MAINS CHECK mode consists of the distortion products following the THD+N notch filter.

The bargraph function may be conveniently used to monitor the ac mains supply for extended periods of time, with the wide portions (minimum hold and maximum hold) of the bargraph then indicating the extreme values reached by the power line during the monitoring period. A printout of the bargraph after a period of time thus provides a maximum/minimum line voltage recording function. The maximum and minimum values are specifically, numerically shown in the printout in addition to the analog indication of maximum and minimum shown by the wider portion of the bargraph. To set bargraph end

point calibration, press the soft button under the end of the bargraph to be changed. The AMPLITUDE buttons and knob may then be used to set the value desired. The +10 dB and -10 dB buttons select values which are exact multiples of 10.0 Volts in this mode, and the INC and DEC buttons select exact multiples of 1.00 Volt.

AC MAINS CHECK function is also used as the access to self test mode. In PANELS mode with analyzer setup parameters displayed, the lower left soft button is labeled SELF TEST when in AC MAINS CHECK function. Pressing this button enters self test mode and enables a functional test of the ATS-1. See the SET-UP AND CHECK-OUT chapter for more details on self test.

### 5.10.13. GEN LOAD Function (Device Input Resistance)

The GEN LOAD function measures the equivalent ac resistance (magnitude) of the load connected to either generator output connector. The measuring technique uses the 600 Ohm source impedance of the ATS-1, measures the terminal voltage with the external load connected, and computes the value of the equivalent resistive load. The technique is thus quite sensitive at low values of device input resistance and becomes progressively less sensitive at high values, indicating only ">20 k" in the case of



very high load resistances. Please note that the error with purely reactive loads can exceed 50%. Selecting GEN LOAD function automatically selects the sine waveform from the ATS-1 generator. This measurement is normally made at 1 kHz, but the generator frequency may be changed to any other value if desired to see any variation of device input resistance with frequency. In SWEEP mode, the generator frequency may be swept across any selected frequency range to provide a graph of input resistance versus frequency. This may be particularly useful, for example, to display loudspeaker impedance curves. Note that a 200 mV signal is normally applied to the output connectors in order to make this measurement, so be sure a signal of this level will not harm the device to be measured before connecting the cable and selecting GEN LOAD.



## 6. DIAGRAMS

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This chapter contains several diagrams to assist your understanding of how the ATS-1 accomplishes its measurement tasks. While knowledge of internal circuitry is not required in order to operate the ATS-1, it may be more intelligently applied and limitations may be better understood by reference to these diagrams.

### 6.1. Instrument Functional Block Diagram

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Figure 6-1 is a simplified block diagram of the ATS-1. The generator consists of a sinewave main oscillator or squarewave generator transformer-coupled to the output connectors. Figure 6-2 shows more detail on the generator output circuitry. When the IMD (Intermodulation Distortion) option is present, a second sinewave oscillator is added whose output is summed with the main oscillator to provide the necessary two-tone output signal. With the IMD waveform selected, the rear connector carries the lower-frequency of the IMD tone pair.

The ATS-1 analyzer consists of two identical wide-range autoranging preamplifiers, a principal meter with filters, a secondary meter, a wow and flutter discriminator, and phase and frequency meters. The principal meter consists of a switchable and tunable bandpass or bandreject filter, additional amplification, built-in high-pass and low-pass filters, built-in CCIR and A-weighting filters, and two sockets for optional filters. The bandreject filter is used only in THD+N and SINAD functions. The bandpass filter is used only in the SELECTIVE modes of AMPLITUDE and NOISE functions and in XTALK function. The output of either the principal meter or the wow and flutter discriminator feeds the primary reading detector. The primary detector, depending upon measurement function and setup parameters of that function, may have true RMS, average, or quasi-peak response. This primary reading detector is normally displayed in the upper-left corner of the display in PANELS mode and graphed with the solid lines in sweeps of all functions except

PHASE. In LEVEL function the filters, additional amplification, and selectable detectors are excluded from the principal meter circuit in order that both meters become identical.

The secondary meter and reading detector have no selectable filters, less gain than the primary meter (10 mV minimum signal for fully-specified performance), and true RMS response only. The measurement of the secondary reading detector is displayed in the upper center portion of the display in LEVEL, THD+N, SINAD, PHASE, IMD, RATIO, W+F, and XTALK functions.

Either the PHASE measurement or the FREQUENCY counter measurement may be displayed in the upper right portion of the display in many functions. In PHASE function, the phase measurement is displayed in the upper left portion of the display.

The AC MAINS CHECK function works by measuring the input line voltage through very large resistors connected directly at the power mains input connector.

The signal monitored by the loudspeaker or headphones is normally picked off at the selected input channel, following input autoranging but preceding any filtering. An internal jumper may be changed to move the pickoff point to the end of the principal meter, following all filtering.

#### 6.1.1. Rear Panel Connectors

A rear-panel BNC connector labeled OSCILLOSCOPE TRIGGER carries a fixed-amplitude sinewave signal at the main oscillator frequency. The rear-panel INPUT MONITOR BNC connector monitors the selected input channel following the input autoranging and thus provides a relatively constant amplitude even as the input signal amplitude varies from 25 mV to 140 Volts. The rear-panel

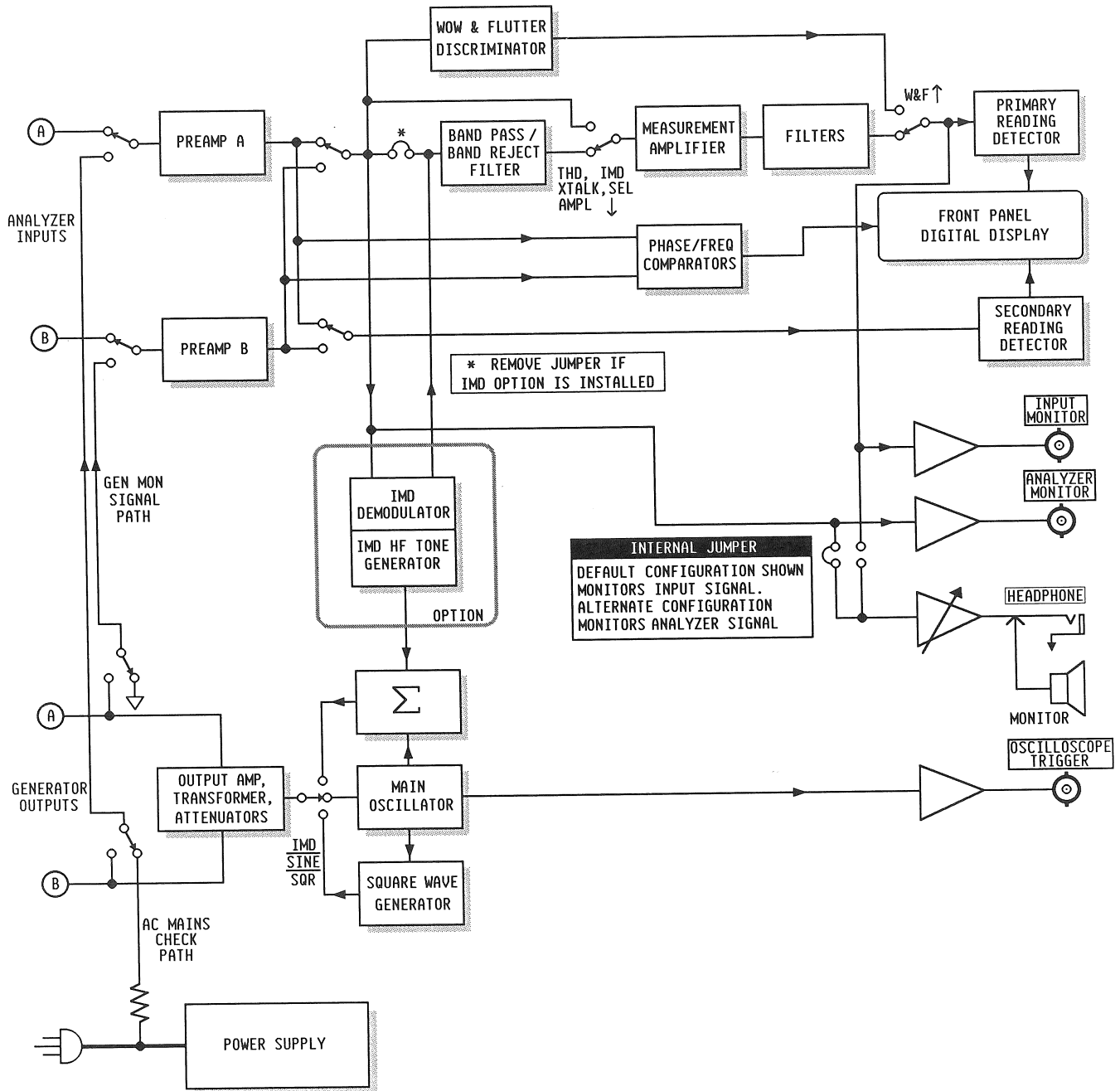


Figure 6-1 Simplified Block Diagram, ATS-1

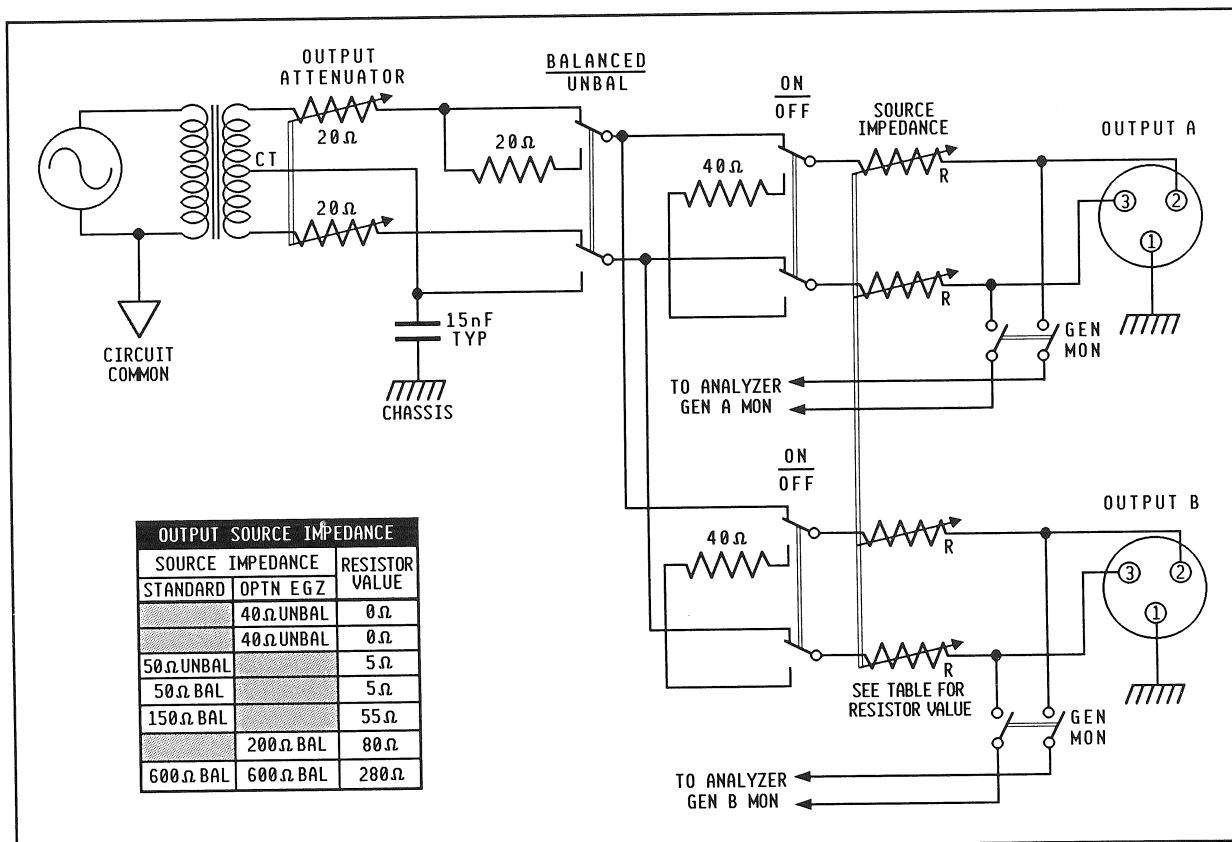


Figure 6-2 Simplified Diagram, Generator Output

ANLR MONITOR connector carries the final signal from the principal meter, following all filters and other processing but preceding the detector.

### 6.1.2. Control, Display, and Operator Interface

A microprocessor (not shown) controls all selectable and variable functions such as generator frequency, generator amplitude, analyzer filter frequency, preamp range selection, filter selection, detector response selection, etc. The outputs of the detectors, frequency counter, and phase meter are also processed and formatted for display by the microprocessor. RAM powered by a back-up battery is used to store the last-used units and filter and mode selections for each measurement function so that they will be automatically restored when that function is next selected. EEPROM stores individual calibration factors for each instrument.

## 6.2. Generator Output Circuit

Figure 6-2 shows a simplified circuit diagram of the output circuitry of the ATS-1 generator. The power amplifier is transformer-coupled to a balanced, compensated resistive attenuator. This attenuator and an electronically-variable gain control in the generator circuit are both controlled by the instrument microprocessor in order to provide the specific output amplitude selected by the operator with the AMPLITUDE knob and buttons. The transformer center-tap is not dc connected to the instrument ground. When the 50 Ohm unbalanced mode is selected, signal is taken between the transformer center-tap and the high terminal of the transformer. Pin 2 of the generator XLR connectors is hot in unbalanced mode, working against pin 3 low. An additional 20 Ohm source resistance is switched in

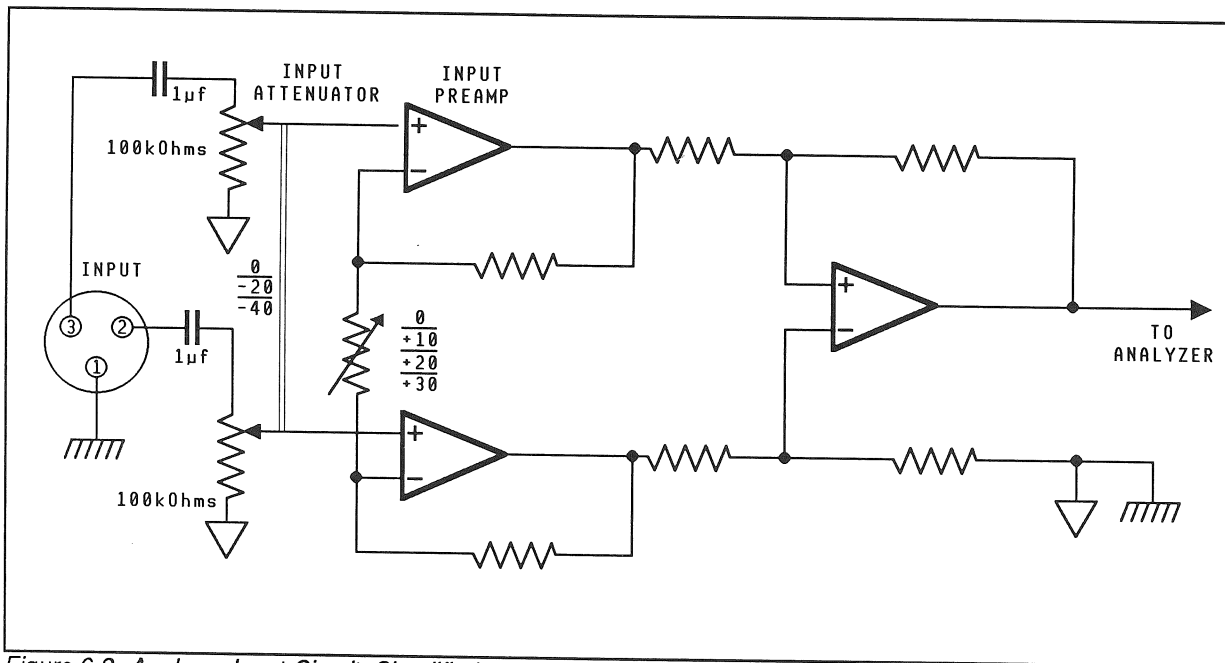


Figure 6-3 Analyzer Input Circuit, Simplified

series with the high terminal in unbalanced mode to preserve the same source impedance as in balanced mode.

When the generator output is turned off, a floating 50 Ohm resistor is connected in place of the generator to back-terminate the output connector so that proper noise measurements may be made. Output impedance selection is made by switching buildout resistors at the output connector. When the INPUT GEN button is pressed so that the analyzer can measure generator output, the connection (labeled GEN MON) in the diagram is made directly across the output connector terminals. Note that the power amplifier, output transformer, and output attenuator are common to both output channels.

### 6.3. Analyzer Input Circuit

Figure 6-3 is a simplified diagram of one channel of the analyzer input. The circuit is a true instrument-grade differential (balanced) input. Both sides (pins 2 and 3) are loaded with 100,000 Ohms to ground, high enough to bridge most audio circuits. The net gain from the input connector to the

analyzer proper is set by a combination of compensated resistive attenuator (zero, 20 dB, or 40 dB attenuation) and switchable-gain amplifiers (zero, +10, +20, or +30 dB gain). Both the attenuator setting and amplifier gain are microprocessor-controlled as part of an automatic ranging circuit, to maintain the signal level fed on to the remainder of the analyzer at an optimum level for low noise and distortion.

## 7. SPECIFICATIONS

### GENERATOR CHARACTERISTICS

Signals	Sine, square, IMD signal (optional)
Frequency Range	10 Hz-120 kHz, sinewave 20 Hz-30 kHz, squarewave
Frequency Resolution	0.02%
Frequency Accuracy	±0.5%
Amplitude Range <sup>1</sup>	0.25 mV-26.25 V [-70 to +30.6 dBu] for 20 Hz-30 kHz sinewaves; 0.25 mV-12.28 V [-70 to +24 dBu] for all other signals
Amplitude Resolution	0.01 dB
Amplitude Accuracy	±0.2 dB, sinewave; ±0.3 dB, squarewave and IMD
Output Impedances	600 BAL, 150 <sup>2</sup> BAL, 50 BAL, 50 UNBAL; all ±2 Ohms. Transformer coupled
Maximum Output Current	75 mA peak BAL; 150 mA peak UNBAL
Sinewave Flatness	±0.05 dB, 10 Hz-20 kHz; ±0.3 dB, 20 kHz-120 kHz
Sinewave THD+N <sup>3</sup>	0.0025% + 3 μV (80 kHz BW), 25 Hz-20 kHz; 0.010% + 10 μV (>300 kHz BW), 10 Hz-100 kHz
Residual Output Xtalk	10 μV or -110 dB to 20 kHz
Squarewave Risettime	2.5-3.0 μsec.

### ANALYZER CHARACTERISTICS

Input Impedance	100 kOhms (±1%) // 150-200 pF, each side to ground.
Maximum Rated Input	350 Vpeak; 250 Vrms, dc-20 kHz.
Common-Mode Rejection	70 dB, 50 Hz-20 kHz, V <sub>in</sub> ≤ 2 V; 50 dB, 50 Hz-1 kHz, V <sub>in</sub> > 2 V

### AMPLITUDE/NOISE FUNCTIONS

Measurements can be unweighted (UN-WTD), weighted (WTD), or SELECTIVE

Measurement Range	<1 μV-250 V [-118 to +50 dBu]
Accuracy	±0.2 dB UN-WTD; ±0.5 dB WTD or SELECTIVE
Flatness (UN-WTD)	±0.05 dB, 20 Hz-20 kHz ±0.2 dB, 10 Hz-50 kHz ±0.5 dB, 50 kHz-120 kHz -3 dB at >300 kHz
UNWTD Mode Filters	400 Hz ±5% (3 pole) or <10 Hz (no highpass) plus 22 kHz ± 5% (5 pole) <sup>4</sup> , 30 kHz ± 5% (3 pole), 80 kHz ± 5% (3 pole), or >300 kHz (no lowpass)

WTD Mode Filters	400 Hz ±5% (3 pole) or <10 Hz (no highpass) plus "IEC-A" per IEC 179 (rms det.); "CCIR-QPK" per CCIR Rec 468; "CCIR-ARM" per Dolby Bulletin 19/4; "CCIR-RMS" (0 dB at 1 kHz, rms det.) AUX1 or AUX2 (option filters)
Selective Tuning Range	20 Hz-120 kHz ±3% (2-pole, Q=5)
Residual Noise	1.5 μV [-114 dBu], UNWTD 22-22 kHz; 1.0 μV [-118 dBu], WTD IEC-A 5.0 μV [-104 dBu], WTD CCIR-QPK;

### THD+N/SINAD FUNCTIONS

The THD+N function features three different tuning modes: "AUTO-TUNE" (determined by input frequency counter), "GEN-TRACK" (ganged to generator setting), or "FIX-TUNE" (set using the front panel frequency controls, ±3% lock range). Measurements can be unweighted (UN-WTD) or weighted (WTD) using the same filters as the Amplitude/Noise function. Display also includes input level and frequency (notch frequency in FIX-TUNE mode).

Fundamental Range	10 Hz-100 kHz, THD+N mode; 400 Hz or 1 kHz (±3%), SINAD mode
Measurement Range Accuracy	<0.001%-100% ±1 dB, harmonics to 120 kHz
Residual THD+N <sup>3</sup>	0.0025% + 3 μV (80 kHz BW), 25 Hz-20 kHz; 0.010% + 10 μV (>300 kHz BW), 10 Hz-100 kHz
Minimum Input	20 mV <sup>5</sup> [-30 dBu] in AUTO-TUNE mode; 800 <sup>6</sup> μV [-60 dBu] in other modes.
Nulling Time	Typically 2-3 seconds above 25 Hz. Increases in a "1/V" fashion for inputs below 20 mV [-30 dBu]

### WOW & FLUTTER FUNCTION

Measurements are processed to display only the highest ("PEAK") or second-highest ("2σ") of the previous 20 raw readings. Display also includes input level and frequency. The frequency readout can be selected to display the absolute frequency, or speed error relative to 3.00 kHz or 3.15 kHz.

Test Signal Frequency	2.80 kHz to 3.35 kHz
Detection Modes	IEC (quasi-peak), NAB (average), or JIS
Response	UNWTD (0.5-200 Hz BW) or WTD per IEC 386
Measurement Range	<0.005%-3% (single range)
Accuracy	±[5% of reading + 0.002%]
Residual W+F	≤0.005% WTD; 0.01% UNWTD
Minimum Input	20 mV <sup>5</sup> [-30 dBu]

**LEVEL FUNCTION**

Displays both input levels simultaneously, plus phase difference or frequency of the selected input.

Range	<10 mV-250 V [-38 to +50 dBu].
Accuracy	±[0.1 dB +100 µV] (rms detection)
Response Flatness ( $V_{in} \geq 10$ mV)	±0.05 dB, 20 Hz-20 kHz; ±0.2 dB, 10 Hz-50 kHz; ±0.5 dB, 50 kHz-120 kHz; -3 dB at ≥300 kHz

**LEVEL RATIO FUNCTION**

Measurement Range	<-80 dB to +100 dB, 0.01 dB resolution
Accuracy	±0.1 dB, 20-20 kHz
Minimum Input	10 mV [-38 dBu], numerator signal; 10 µV [-98 dBu], denominator signal

**PHASE FUNCTION**

Measurement Ranges	-270/+90°, -180/+180°, or -90/+270°, 0.1° resolution
Accuracy	±2°, 20 Hz-20 kHz, ±5°, 10 Hz-50 kHz
Minimum Input	20 mV <sup>5</sup> [-30 dBu], both channels

**CROSSTALK FUNCTION**

Similar to RATIO function except numerator signal is processed by a tracking bandpass filter (2 pole, Q = 5).

Measurement Range	-140 dB to 0 dB
Accuracy	±0.5 dB
Frequency Range	10 Hz-120 kHz
Residual Input Xtalk	-120 dB at 20 kHz, $R_s \leq 600$ Ohms
Minimum Input	20 mV <sup>5</sup> [-30 dBu] in reference channel

**AC MAINS CHECK FUNCTION**

Displays voltage, THD+N (20 kHz BW limited), and frequency of the ac mains

Measurement range	0.85-1.10 of nominal setting
Voltage Accuracy	±1%

**GEN LOAD FUNCTION**

Displays the equivalent ac resistive loading on selected generator output. Intended for checking input terminations, loudspeaker impedance, or locating shorts.

Measurement Range	<1 Ohm to 20 kOhm
Accuracy	±[5% +0.5 Ohm] for readings ≤ 1 kOhm. Degrades rapidly above 1 kOhm, or with reactive loads.
Frequency Range	20 Hz-20 kHz
Test Voltage	200 mV default. Usable from 10 mV to generator maximum.

**FREQUENCY MEASUREMENT (all functions)**

Measurement Range	<10 Hz->200 kHz
Accuracy	±0.01% [100 PPM]
Resolution	5 digits
Minimum Input	20 mV <sup>5</sup> [-30 dBu]

**AUXILIARY OUTPUT SIGNALS**

Analyzer Signal	Buffered analyzer output signal. Typically 3 Vpp max, $R_{out} = 600$ Ohm ±10%.
Input Signal	Buffered version of selected input. 0.8Vp-p-3 Vpp nominal range, $R_{out} = 600$ Ohm ±10%.
Generator Sync	3 Vpp sinewave at same frequency as generator (LF tone only with IMD). $R_{out} = 680$ Ohm ±10%.

**IMD OPTION CHARACTERISTICS**

Generator Signal	Selectable 50-60-70-250 Hz (±1%) plus 7 kHz or 8 kHz (±1%), mixed in a 4:1 ratio (LF:HF)
Analyzer Signal Compatibility	Any combination of 40-250 Hz (LF) and 3 kHz-20 kHz (HF) tones, mixed in any ratio from 0:1-8:1 (LF:HF)
Measurement Range	<0.0025%-20%
Accuracy	±1 dB, per SMPTE RP120-1983, DIN 45403
Residual IMD <sup>3</sup>	0.0025% [-92 dB], $V_{in} \geq 200$ mV
Minimum Input	100 mV <sup>5</sup>

**GENERAL CHARACTERISTICS**

Temperature Range	0C to +40C, operating -20C to +60C, storage
Power Requirements	100/120/220/240 V (-12%/+10%), 48-63 Hz 60 VA max
Dimensions (WxHxD)	16.5 x 6.0 x 13.6 inches [41.9 x 15.2 x 34.5 cm]
Weight	Approx. 20 lbs [9.1 kg]

**NOTES TO SPECIFICATIONS**

- 1 Open-circuit, balanced source impedance selection. Reduce maximum amplitude by a factor of 2 [-6 dB] with 40 Ohm UNBALanced output impedance selection. Accuracy and flatness are unspecified below 0.5 mV.
- 2 Option EGZ provides 40Ω BAL, 200Ω BAL, 600Ω BAL, and 40Ω UNBAL selection
- 3 System specification including contributions from both generator and analyzer. Generator  $R_{load}$  must be ≥600Ω.
- 4 Combined with 22 Hz highpass per CCIR Rec 468. "22 kHz-QPK" selection uses quasi-peak detection per CCIR Rec 468.
- 5 For fully specified performance. Usable with inputs as low as 10 mV. Measurements are disabled for inputs below approximately 8 mV.
- 6 Input must be ≥10 mV with "%" or "dB" unit for specified accuracy.



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