



**PLEASE CHECK FOR CHANGE INFORMATION  
AT THE REAR OF THIS MANUAL.**

**AA 501A  
DISTORTION  
ANALYZER  
WITH OPTIONS 01 AND 02**

**INSTRUCTION MANUAL**


**Tektronix, Inc.  
P.O. Box 500  
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070-6592-00  
Product Group 76**

Serial Number \_\_\_\_\_

First Printing JUL 1987  
Revised NOV 1987

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**WARNING**

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.

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# OPERATORS SAFETY SUMMARY

This general safety information is for both operating and servicing personnel. Specific warnings and cautions will be found throughout the manual where they apply, but may not appear in this summary.

## TERMS

### In This Manual

**CAUTION** statements identify conditions or practices that can result in damage to the equipment or other property.

**WARNING** statements identify conditions or practices that can result in personal injury or loss of life.

### As Marked on Equipment

**CAUTION** indicates a personal injury hazard not immediately accessible as one reads the marking, or a hazard to property including the equipment itself.

**DANGER** indicates a personal injury hazard immediately accessible as one reads the marking.

## SYMBOLS

### In This Manual



This symbol indicates where applicable cautionary or other information is to be found.



Protective ground (earth) terminal.



ATTENTION—refer to manual.



Refer to manual.

### Power Source

This product is designed to operate from a power module that does not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

### Grounding the Product

This product is grounded through the grounding conductor of the power module power cord. To avoid electrical shock, plug the power cord into a properly wired receptacle before connecting to the product input or output terminals. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.

### Danger Arising From Loss of Ground

Upon loss of the protective-ground connection, all accessible conductive parts (including knobs and controls that may appear to be insulating) can render an electric shock.

### Use the Proper Power Cord

Use only the power cord and connector specified for your product.

Use only a power cord that is in good condition.

Refer cord and connector changes to qualified service personnel.

### Use the Proper Fuse

To avoid fire hazard, use only the fuses specified in the parts list for your product, and which is identical in type, voltage rating and current rating.

Refer fuse replacement to qualified service personnel.

### Do Not Operate in Explosive Atmospheres

To avoid explosion, do not operate this product in an atmosphere of explosive gases unless it has been specifically certified for such operation.

### Do Not Operate Plug-in Unit Without Covers

To avoid personal injury, do not operate this product without covers or panels installed. Do not apply power to the plug-in via a plug-in extender.

# **SERVICING SAFETY SUMMARY**

## **FOR QUALIFIED SERVICE PERSONNEL ONLY**

*Refer also to the preceding Operators Safety Summary*

### **Do Not Service Alone**

Do not perform internal service or adjustment of this product unless another person capable of rendering first aid and resuscitation is present.

### **Use Care When Servicing With Power On**

Dangerous voltages may exist at several points in this product. To avoid personal injury, do not touch exposed connections and components while power is on.

Disconnect power before removing protective panels, soldering, or replacing components.

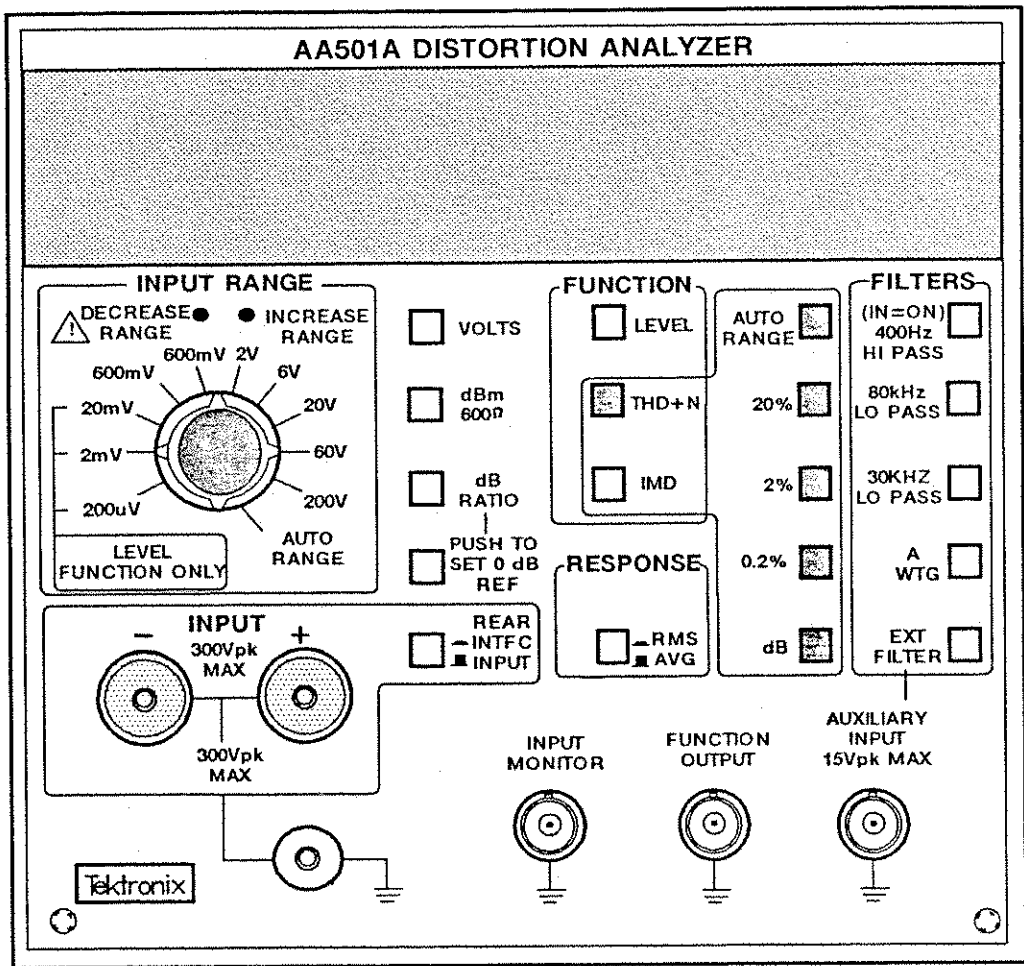
### **Do Not Wear Jewelry**

Remove jewelry prior to servicing. Rings, necklaces, and other metallic objects could come into contact with dangerous voltages and currents.

### **Power Source**

This product is intended to operate from a power module that will not apply more than 250 volts rms between the supply conductors or between either supply conductor and ground. A protective ground connection by way of the grounding conductor in the power cord is essential for safe operation.





6592-13

AA 501A Distortion Analyzer.



# SPECIFICATION

## Instrument Description

The AA 501A is a fully automatic distortion analyzer packaged as a two-wide TM 500 plug-in. Total harmonic distortion is measured with the standard instrument. Option 01 instruments also measure SMPTE/DIN intermodulation distortion and CCIF two-tone difference frequency distortion. In addition, Option 02 instruments permit noise measurements in accordance with CCIR recommendation 468-2 or DIN 45405.

Distortion set level, frequency tuning and nulling are fully automatic, requiring no operator adjustment. Input level range and distortion measurement range selections are fully automatic or may be manually selected. Distortion readout is provided in percent or dB.

The AA 501A is also a high sensitivity, autoranging, audio frequency voltmeter. Readings may be in volts, dBm, or dB relative to any arbitrary reference.

Filters are included which allow measurement of noise to IHF and FCC specifications. Option 02 instruments provide a quasi-peak detector for noise measurements in accordance with CCIR or DIN standards. A hum rejection filter is provided as are provisions for external filters.

All readings are displayed on a 3 1/2 digit readout. An uncalibrated analog readout is also provided to aid in nulling and peaking applications.

Ac to dc conversion is either average or true rms responding, allowing conformance with most standards. Op-

tion 02 instruments provide quasi-peak or true rms detection. This feature permits comparison with readings obtained on other instruments.

Ac input and output connections are available on both the front panel and the rear interface. Dc signals, corresponding to the displayed reading, are available through the rear interface. This allows flexibility in interconnection with other instruments such as filters, chart recorders, spectrum analyzers, oscilloscopes, etc.

## Performance Conditions

The electrical characteristics in this specification are valid only if the AA 501A has been adjusted at an ambient temperature between +20°C and +30°C. The instrument must be in a noncondensing environment whose limits are described under the environment section. Allow twenty minutes warm-up time for operation to specified accuracy; sixty minutes after exposure to or storage in a high humidity (condensing) environment. Any conditions that are unique to a particular characteristic are expressly stated as part of that characteristic.

The electrical and environmental performance limits, together with their related validation procedures, comprise a complete statement of the electrical and environmental performance of a calibrated instrument.

Items listed in the Performance Requirements column of the Electrical Characteristics are verified by completing the Performance Check in the Calibration section of this manual. Items listed in the Supplemental Information column are not verified in this manual.

**Table 1-1**  
**ELECTRICAL CHARACTERISTICS**

Characteristics	Performance Requirement		Supplemental Information
<b>INPUT (all functions)</b>			
Impedance	100 k $\Omega$ $\pm$ 2%, each side to ground		Full differential. Each side ac coupled through 1 $\mu$ F and shunted to ground by approximately 200 pF. Dual banana jack connectors at 0.750 inch spacing with ground connector additionally provided.
Input ranges	200 $\mu$ V to 200 V in 10 steps		2-6 sequence from 200 $\mu$ V to 200 V Range selection is manual or automatic. Autoranging time is typically < 1 second. Separate increase range and decrease range indicators illuminate whenever input level does not fall within optimum window for selected range. For specified instrument performance both indicators must be extinguished.
Maximum input voltage			300 V peak, 200 V rms either input to ground or differentially. Will recover without damage from continuous overloads of 120 V rms or 200 V rms for 30 minutes on all ranges. For linear response, peak input voltage must not exceed 3 times INPUT LEVEL RANGE setting.
Common mode rejection (inputs shorted)	$\geq$ 50 dB at 50 or 60 Hz for common mode signals up to one-half of selected input range or 50 mV, whichever is greater.		Typically $\geq$ 40 dB to 300 kHz.
<b>LEVEL FUNCTION</b>			
Modes			Volts, dBm (600 $\Omega$ ), or dB ratio with push to set 0 dB reference. Input range determines display range. Single effective range in dB modes with 0.1 dB resolution. Stored 0 dB reference is unaffected by subsequent changes in mode or function.
Accuracy $V_{in} \geq 100 \mu$ V (-78 dBm) with level ranging indicators extinguished ( $T \leq +40^\circ$ C)	VOLTS	dBm OR dB RATIO	
20 Hz to 20 kHz	Within $\pm(2\% + 1$ count)	$\pm 0.3$ dB $\pm 0.5\%$ of reading	
10 Hz to 20 Hz and 20 kHz to 100 kHz	Within $\pm(4\% + 2$ counts)	$\pm 0.5$ dB	
Bandwidth (no filters selected)	At least 300 kHz		

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
Residual noise (Inputs shorted, $T \leq +40^{\circ}\text{C}$ )	$\leq 3.0 \mu\text{V}$ ( $-108 \text{ dBm}$ ) with 80 kHz, 400 Hz filters. Standard and Option 01 instruments only. $\leq 1.5 \mu\text{V}$ ( $-114 \text{ dBm}$ ) with A weighting filter. Option 02 only. $\leq 5.0 \mu\text{V}$ ( $-104 \text{ dBm}$ ) with CCIR weighting and quasi-peak response.	DC 510/DC 5010 radiated magnetic interference will degrade residual noise above specifications if installed directly to the left of the AA 501A.
<b>TOTAL HARMONIC DISTORTION PLUS NOISE FUNCTIONS</b>		
Fundamental frequency range	10 Hz to 100 kHz	Fully automatic tuning and nulling. For proper tuning $\text{THD} + \text{N} \leq 10\%$ . After initial tuning $\text{THD} + \text{N}$ can degrade to 30% without loss of lock for SINAD testing. Typical nulling time is less than 5 s above 20 Hz.
Distortion ranges		Auto-range, 20%, 2%, 0.2%, and dB. dB is internally autoranging with single effective display range. Auto range allows measurements above 20%.
Accuracy ( $\text{THD} \leq 30\%$ and readings $\geq 4\%$ of selected distortion range).		Accuracy is limited by residual $\text{THD} + \text{N}$ and filter selection. 100% reference level is total input signal amplitude including distortion and noise components.
20 Hz to 20 kHz	Within $\pm 10\%$ ( $\pm 1 \text{ dB}$ ) for harmonics $\leq 100 \text{ kHz}$ .	
10 Hz to 100 kHz	Within $+10\% - 20\%$ ( $+1 \text{ dB}, -2 \text{ dB}$ ) for harmonics $\leq 300 \text{ kHz}$	
Residual $\text{THD} + \text{N}$ ( $V_{in} \geq 250 \text{ mV}$ , all distortion, noise, and nulling error sources combined, $T \leq 40^{\circ}\text{C}$ )		Measured with SG 505 oscillator
20 Hz to 20 kHz with 80 kHz noise limiting filter	$< 0.0032\%$ rms Response ( $-90 \text{ dB}$ ) $< 0.0025\%$ Average Response ( $-93 \text{ dB}$ )	
10 Hz to 50 kHz, no filter	$\leq 0.0071\%$ rms Response ( $-83 \text{ dB}$ )	
50 kHz to 100 kHz, no filter	$< 0.010\%$ rms Response ( $-80 \text{ dB}$ )	
Typical fundamental rejection		At least 10 dB below specified residual $\text{THD} + \text{N}$ or the actual signal $\text{THD}$ , whichever is greater.

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
<b>INTERMODULATION DISTORTION FUNCTION (OPT 01 and 02)</b>		
Operation		Fully automatic SMPTE, DIN, or CCIF difference tone tests depending upon actual input signal whenever respective IMD $\leq 20\%$ . Distortion ranges are same as THD+N function. Internal jumper selects Automatic, CCIF, or SMPTE/DIN.
<b>SMPTE/DIN tests</b>		
Lower frequency range		50 Hz to 250 Hz
Upper frequency range		Useable from 3 kHz to 160 kHz
Level ratio range		1:1 to 4:1, lower:upper
Residual IMD $V_{in} \geq 250$ mV, 60 Hz, and 8 kHz, 4:1 amplitude ratio, $T \leq +40^\circ\text{C}$		Measured with SG 505 pair. $< .0025\%$ ( $-92$ dB)
<b>CCIF difference tone test</b>		
Frequency range		Useable from 4 kHz to 160 kHz
Difference frequency range		80 Hz to 1 kHz
Minimum input level	60 mV ( $-22$ dBm)	
Residual IMD $V_{in} \geq 250$ mV, 14 kHz and 15 kHz, $T \leq +40^\circ\text{C}$	Measured with SG 505 pair. $\leq 0.0018\%$ ( $-92$ dB)	
Accuracy (IMD $\leq 20\%$ and readings $\geq 4\%$ of selected distortion range)	Within $\pm 10\%$ ( $\pm 1$ dB) for IM components $\leq 1$ kHz (Accuracy is limited by residual IMD and filter selection.)	
<b>FILTERS</b>		
400 Hz high pass	$-3$ dB at 400 Hz $\pm 5\%$ ; at least $-40$ dB rejection at 60 Hz.	Three pole Butterworth response.
80 kHz low pass	$-3$ dB at 80 kHz $\pm 5\%$	Three pole Butterworth response.
30 kHz low Pass	$-3$ dB at 30 kHz $\pm 5\%$	Three pole Butterworth response.
A weighting (standard and Option 01 instrument only)		Within specifications for type 1 sound level meters listed in ANSI S 1.4 1971 (revised 1976) and IEC Recommendation 179. Test on 2 V range with V approximately equal to 1 V: 100 kHz: $-19.1 \pm 0.7$ dB 1 kHz: $+0.3 \pm 0.4$ dB 10 kHz: $-2.8 \pm 1.0$ dB

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
CCIR WTG (Option 02 only)		<p>Within specifications of CCIR recommendation 468-2 and DIN 45405 for noise measurements with quasi-peak detector. Rms detector calibration shifted for 0 dB at 2.00 kHz instead of 1.00 kHz. Test on 2 V range with <math>V_{in}</math> 0.4 V: with quasi-peak response.</p> <p>1 kHz: 0.0 dB <math>\pm</math> 0.2 dB also test with <math>V_{in}</math> set for +12.2 dB at 6.3 kHz:</p> <p>100 Hz: -19.8 dB +0.7 dB 1 kHz: 0.0 dB <math>\pm</math> 0.4 dB</p> <p>10 kHz: +8.1 dB <math>\pm</math> 0.7 dB 20 kHz: -22.2 dB <math>\pm</math> 1.5 dB</p>
External filter	Selects front panel AUXILIARY INPUT allowing connection of external filter between it and FUNCTION OUTPUT.	
<b>FRONT PANEL SIGNALS</b>		
Input Monitor		
$V_{in} \geq 50$ mV	1 V rms $\pm$ 10% (10 Hz to 100 kHz)	Constant amplitude (average response) version of differential input signal. THD is typically $\leq$ 0.0010% (-100 dB) from 20 Hz to 20 kHz. Settling time is $\leq$ 1.5 seconds.
$V_{in} \leq 50$ mV		Approximately 20 times input signal.
Function Output		
Signal	1 V, $\pm$ 3%, for 1000 count volts or % display	Selected and filtered ac signal actually measured.
Impedance	1 k $\Omega$ , $\pm$ 5%	
Auxiliary Input		
Sensitivity	1 V, $\pm$ 3%, for 1000 count volts or % display	Loop through accuracy from FUNCTION OUTPUT is $\pm$ 3%.
Maximum Input Voltage		15 V peak, 6 v peak for linear response.
Impedance	100 k $\Omega$ , $\pm$ 5%	Ac coupled.
<b>REAR INTERFACE SIGNALS</b>		
Rear interface input		Pins 28B (+), 28A (-), 27B and 27A (common) are front panel selectable and independent of main front panel input. All characteristics are the same as main INPUT except maximum input voltage is limited to 42 V peak, 30 V rms. Due to potential crosstalk at the rear interface, noise and distortion performance may be degraded.
Input monitor		Pins 24A and 23A (gnd) same as front panel INPUT MONITOR

Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
Function output		Pins 23B and 24B (gnd) same as front panel FUNCTION OUTPUT.
Auxiliary input		Pins 25B and 26B (gnd) same as front panel AUXILIARY INPUT. Maximum input voltage is 15 V peak, 6 V peak for linear operation.
Ac/dc converter output		Pins 20A and 19A (gnd). Dc output of the selected ac to dc converter. 1 V $\pm$ 5% for 1000 count display with 500 $\Omega$ $\pm$ 5% source resistance.
dB converter output		Pins 19B and 20B (gnd). Dc output of the logarithmic dB converter. 10 mV $\pm$ 5% equals 1 dB of display with 1 k $\Omega$ $\pm$ 5% source resistance. Changes in level or distortion range will cause brief ac transients.
<b>DETECTORS AND DISPLAYS</b>		
Detectors (Response)		
RMS		True rms detection
AVG (standard and Option 01 only)		Average detection, rms calibrated for sinewaves. Typically reads 1 to 2 dB lower than true rms detection for noise, THD+N, and IMD measurements.
Quasi-peak (Option 02 only)		Quasi-peak detection, rms calibrated for sinewaves. Within specifications of CCIR Recommendation 468-2 and DIN 45405. Due to the peak hold nature of its response readings, considerably higher than rms response will occur with large crest factor signals (such as noise). The input range indicators should be ignored and auto-ranging avoided with these types of signals. Test on 2 V range at Vin 1.0 V. Reading with 10 Hz repetition rate 1 cycle tone bursts of 200 Hz triggered at 0° phase, shall be $-2.3$ dB $\pm$ 0.3 dB referenced to same amplitude continuous 200 Hz signal.
Displays		
Digital	3 1/2 digit, 2000 count LED. Overrange indication is 1, blank, blank, blank.	
Analog bar graph	10 segment LED intensity modulated bar graph display of digital readout. Segments are logarithmically activated with approximately 2.5 dB/segment.	



Table 1-1 (cont)

Characteristics	Performance Requirement	Supplemental Information
<b>MISCELLANEOUS</b>		
Power consumption		Approximately 24 watts.
Internal power supplies		
+15		Nominally +15.1 V $\pm$ 3%
-15		Nominally -15.1 V $\pm$ 5%
+5		Nominally +5.25 V $\pm$ 5%
Fuse data		
F4060		3 AG, 1 A, 250 V, fast blow
F4061		3 AG, 1 A, 250 V, fast blow
F4062		3 AG, 1.5 A, 250 V, fast blow
Recommended adjustment interval		2000 hours or 12 months, whichever occurs first.
Warm-up time		20 minutes; 60 minutes after storage in high humidity environment.
MTBF		6000 hours.

**Table 1-2**  
**ENVIRONMENTAL CHARACTERISTICS**

Characteristics	Description	
Temperature Operating Non-operating	0°C to +50°C -40°C to +75°C	Meets MIL-T-28800C, class 5.
Humidity	95% RH, 0 to +30°C 75% RH, to +40°C 45% RH, to +50°C	Meets MIL-T-28800C, class 5.
Altitude Operating Non-operating	4.6 km (15,000 ft) 15 km (50,000 ft)	Exceeds MIL-T-28800C, class 5.
Vibration	0.38 mm (0.015") peak to peak, 5 Hz to 55 Hz, 75 minutes.	Meets MIL-T-28800C, class 5, when installed in qualified power modules. <sup>b</sup>
Shock	30 g's (1/2 sine), 11 ms duration, 3 shocks in each direction along 3 major axes, 18 total shocks.	Meets MIL-T-28800C, class 5, when installed in qualified power modules. <sup>b,c</sup>
Bench Handling (plug-in only)	12 drops from 45°, 4" or equilibrium, whichever occurs first.	Meets MIL-T-28800C, class 5.
Package Product Vibration and Shock (Plug-in only)	Qualified under National Safe Transit Association Preshipment Test Procedures 1A-B-1 and 1A-B-2.	
Electromagnetic Susceptibility	Within limits of MIL-STD-461B (April 1, 1980) Class B.	
Electromagnetic Interference	Within limits of F.C.C. Regulations, Part 15, Subpart J, Class A; VDE 0871 category B, VDE 0875; and MIL-STD-461B (April 1, 1980) Class B	
Electrostatic Immunity	At least 15 kV discharge from 500 pF in series with 100 Ω to instrument case or any front panel connector without damage or permanent performance degradation (Input terminals limited to 10 kV).	

<sup>a</sup>With TM 500/5000-Series power module. System performance subject to exceptions of power module or other individual plug-ins.

<sup>b</sup>Refer to TM500/5000 power module specifications.

<sup>c</sup>Requires power module retainer bar or clip.

Table 1-3  
PHYSICAL CHARACTERISTICS

Characteristics	Description
Maximum Overall Dimensions Height Width Length	126.0 mm (4.96 inches) 131.2 mm (5.16 inches) 285.5 mm (11.24 inches)
Net Weight	Approximately equal to 2.04 kg (4.5 lbs.)
Finish Front Panel Chassis	Plastic-aluminum laminate Anodized aluminum



# OPERATING INSTRUCTIONS

## Preparation For Use

The AA 501A is calibrated and ready for use when received. It operates in any two compartments of a TM 500/TM 5000-Series power module. See the power module instruction manual for line voltage requirements and power module operation. Figure 2-1 shows the AA 501A installation and removal procedure.

### CAUTION

*Turn the power module off before inserting the AA 501A. Otherwise, arcing may occur at the rear interface connectors, reducing their useful life and damage may result to the plug-in circuitry.*

Check to see that the plastic barriers on the interconnecting jack of the selected power module compartment

match the cutouts in the AA 501A circuit board edge connector. Align the AA 501A chassis with the upper and lower guides of the selected compartment. Press the AA 501A in, to firmly seat the circuit board in the interconnecting jack.

To remove the AA 501A pull the release latch (located in the lower left corner) until the interconnecting jack disengages and the AA 501A slides out.

Check that the AA 501A is fully inserted in the power module. Turn the power module power switch ON. One or more characters in the LED display should now be visible.

## Repackaging Information

If the Tektronix instrument is to be shipped to a Tektronix Service Center for service or repair, attach a tag showing the owner (with address) and the name of an indi-

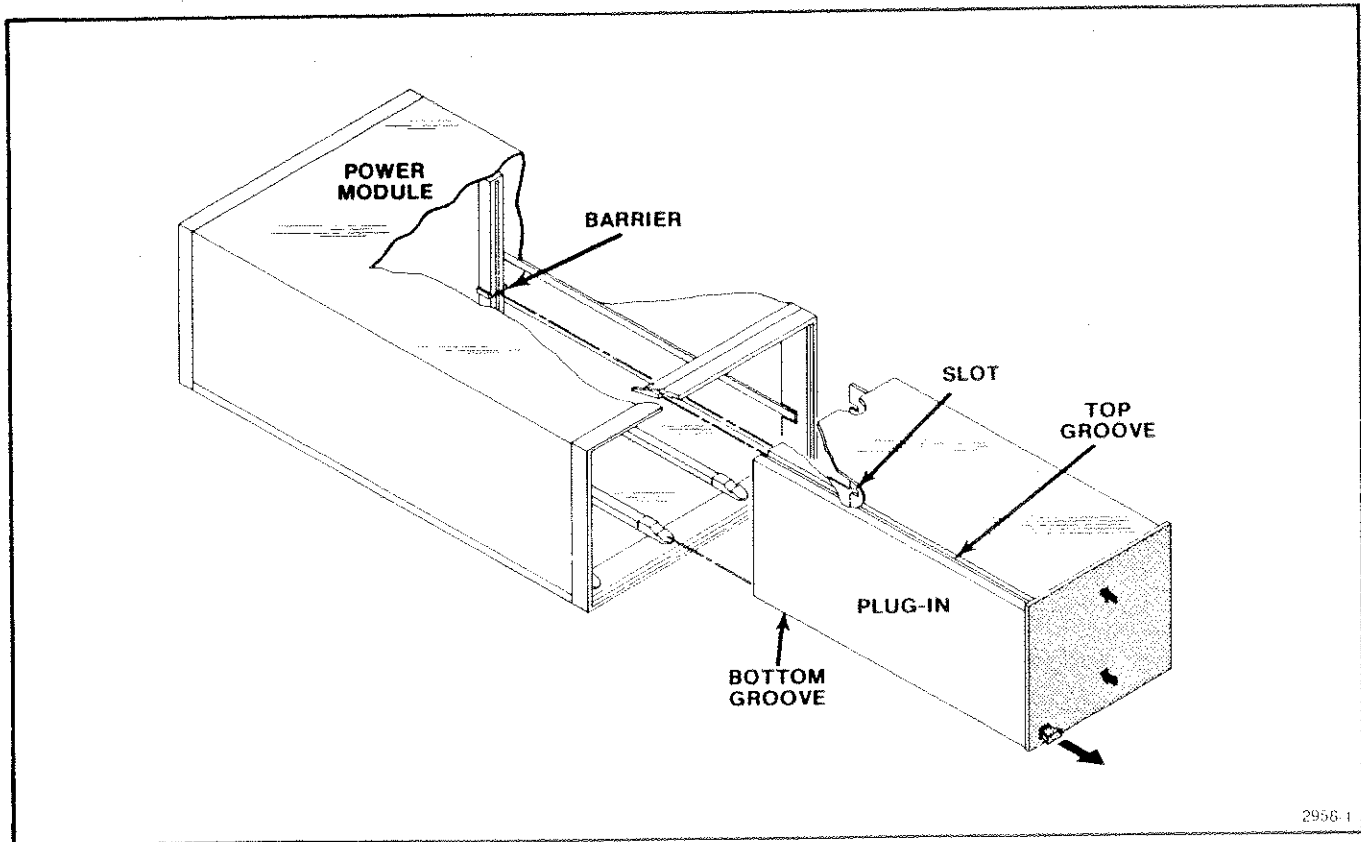


Fig. 2-1. Installation and removal.

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## Operating Instructions—AA 501A

vidual at your firm that can be contacted. Include the complete instrument serial number and a description of the service required.


Save and reuse the package in which your instrument was shipped. If the original packaging is unfit for use or not available, repackage the instrument as follows:

Surround the instrument with polyethylene sheeting to protect the finish of the instrument. Obtain a carton of corrugated cardboard of the correct carton strength and having inside dimensions of no less than six inches more than the instrument dimensions. Cushion the instrument by tightly packing three inches of dunnage or urethane foam between carton and instrument on all sides. Seal the carton with shipping tape or an industrial stapler.

The carton test strength for this instrument is 200 pounds per square inch.

### Controls, Connectors, and Indicators

All controls, connectors and indicators (except for the rear interface connector) required for operation of the AA 501A are located on the front panel. Fig. 2-2 provides a brief description of all front panel controls, connectors, and indicators.

- 1 INPUT RANGE**  
Selects input voltage range or AUTORANGE. The three most sensitive ranges operate in the LEVEL FUNCTION only.
- 2 DECREASE RANGE**   
When this light is illuminated, reduce the INPUT LEVEL RANGE until the light goes out. If the FUNCTION selected is THD+N or IMD (on Option 01 or 02 instruments) a flashing light indicates insufficient input signal level for distortion measurements.
- 3 INCREASE RANGE**  
When this light is illuminated, increase the INPUT LEVEL RANGE until the light goes out.
- 4 + INPUT**  
Differential input terminal. Positive going input signal provides positive going output signal at INPUT MONITOR.
- 5 - INPUT**  
Differential input terminal. Negative going input signal provides positive going output at INPUT MONITOR.
- 6 Release Latch**
- 7 LEVEL**  
Button in selects input level measuring function.
- 8 VOLTS**  
Button in selects voltage units for level function.
- 9 dBm 600  $\Omega$**   
Button in selects dBm units for level function. 0 dB reference is 0.7746 V corresponding to 1 mW into 600  $\Omega$ .
- 10 dB RATIO**  
Button in selects dB ratio, with respect to preset level, as units for level function.
- 11 PUSH TO SET 0 dB REF**  
Push button to set display to 0 with input signal applied to INPUT terminals in LEVEL function. dB RATIO and LEVEL pushbuttons must be in for this feature to operate.
- 12 REAR INTFC-INPUT**  
Button in selects rear interface input; button out selects front panel input.
- 13 RESPONSE**  
Button in gives RMS detection (responds to the rms value of the input waveform). Button out gives average detection or quasi-peak detection (option 02 instruments) both are rms calibrated for sinewaves.
- 14 THD+N**  
Button in selects total harmonic distortion function.
- 15 IMD (Option 01 and 02 only)**  
Button in selects intermodulation distortion function.
- 16 AUTO RANGE**  
Button in selects automatic distortion range selection (0.2% to 100% full scale).
- 17 20%**  
Button in selects full scale distortion readout of 20% with 0.01% resolution.

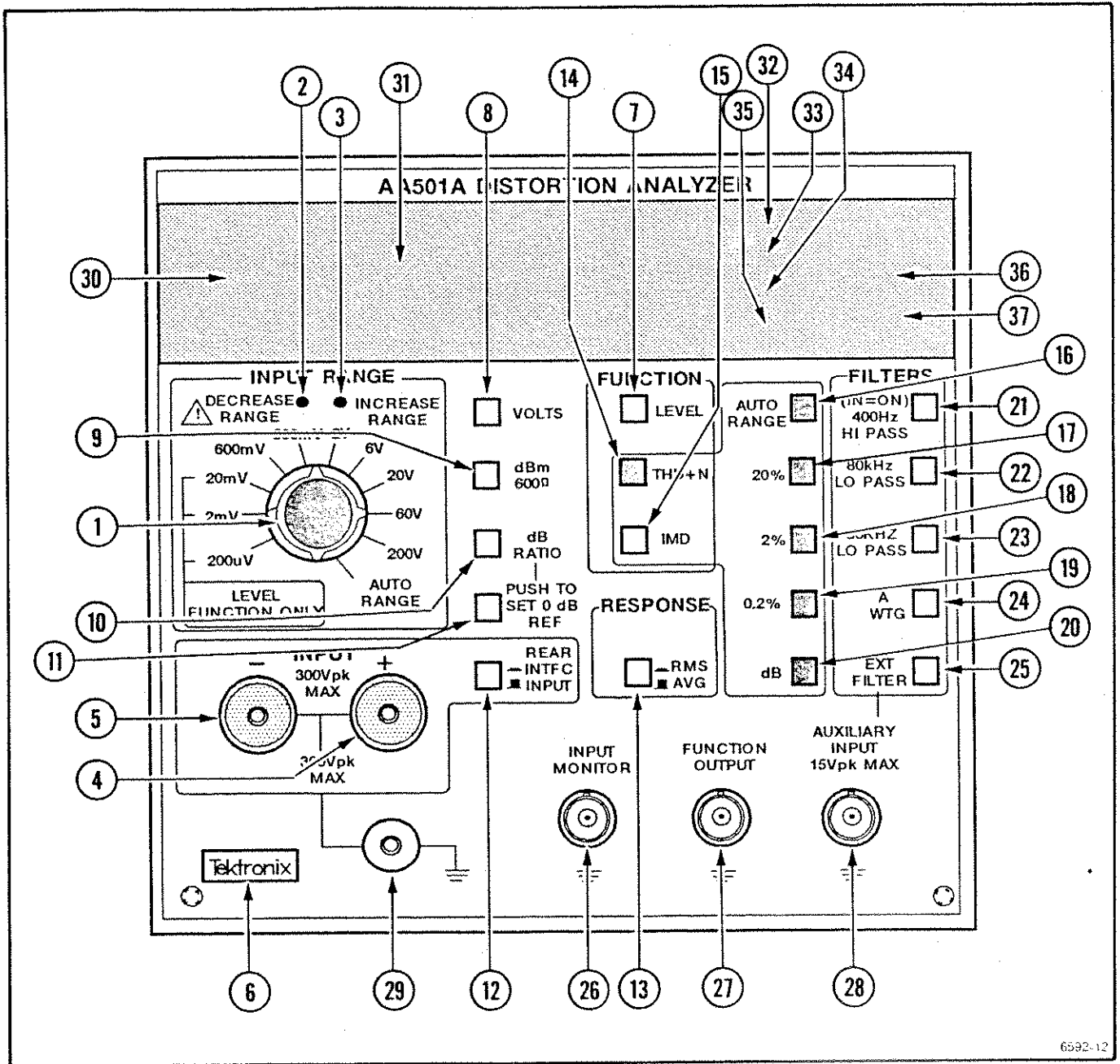


Fig. 2-2. Front panel controls and connectors.

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## Operating Instructions—AA 501A

- 18** **2%**  
Button in selects full scale distortion readout of 2% with 0.001% resolution.
- 19** **0.2%**  
Button in selects full scale distortion readout of 0.2% with 0.0001% resolution.
- 20** **dB**  
Selects single equivalent 0 dB to -100 dB distortion display range with 0.1 dB resolution.
- 21** **400 Hz HI PASS**  
Button in connects filter before detector circuit in all functions.
- 22** **80 kHz LO PASS**  
Button in connects filter before detector circuit in all functions.
- 23** **30 kHz LO PASS; AUDIO BANDPASS, 22.4 Hz to 22.4 kHz in Option 02**  
Button in connects filter before detector circuit in all functions.
- 24** **'A' WEIGHTING (CCIR WEIGHTING In Option 02 Instruments)**  
Button in connects filter before detector circuit in all functions.
- 25** **EXT FILTER**  
Button in allows connection of external filter between FUNCTION OUTPUT and AUXILIARY INPUT in all functions.
- 26** **INPUT MONITOR**  
Provides a buffered sample of the input signal.
- 27** **FUNCTION OUTPUT**  
Provides a sample of the selected FUNCTION signal additionally processed by selected filters.
- 28** **AUXILIARY INPUT**  
Provides input to the detector circuit when the EXT FILTER button is pressed.
- 29** **Ground**  
Provides front panel chassis ground connection.

- 30** **LED Bar Graph**  
Provides approximate analog display of the digital display for nulling and peaking. Each segment represents approximately 2.5 dB.
- 31** **Digital Display**  
3-1/2 digits. Overrange indication is a blanked display with the numeral 1 in the most significant digit position.
- 32** **V**  
Illuminated when display units are volts.
- 33** **mV**  
Illuminated when display units are millivolts.
- 34**  **$\mu$ V**  
Illuminated when display units are microvolts.
- 35** **%**  
Illuminated when display units are percent.
- 36** **dBm**  
Illuminated when display units are dBm.
- 37** **dB**  
Illuminated when display units are dB.

### Instrument Connections

To make connections to the AA 501A, refer to Fig. 2-3. Connections can be made to the rear interface connector. However, low level or distortion measurements made through the rear interface may be degraded due to crosstalk. To measure signals connected to the front panel make certain the INPUT pushbutton is out. To select the rear interface signal input press the INPUT pushbutton.

#### **CAUTION**

*Maximum front panel input voltage is 300 V peak, 200 V rms either input to ground or differentially. Maximum rear interface input is 42 V peak and 30 V rms.*

The AA 501A input circuitry is protected against accidental overloading. This circuitry will recover without damage from continuous 120 V rms (30 minutes at 200 V rms) overloads in any INPUT RANGE setting.



In most cases, for maximum hum rejection, follow the cabling and grounding as shown in the figure. Shielded, twisted pair offers maximum hum and radio frequency interference rejection. Cable shielding, if used, should be grounded only at the AA 501A front panel ground post. Use shielded cable to connect the output of an oscillator, external to the device under test, to the input of the device. Generally, to avoid possible ground loops, if the device under test has one side of the input grounded, float the output of the external oscillator. If the input to the device under test is floating (not chassis grounded) select the grounded mode for the output of the oscillator. Terminate the output of the device under test in its recommended load impedance, or the load impedance specified in the appropriate standard.

Figure 2-3 shows an optional oscilloscope for visual monitoring. If connected as shown, channel 1 displays a sample of the input signal and channel 2 displays the distortion components when in the IM or THD+N function.

**Level Measurements**

In the LEVEL function the AA 501A operates as a wide band ac voltmeter. The Specification section of this manual contains the operating parameters. The meter is rms calibrated and either rms or average (quasi-peak in option 02 instruments) responding, depending on the position of the RESPONSE pushbutton.

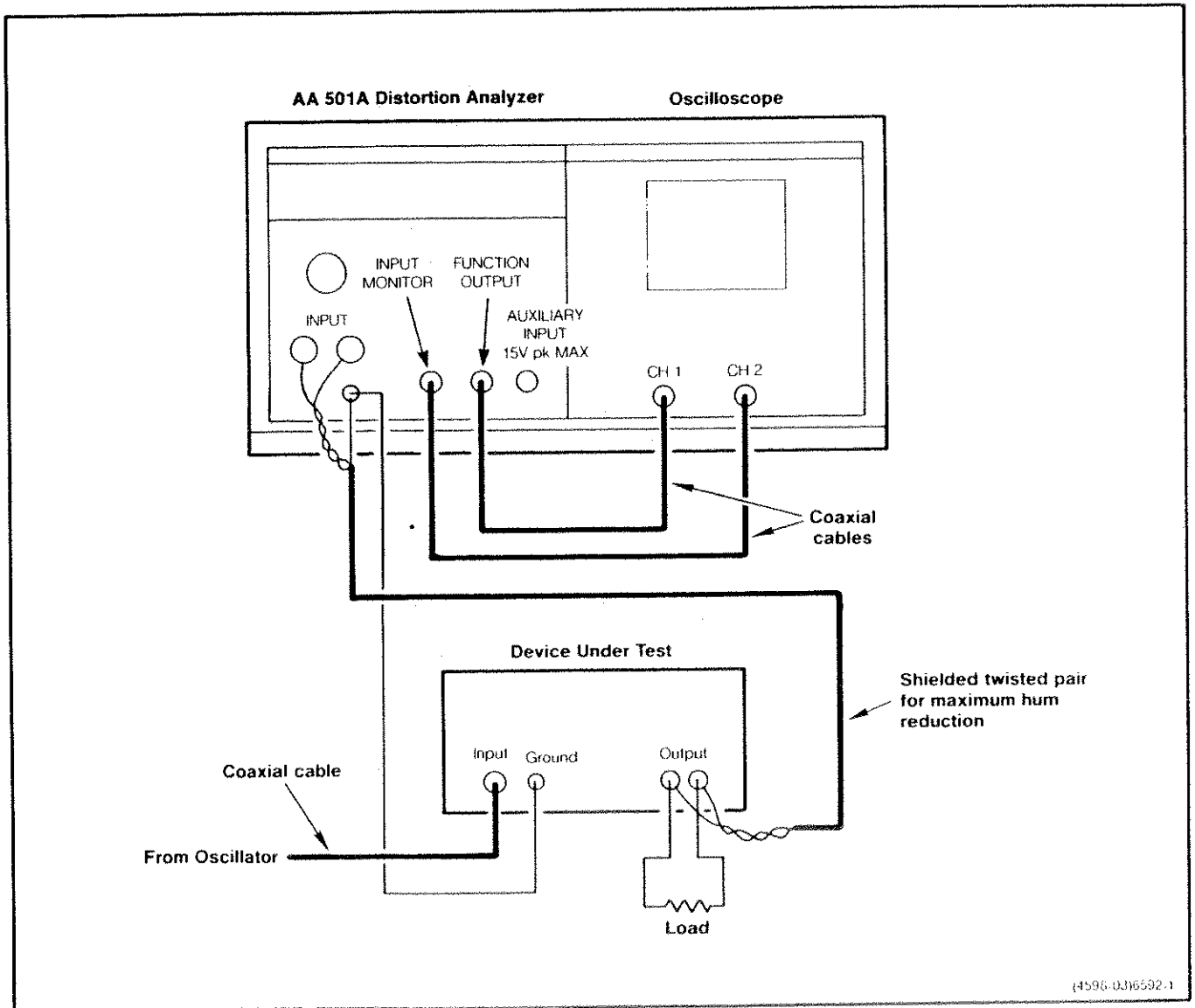


Fig. 2-3. Typical connections for distortion measurements.

Press the FUNCTION LEVEL pushbutton. The top three buttons to the left of the FUNCTION pushbuttons select readout units as VOLTS, dBm 600  $\Omega$ , or dB RATIO. For example, to measure voltage, press the VOLTS pushbutton. If the INCREASE RANGE LED is illuminated, adjust the INPUT LEVEL RANGE control to the higher ranges until the LED goes out. If the DECREASE RANGE LED is illuminated, turn the INPUT RANGE control counterclockwise until the DECREASE RANGE LED goes out. Readings are usable as long as the display is not overranged however for specified accuracy the DECREASE RANGE LED must also be off. Overrange is indicated by a blank display with the numeral 1 in the most significant digit slot.

If the INPUT LEVEL RANGE switch is placed in the AUTO RANGE position, the input level is adjusted automatically. The LED's (VOLTS, mVOLTS or  $\mu$ VOLTS) automatically illuminate showing the proper display units. Notice that the three most sensitive ranges on the INPUT LEVEL RANGE control operate in the LEVEL FUNCTION only.

When the dBm 600  $\Omega$  pushbutton is pressed, the LED opposite dBm on the display indicates the display units. The reference level for this measurement, 0 dBm, is 0.7746 V corresponding to 1 mW dissipated in 600 ohms. The INPUT LEVEL RANGE switch operates as previously described.

The dB RATIO mode permits direct amplitude ratio measurements of two input signals. When the dB RATIO pushbutton is pressed, the LED opposite the dB nomenclature on the display illuminates. To use this feature, press the dB RATIO pushbutton. To establish the input signal as 0 dB reference, push the PUSH TO SET 0 dB REF pushbutton and notice that the display reads all zeros. Release the 0 dB REF pushbutton. As the amplitude of the input signal is changed, the display reads the dB ratio of the input signal to the reference signal amplitudes.

There are many useful applications for the dB RATIO mode in measurements of gain-loss, frequency response, S/N ratio, etc. For example, the corner frequency of a filter may be quickly checked. Set the test frequency to some midband value and set the zero dB reference. Adjust the test frequency until the display reads  $-3.0$  dB; this is the corner frequency of the filter.

Gain measurements may be simplified by using this feature. Set the device to be tested as desired and connect the AA 501A input to the input of the device under test. Press the PUSH TO SET 0 dB REF pushbutton. Then connect the input of the AA 501A to the device output and read the gain or loss directly from the display.

When measuring signal to noise ratio or making noise level measurements, it is often desirable to employ a frequency dependent weighting network. The AA 501A provides several internal filters, as well as facilities for connecting external filters. For information on their operation and use, see the text under Filters in this section of this manual.

### Distortion Measurements

Distortion is a measure of signal impurity. It is usually expressed as a percentage or dB ratio of the undesired components to the desired components. Harmonic distortion is simply the presence of harmonically related or integral multiples of a single pure tone called the fundamental, and can be expressed for each particular harmonic. Total harmonic distortion, or THD, expresses the ratio of the total power in all significant harmonics to that in the fundamental.

A distortion analyzer removes the fundamental of the signal investigated and measures the remainder. See Fig. 2-4. Because of the notch filter response, any signal other than the fundamental influences the measurement.

A total harmonic distortion measurement inevitably includes effects from noise or hum. The term THD+N has been recommended<sup>1</sup> to distinguish distortion measurements made with a distortion analyzer from those made with a spectrum analyzer. A spectrum analyzer allows direct measurement of each harmonic. However, it is relatively complex, time consuming, and requires interpretation of a graphic display.

<sup>1</sup>IHF-A-202 1978, Standard Methods of Measurement for Audio Amplifiers, The Institute of High Fidelity, Inc., 489 Fifth Avenue, New York, N.Y. 10017

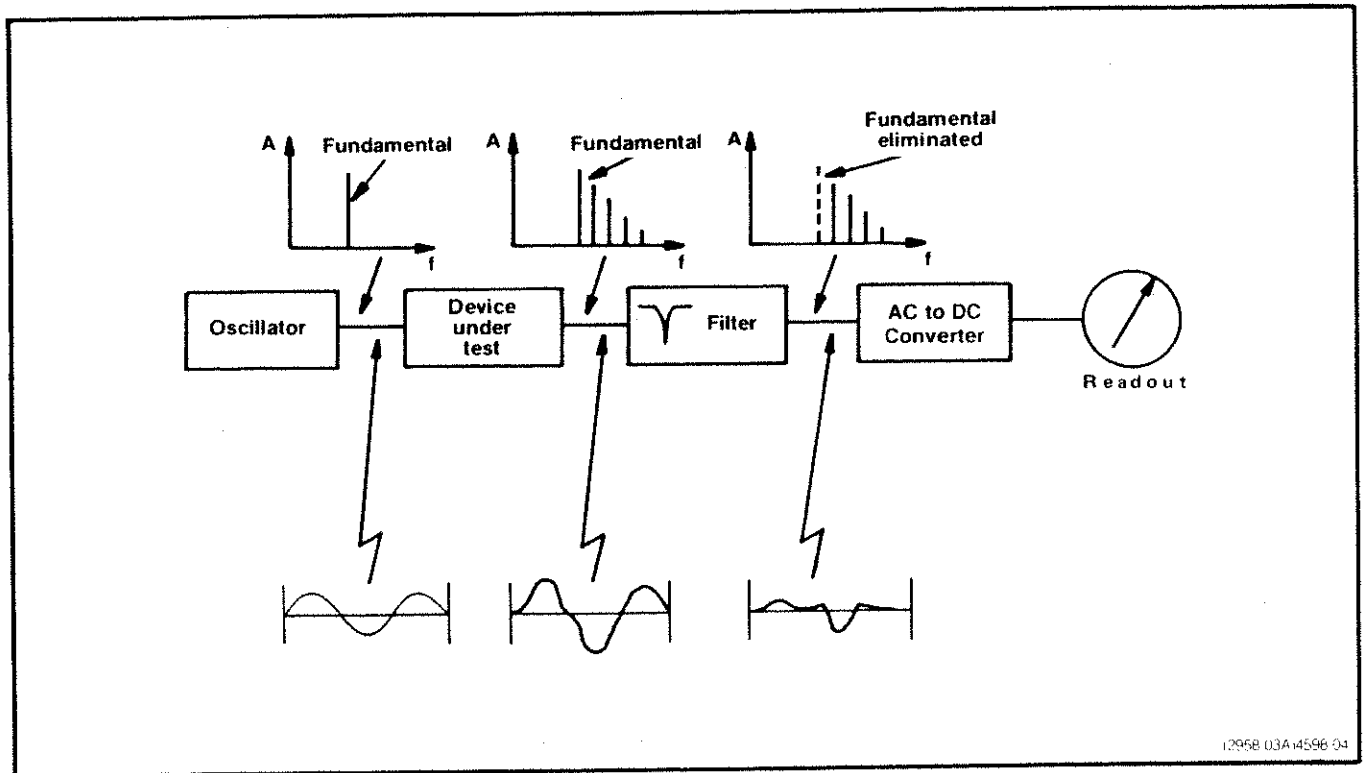


Fig. 2-4. Block diagram of a basic harmonic distortion analyzer.

Distortion analyzers can quantify the nonlinearity of a device or system. The transfer (input vs output) characteristic of a typical device is shown in Fig. 2-5. Ideally this is a straight line. A change in the input produces a proportional change in the output. Since the actual transfer characteristic is nonlinear, a distorted version of the input waveshape appears at the output. The output waveform is the projection of the input sine wave on the device transfer characteristic as shown in Fig. 2-6. The output waveform is no longer sinusoidal, due to the nonlinearity of the transfer characteristic. Using Fourier analysis it can be shown that the output waveform consists of the original input sine wave, plus sine waves at integer multiples of the input frequency. These harmonics represent nonlinearity in the device under test. Their amplitudes are related to the degree of nonlinearity.

### Distortion Measurement Procedure

All of the controls found on a traditional distortion analyzer are automated on the AA 501A. It is only necessary to set the INPUT RANGE and distortion range switches to AUTO RANGE. Press THD+N and wait briefly for a reading.

Minimum input signal amplitude for valid distortion measurements is 60 mV. To provide greater flexibility, the instrument may be manually operated as described in the following paragraphs.

Adjustment of the input level range control is the same as for level measurements. Manually setting the INPUT RANGE control to the correct scale ensures that the input is within the 10 to 12 dB range of the internal auto set-level circuitry. The range LED's must be extinguished to make readings to specified accuracy. The 200  $\mu$ V, 2 mV and 20 mV ranges do not operate in the distortion function and a flashing Decrease Range LED indicates insufficient input signal level for distortion measurements.

To manually select a distortion range, press the THD+N button and the desired range button. Selection of AUTO RANGE causes the instrument to autorange the distortion readout. The remaining range pushbuttons cause the instrument to stay in these ranges without autoranging. This may reduce the measurement time slightly if the approximate reading is already known. This is useful in production line testing or in the testing of low distortion equipment. The dB display is effectively a single range; however, internal instrument operation is identical to AUTO RANGE.

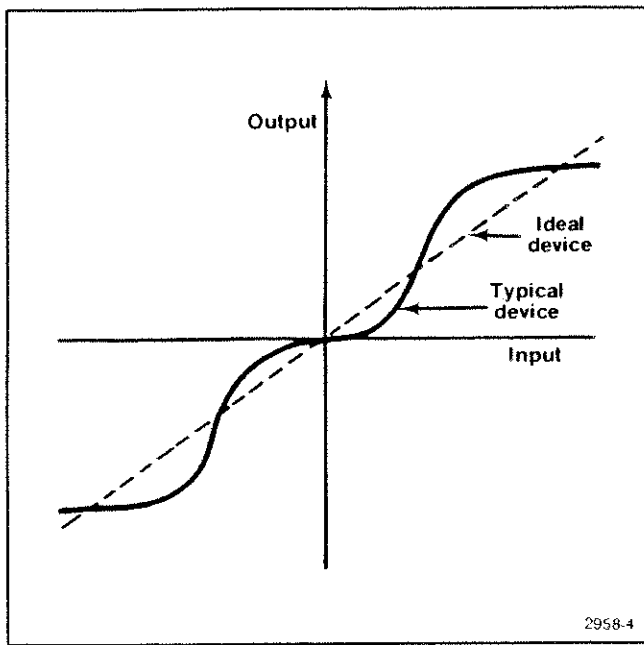


Fig. 2-5. Transfer characteristics of an audio device.

When making distortion measurements, the RESPONSE button should normally be in the RMS position. Current distortion measurement standards require the use of rms reading instruments by specifying power summation of each of the components. The AVG response may be used when making comparisons with readings taken with older distortion analyzers. However, it may read up to 25% (2 dB) lower than rms response when noise is significant and even lower with high crest factor distortion signals (characteristic of crossover or hard-clipping non-linearities).

For frequencies below 20 kHz, the residual wideband noise in the measurement may be reduced by activating the 80 kHz LO PASS filter. If hum (line related components) are interfering with the measurement, they may be reduced with the 400 Hz HI PASS filter. This filter should not be employed with fundamental frequencies below approximately 400 Hz because of additional error due to rolloff. For more information see text under Filters in this section of this manual.

## High Distortion Measurement Limitations

### NOTE

*Care must be taken to ensure proper locking for input signals with 10% or greater noise or non-harmonic components, because the AA 501A automatically tunes and nulls out the fundamental frequency prior to making a THD + N measurement.*

In those applications which require higher THD + N measurements (for example, SINAD<sup>2</sup> testing) the internal circuitry will remain locked to noise levels of approximately 30%, after it is initially given a clean signal. To perform a SINAD test, the receiver under test is first given a high level modulated rf input. The AA 501A will lock onto the audio signal at the demodulated output. The rf level feeding the receiver is then reduced until a -12 dB (25%) THD + N reading is obtained on the AA 501A and becomes a measure of the receiver's sensitivity.

## IM Distortion Measurements (Option 01 and Option 02)

Another measurement of distortion investigates the interaction of two or more signals. Many tests have been devised to measure this interaction. Three common standards are SMPTE<sup>3</sup>, DIN<sup>4</sup>, and CCIF<sup>5</sup>. The AA 501A with Option 01 and Option 02 is capable of automatically selecting and performing all three tests.

To measure intermodulation distortion (IM), according to SMPTE and DIN standards, the device under test is excited with a low frequency and high frequency signal simultaneously (Fig. 2-7). The output signal is high-pass filtered to remove the low frequency component. The high frequency tone is then demodulated, as an AM radio signal. The demodulator output is low-pass filtered to remove the residual carrier (high frequency) components. The amplitude of the low frequency modulation is displayed as a percentage of the high frequency level.

<sup>2</sup>Defined in Electronic Industries Association Standard No. RS 204A, July 1972, Electronic Industries Association, Engineering Department, 2001 Eye St. N.W., Washington, D.C. 20006.

<sup>3</sup>Society of Motion Picture and Television Engineers, Standard No. TH 22.51, 862 Scarsdale Avenue, Scarsdale, N.Y. 10583.

<sup>4</sup>Deutsches Institut für Normung e V, No. 45403 Blatt 3 and 4, January 1975, Beuth Verlag GmbH, Berlin 30 and Köln 1.

<sup>5</sup>International Telephone Consultative Committee.

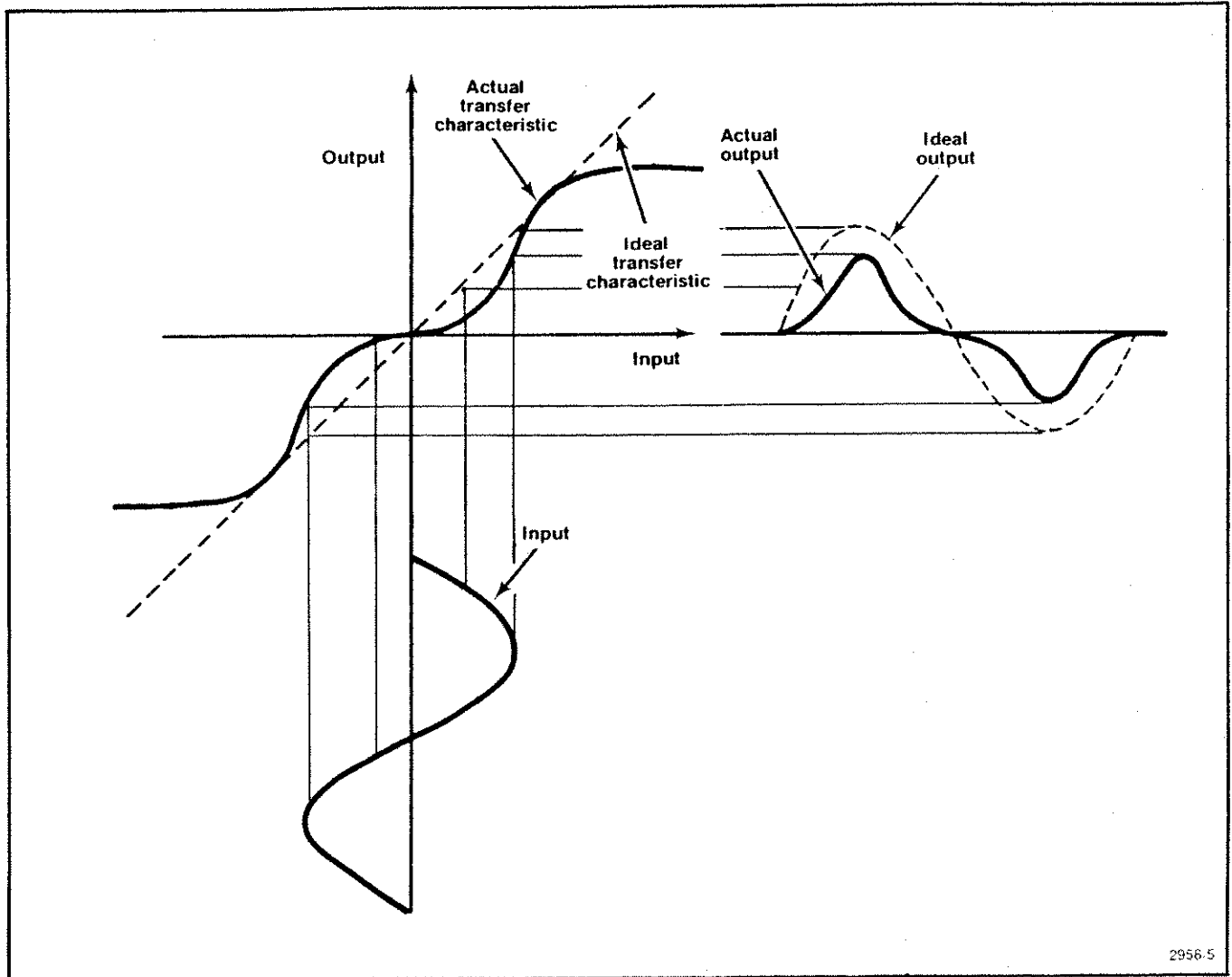


Fig. 2-6. THD test of transfer characteristics.

As shown in Fig. 2-8, when this composite signal is applied to the device, the output waveform is distorted. As the high frequency tone is moved along the transfer characteristic by the low frequency tone, its amplitude changes. This results in low frequency amplitude modulation of the high frequency tone. This modulation is apparent in the frequency domain as sidebands around the high frequency tone. The power in these sidebands represents nonlinearity in the device under test.

The amplitude ratio of low to high frequencies should be between 4:1 and 1:1. The AA 501A circuitry automatically adjusts calibration to compensate for the selected test signal ratio. Some additional range is provided in this circuitry to enable measurement of devices with nonflat frequency response.

SMPTE standard test frequencies are 60 Hz and 7 kHz. The DIN standard is virtually identical to the SMPTE standard except for the two frequencies used. They may be any pair of octave band center frequencies, with the upper at least eight times as high as the lower (250 Hz and 8 kHz are most common). The AA 501A can accept a wide range of test frequencies as shown in the Specification section.

CCIF difference frequency distortion is measured with two high frequency sine waves driving the device under test. Both are of equal level and closely spaced in frequency. Nonlinearities in the device under test cause the sine waves to cross modulate. This creates new signals at various sum and difference frequencies from the inputs. For example, the commonly used 14 kHz and 15 kHz test frequencies produce 1 kHz, 13 kHz, 14 kHz, 15 kHz, 16 kHz, 28 kHz, etc.

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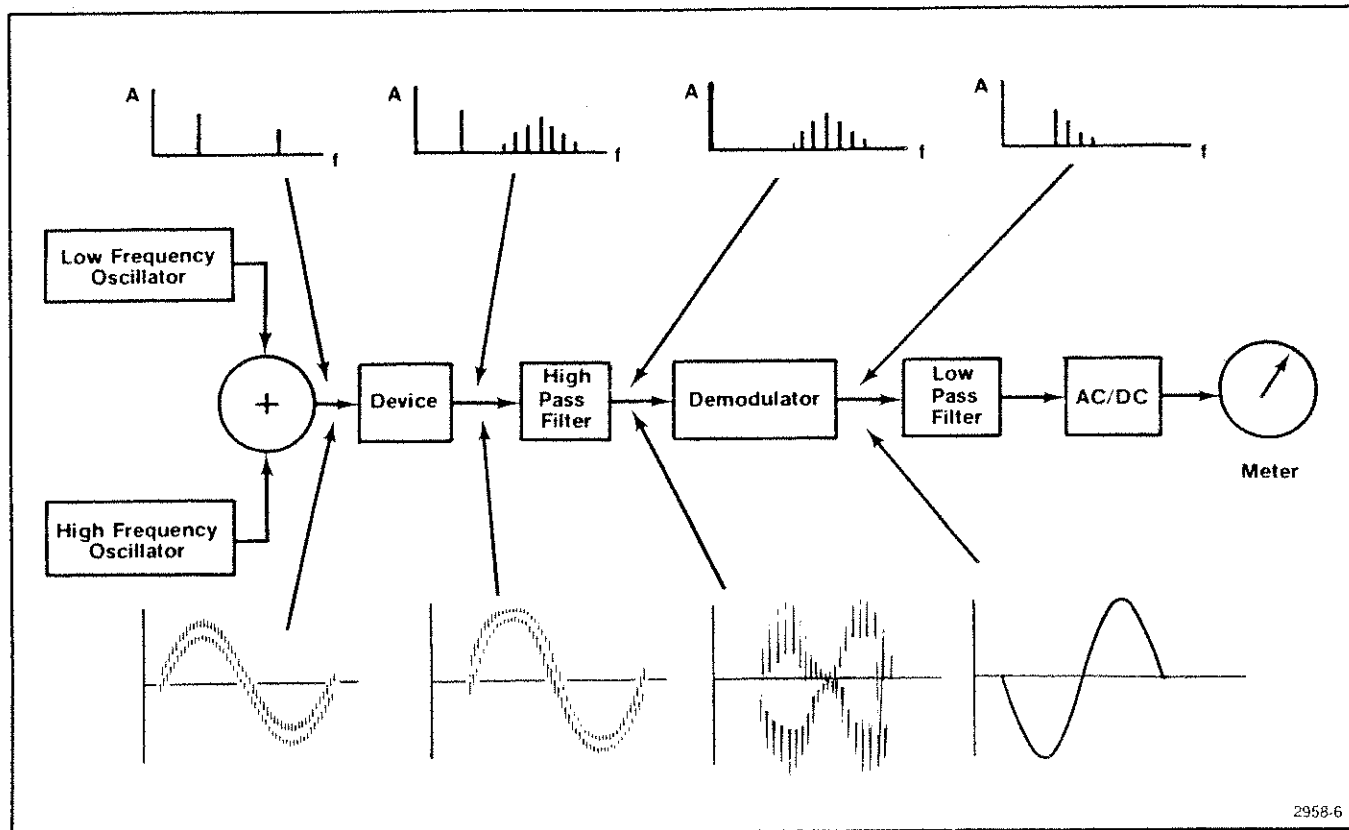


Fig. 2-7. Block diagram of basic IM analyzer.

The user could measure each new component with a tunable filter such as a spectrum analyzer; however, this is usually limited to an 80 dB dynamic range and is very tedious. In many systems and especially those with asymmetric non-linearities, a good measure of this distortion may be obtained by investigating only the difference frequency (in this example 1 kHz). If only the low frequency component is measured, it is called a CCIF second order difference frequency distortion test.

To measure two tone difference frequency distortion the device is excited with two input signals as described above. The output of the device is low-pass filtered to remove the two test tones and extract the difference frequency product. The level of this component is expressed as a percentage of the high frequency signals. The AA 501A CCIF difference frequency mode will accept any pair of input frequencies which are within limits as listed in the Specification section. The amplitudes of the two signals should be equal.

### IM Distortion Measurement Procedure (Option 01 and Option 02)

Intermodulation and THD testing are similar, using the AA 501A. After connecting the appropriate signal source to the device under test, set the INPUT RANGE as described in the THD section. Press the IMD FUNCTION button and select a distortion range. Selecting AUTO RANGE or dB provides automatic ranging. The AA 501A accepts either a SMPTE, DIN, or a CCIF difference frequency test signal. Selection between the necessary analyzing circuits is accomplished automatically for IMD levels less than 20%, based upon the spectral content of the test tones. (There is a moveable jumper inside the AA 501A to allow defeating the automatic test selection circuitry for special applications requiring IMD measurements in excess of 20%. Refer any jumper changes to qualified service personnel.)

The LO PASS filter may be selected in the IM mode but will have little or no effect. The 400 Hz HI PASS and the WEIGHTING filters will cause erroneous readings because the IM components of interest generated by the tests fall between 50 Hz and 1 kHz. These filters, when activated in the IM mode may attenuate some of the frequency components being measured and should be avoided.

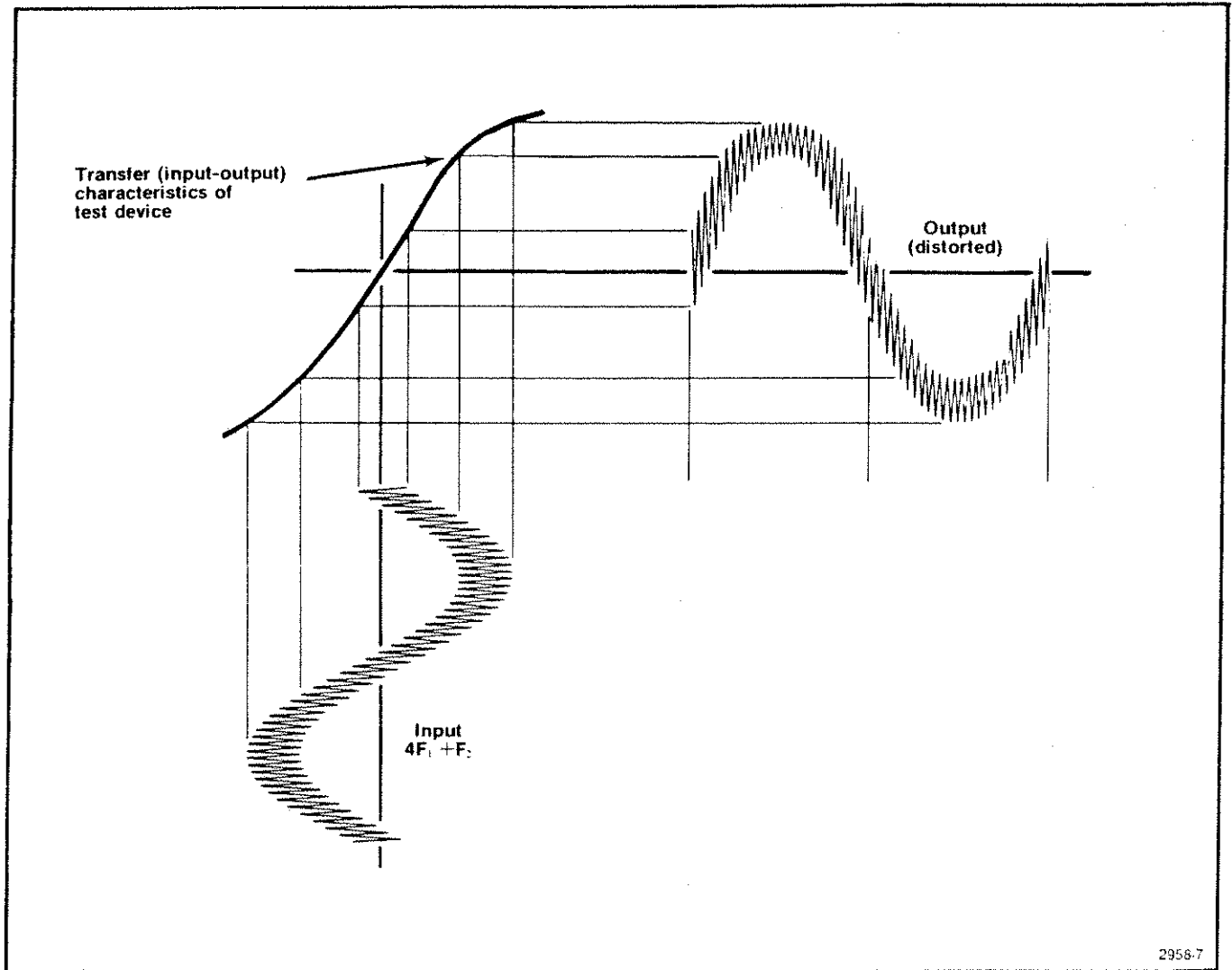


Fig. 2-8. IM test of transfer characteristics in time and frequency domain.

### Filters

The five buttons along the right edge of the instrument allow selection of four built-in frequency weighting filters plus an external filter, as desired. See Fig. 2-9 for response curves of the various filters. The 400 Hz, 30 kHz, and 80 kHz filters are both 3-pole (18 dB per octave rolloff) Butterworth alignment. The AUDIO BAND PASS (Option 02 only) filter (Option 02 only) follows CCIR Recommendation 468-2<sup>6</sup> for unweighted response. It is approximately two pole response below the lower 3 dB point of 22.4 Hz and three pole response above the upper 3 dB point of 22.4 kHz. They are placed in the measuring circuitry immediately before the average or rms detectors. These filters are functional in all modes of operation. They also affect the signal at the FUNCTION OUTPUT connector.

Check the position of all filter pushbuttons before making measurements, to prevent inaccurate results. Filtering takes place after all gain circuits. Therefore, it is possible to overload part of the instrument, when operating in the manual distortion ranges with a filter selected, even though the display is not overranged. This may be checked by releasing the filter pushbuttons and checking the display for over-range or by pressing the AUTO RANGE pushbutton.

<sup>6</sup>International Radio Consultative Committee.

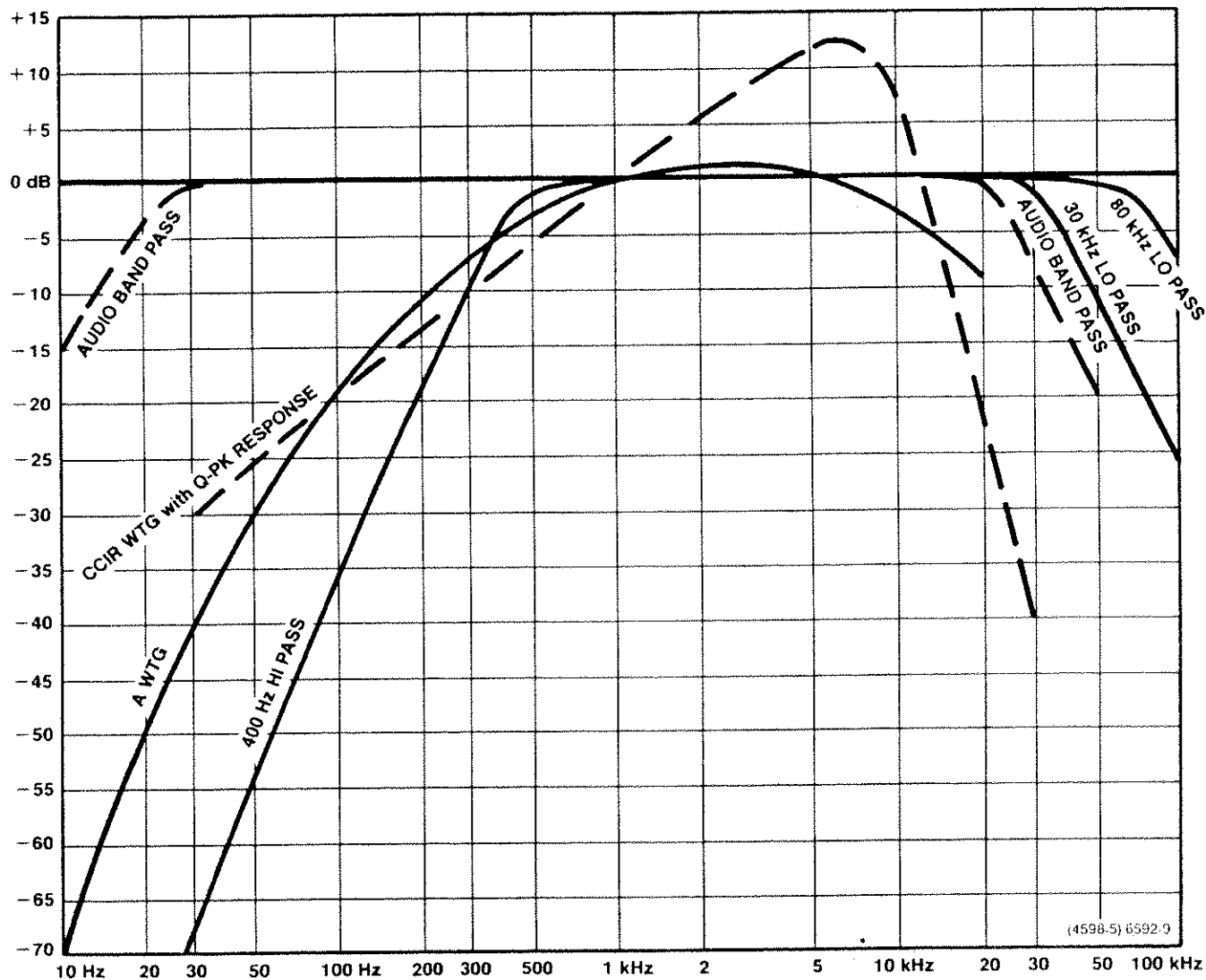


Fig. 2-9. Response curves for AA 501A filters.

The 400 Hz HI PASS filter is used to reduce the effects of hum on the measurement. Although the differential input and common mode rejection of the AA 501A reduce the effects of ground loops, extremely bad measurement conditions may require use of this filter. The device under test may also generate an undesirable amount of hum, limiting the noise and distortion residuals obtainable. This filter may be used when measuring harmonic distortion of signals at about 400 Hz or greater, but should not be used when measuring levels at frequencies less than 1 kHz, nor when measuring intermodulation distortion.

The 30 kHz LO PASS filter provides bandwidth limiting for broadcast proof of performance testing. It is also useful for unweighted noise measurements on audio equipment, providing an equivalent noise bandwidth of 31.5 kHz. When

the 30 kHz filter is used, the 80 kHz filter is disabled. It may be desirable to modify the 30 kHz filter so that it conforms to the 22.4 kHz IEC standard for audio noise measurements. This may be performed by qualified service personnel as described in the Service section of this manual.

Use of the 80 kHz LO PASS filter reduces the effects of wideband noise and permits measurement of lower THD+N for input signals up to 20 kHz. For 20 kHz inputs, it allows measurement of harmonics up to the fourth order. Do not use this filter if harmonic components above 80 kHz are of interest. When checking noise, the 80 kHz filter may be used to reduce the measurement bandwidth. However, for most noise measurements, the AUDIO BANDPASS or WEIGHTING filters are recommended as they correlate better with the perceived noise level.



The AUDIO BAND PASS filter (Option 02 only) provides bandwidth limiting according to CCIR Recommendation 468-2 and DIN 45405. It is also useful for unweighted measurements on certain acoustic equipment. When the AUDIO BAND PASS filter is used, the 80 kHz filter is disabled.

The 'A' weighting filter (standard and Option 01 instruments only) is used when measuring the subjective noise of audio equipment. It conforms to the noise measurement standards of the Institute of High Fidelity (IHF). The filter shape is within ANSI, DIN, and IEC<sup>7</sup> standards for class 1 sound level meters.

The CCIR weighting filter (option 02 instruments only) is also used when measuring the subjective noise of audio equipment, however it conforms to CCIR Recommendation 468-2 and DIN 45405 when used with the quasi-peak detector response. This filter may also be used with the rms detector, however the gain calibration is shifted for unity gain at 2.0 kHz instead of 1.0 kHz permitting noise measurements similar to those proposed by Dolby et al<sup>8</sup> on tape recording and playback systems.

Connections for an external filter are also provided. Press the EXT FILTER pushbutton. Connect the external filter between the FUNCTION OUTPUT and the AUXILIARY INPUT. One application for the external filter is selective measurement of individual harmonics or components of an input signal. This may be accomplished using a unity gain bandpass filter as an external filter<sup>9</sup> and adjusting the frequency to the harmonic desired.

## Displays

The AA 501A provides two display forms for manual measurements. The digital readout displays the selected function with units. Overrange indication blanks all digits and displays a numeral 1 in the most significant digit slot.

For rapid nulling or peaking applications, the digital display is supplemented by an uncalibrated LED bar graph for an analog meter-like display. The bar graph responds logarithmically, with each segment representing approximately a 2.5 dB change in the selected function. Additionally, the intensity of the segments is modulated between steps permitting resolution of changes as small as 0.5 dB. The range of the bar graph is determined by the measurement range in use. When using this feature it may be desirable to select a manual range to prevent confusing displays caused by autoranging.

## Monitoring

The interface capabilities of the AA 501A may aid considerably in the interpretation of measurements.

The INPUT MONITOR connector provides a fixed amplitude version (approximately equal to 1 V rms) of the input signal for input signals of 50 mV or greater. This allows display of the input signal on an oscilloscope, without constantly readjusting the oscilloscope sensitivity. At input levels below about 50 mV the INPUT MONITOR signal is approximately 26 dB (gain of approximately equal to 20) above the input signal level.

The FUNCTION OUTPUT is taken after the distortion measurement and high gain amplifier circuitry. It can be used for monitoring the signal read on the display. The signal at the FUNCTION OUTPUT connector is 2 V for a full scale reading on the display. In the level function this connector becomes an amplified version of the input signal. The gain from the input to this output is dependent on the LEVEL RANGE switch, and is given in Table 2-1. When the AA 501A is used as a constant gain differential amplifier the INPUT RANGE switch must be set to a fixed range. In the distortion function this output can be displayed on an oscilloscope to view the distortion components. This output may also be used to drive a spectrum analyzer or selective voltmeter for examining the individual harmonics or modulation products. When an oscilloscope is used, the triggering signal is best taken from the sync output on the oscillator. If this is not possible (for example in tape recorder or Telco link testing) it should be obtained from the INPUT MONITOR connector on the AA 501A.

<sup>7</sup>International Electrotechnical Commission, Publication 179, second edition, Precision Sound Level Meters, 1973, Central Office of IEC (sales department), 1, rue de Varembe', 1211 Geneva 20 Switzerland.

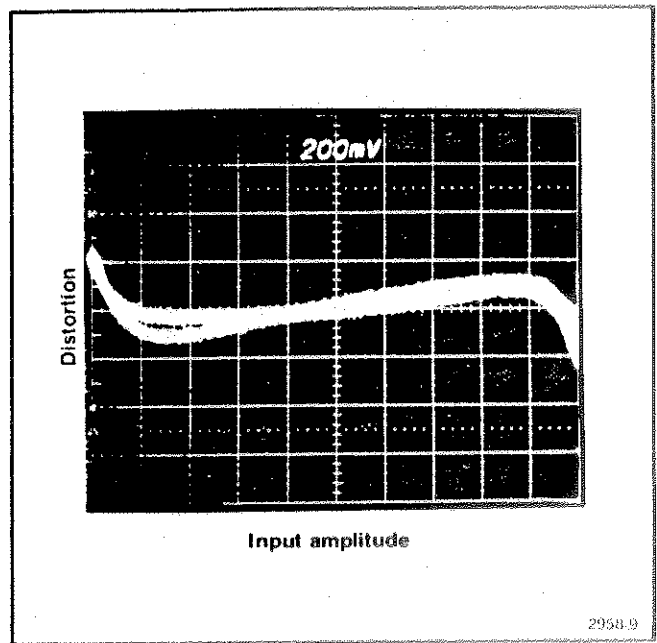
<sup>8</sup>Dolby et al, CCIR/ARM: A Practical Noise-Measurement Method, Journal of the Audio Engineering Society, Vol. 27, No. 3, March 1979, p. 149.

<sup>9</sup>International Radio Consultive Committee.

**Table 2-1**  
**Gains from INPUT terminals to FUNCTION OUTPUT**  
**connector for various settings of the**  
**INPUT LEVEL RANGE control**

LEVEL RANGE Setting	Gain to FUNCTION OUTPUT
200 V	-40 dB
60 V	-30 dB
20 V	-20 dB
6 V	-10 dB
2 V	0 dB
600 mV	+10 dB
200 mV	+20 dB
20 mV	+40 dB
2 mV	+60 dB
200 $\mu$ V	+80 dB

One interesting use of the Function Output and Input Monitor signals is to investigate the non-linearities of the transfer function of a device under test with the THD+N mode. For this measurement, the FUNCTION OUTPUT drives the vertical input of an oscilloscope while the INPUT MONITOR drives the horizontal. The resulting display is similar to Fig. 2-10, and represents the deviation from linearity of the transfer characteristic. In other words, it represents the transfer characteristic after the best fit straight line is removed. This can be particularly useful in diagnosing sources of non-linearity such as clipping, crossover, etc. If the device under test has large amounts of phase shift at the test frequencies it may be necessary to introduce compensating phase shift into the horizontal channel. Since the FUNCTION OUTPUT is taken after the filters, they will affect the signal seen at this connector. The vertical scale is the deviation from the best fit line and is related to the distortion range and vertical sensitivity of the oscilloscope.



**Fig. 2-10. Oscilloscope display of deviation from linearity.**

## **WARNING**

THE FOLLOWING SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID PERSONAL INJURY, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO. REFER TO OPERATORS SAFETY SUMMARY AND SERVICE SAFETY SUMMARY PRIOR TO PERFORMING ANY SERVICE.



# THEORY OF OPERATION

## Introduction

Refer to the block diagram located in the foldout pages of this manual for a brief description and overall view of the AA 501A operation. A detailed circuit description follows.

## Input Amplifier

The input amplifier is designed for low noise and distortion. The input configuration is differential with single-ended output. This circuit provides good common mode rejection for suppression of ground loop currents and other unwanted signals which may be present on both input leads. The input stage is also protected to withstand at least 200 V rms on any input range.

The input amplifier gain is set by the logic circuitry at 0 dB (unity), +10 dB or +20 dB. The logic circuitry controls the gain so that the signal voltage at the output of the amplifier remains between 0.75 V and 3.0 V rms. An attenuator, prior to the amplifier, provides additional gain settings from -10 dB to -40 dB in 10 dB steps. The actual gain or attenuation selected depends on the input voltage level (or the setting of the INPUT RANGE switch if not in AUTO RANGE). For example, the 200 V Input Range corresponds to 40 dB of attenuation and amplifier unity gain.

The input signal, from the front panel connections or the rear interface input (selected by front panel switch S6181) enters the input amplifier through P4070/J4070. Each input is ac coupled through C5070 or C4070. The signal then passes to the differential input attenuator hybrid, R2052. These resistors are laser trimmed and ratioed to maintain gain accuracy and common mode rejection. Relays K2052, K2060, K2061, K2070 and K2071 select attenuation from 10 dB steps. Frequency compensation of the attenuator is provided by C2061, C2051, and R2051.

When there is no attenuation (0 dB), DS3050 and DS3060 limit the input current under overload conditions. The current passing through the lamps warms their filaments, increasing their resistance. These lamps will sustain 120 Vac indefinitely and 200 Vac for at least 30 minutes. If the AA 501A is subjected to greater overloads in the 0 dB attenuator position, the lamps act as fuses. When any attenuation other than 0 dB is selected, the resistance in the hybrid network provides current limiting. The inputs are clamped by Zener diodes VR4071 and VR4070 through four diode connected transistors Q4060, Q4061, Q4070 and Q4071 and four diodes CR4072 through CR4075. When the

post attenuator voltage on any scale exceeds about  $\pm 10$  V, one set of transistors turns on to limit the voltage at diode connected U4050A and B. The effect of the nonlinear capacitance of clamp diodes CR4072, CR4073, CR4074 and CR4075 is eliminated by maintaining a constant voltage across the diodes via a bootstrap arrangement from the outputs of U4050A and B.

The input signal is buffered by low noise amplifiers U4050A and U4050B. On the 0 dB through 40 dB attenuation ranges, these buffers provide unity gain. Relays K2050 and K2051 change the gain to +20 dB or +10 dB, respectively, by adding resistors R4056D or R4056E. Capacitors C4053 and C4062 provide frequency compensation.

The buffer outputs are combined into a single-ended output signal by U4061 (gain = 1.5). This signal is then routed to the automatic gain control circuitry (agc) and input amplifier level detector.

The gains of the combining stage and the buffers are controlled by hybrid resistor R4056. These resistors are laser trimmed and ratioed to insure gain accuracy and common mode rejection.

The signal level at the output of the input amplifier is detected by active rectifier U4041, in conjunction with CR4041 and CR4042. This full wave rectified signal is filtered by U4042A with C3045 and routed to the logic circuitry through J1060, pin 1. Recovery from overload is provided by VR3041. Resistor R4040 sets the filter gain so that, with 2 V rms into the AA 501A input on the 2 V scale (3 V at pin 6 of U4061) the output at pin 1 of U4042 is 6 Vdc.

The gain setting driver relays, K2052 through K2071, are driven by the inverting amplifiers within U1060. Control signals from the logic circuitry enter the input board through P1060-J1060, pins 2 through 9, with one line at a time high (about +12 V). This logic high causes a low at the output of the inverting amplifier and closes the relay. When either 0 dB, +10 dB or +20 dB (pins 6, 7 or 8) is activated, K2052 activates directly or by Q1070 and U1050B. In AUTORANGE, the logic circuitry selects the proper input attenuation or gain to maintain 0.75 V to 3.0 V at U4061 pin 6, for inputs greater than approximately 50 mV.

**Automatic Gain Control** 2

The output of the input amplifier feeds the agc circuitry at levels between 0.75 V and 3.0 V for inputs greater than approximately 50 mV, and the agc automatically adjusts the signal to a constant 1.61 Vac. This is the reference level for the distortion measuring circuits.

The agc circuitry is composed of attenuator R4053, U5041, U5051, R4055, and amplifier U4051. The control element in the agc is a pair of light-dependent resistors (LDRs), U5041 and U5051. These devices consist of a light emitting diode and a semiconductor resistance cell in one package. As more control current is forced through the LEDs, the cells are illuminated more brightly and their cells resistance decreases. This causes more signal to shunt to ground.

The control circuitry for the agc consists of active rectifier, U4042B with diodes CR4052 and CR4051. The filters are composed of U4062A and U4062B and associated components. This circuitry seeks to keep the voltage at the out-

put, pin 6 of low noise operational amplifier U4051, to approximately 1.61 V. This output voltage is varied to calibrate the THD measurements by adjusting R1051, the THD CAL control.

The output of U4051 is fullwave rectified by U4042B with diodes CR4051, CR4052 and integrated by U4062A and C5061 with the reference current from R5041 and R4042. Amplifier U4062B in conjunction with C5060, C5062, R5063, R5064 and C5063 with R5065 provides additional filtering of the rectified voltage to reduce distortion introduced by the agc action. Transistor Q5071 provides the current drive necessary for the LDRs, while VR5051 linearizes the open loop gain of the agc loop to optimize transient response at all signal amplitudes.

**Notch Filter** 2

The leveled output from the agc (U4051) provides the input for the notch filter. The notch is formed by summing the output of an inverting band pass filter with the input signal. See Fig. 3-1. Operational amplifier U4020, and asso-

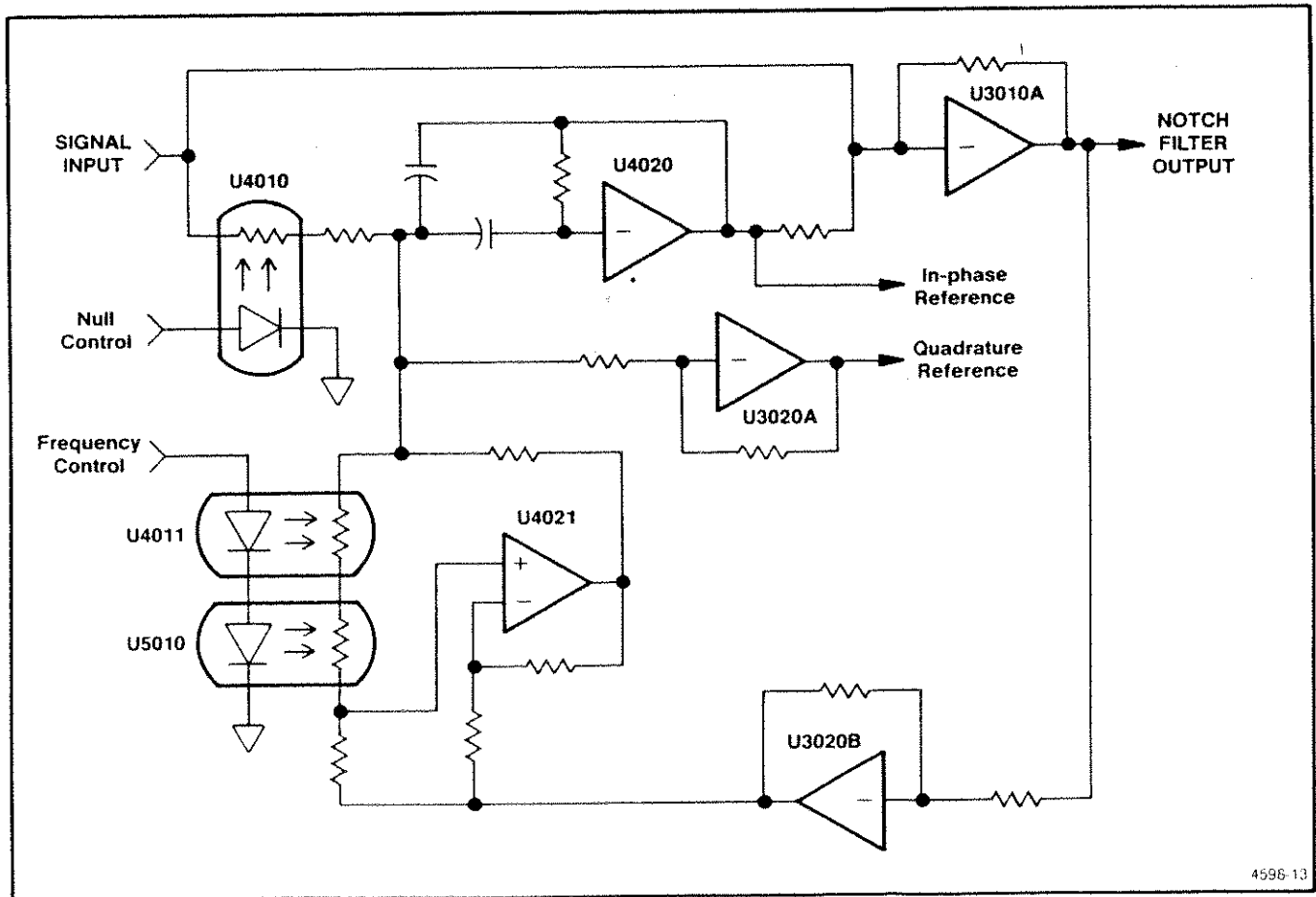


Fig. 3-1. Simplified notch filter.

ciated resistors and capacitors comprises a multiple feed-back path inverting band pass filter. Amplifier U3010A is an inverting summer. Filter tuning is accomplished in half decade bands by switching both resistors and capacitors. Capacitors are switched each decade. Relay K4031 is energized for input frequencies below approximately 10 kHz. When below approximately 1 kHz, K4032 is also activated, while below approximately 100 Hz, K5030, K4032, and K4031 are used. K4030 is energized in the upper half of each decade reducing the tuning resistances by a factor of 3.2 thus scaling up the frequency range by a factor of 3.2. Continuous tuning within each half decade is achieved by adjusting the impedance of an electronic resistor (U4021A and B) with LDR opto isolators U4011 and U5010. As the LDR resistance rises, the electronic resistor value decreases, at the junctions of the outputs of R3026 and R5033, raising the filter frequency.

This circuit technique, although unusual, provides a good compromise between residual noise and distortion sources inherent in U4021, and LDR's U4011 and U5010.

U3020B feeds back a portion of the notch output to the electronic resistor keeping the Q of the bandpass filter nearly constant, as it is tuned.

Minor variations in the gain of the band pass filter (which causes incomplete cancellation of the fundamental) are compensated by a third LDR, U4010. Components C4021, R5032 and C5031 provide additional gain compensation. Drive signals for the LDRs come from the control loop circuitry. Synchronization signals, to run the control loops, come from the outputs of U4020 and U3020A.

## Frequency Band Discriminator 5

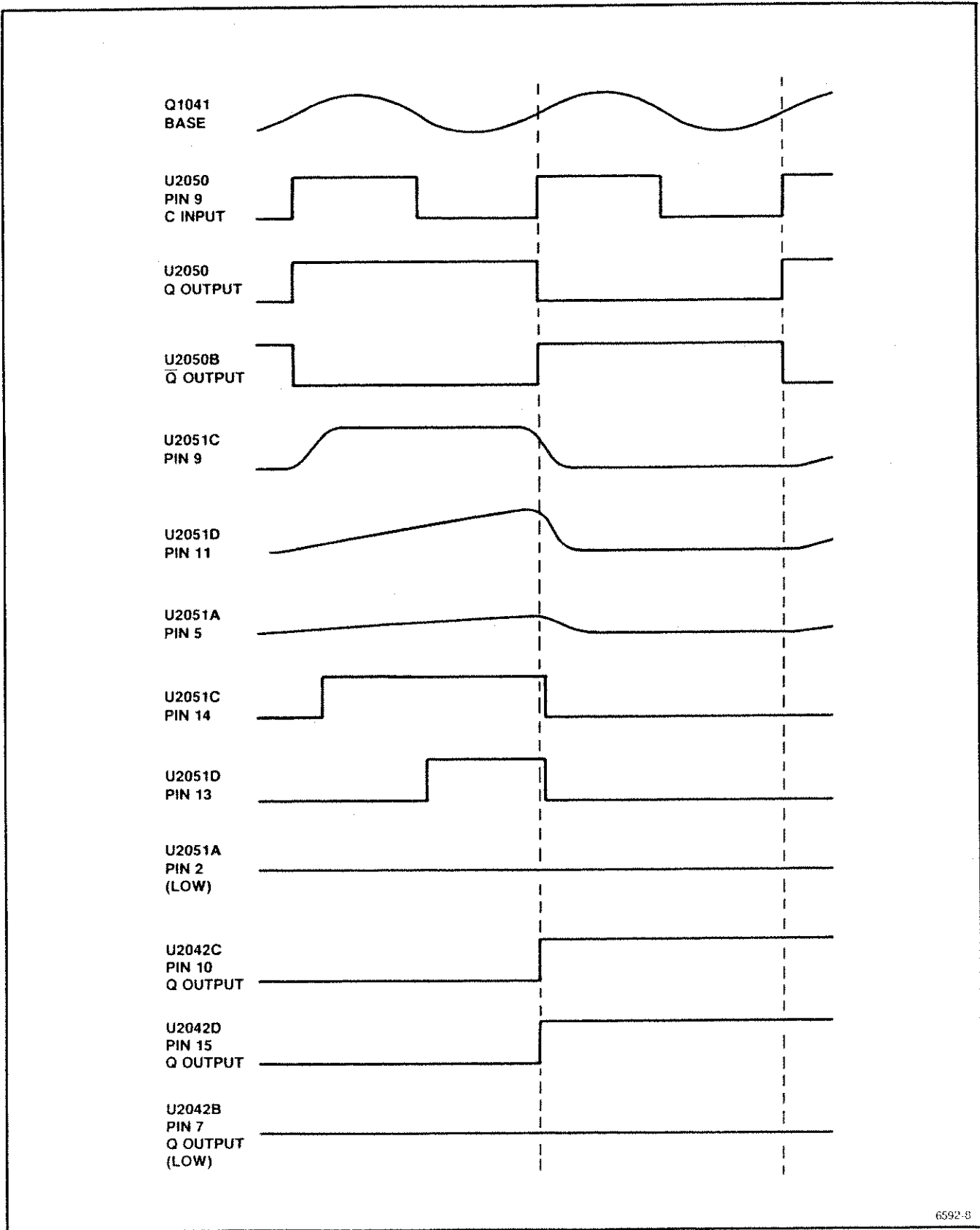
The signal from the junction of R2026 and R3021 located on schematic 2 is squared by a Schmitt trigger, composed of Q1041 and Q1042. The frequency band is determined by measuring the period of the resulting squarewave. When the input goes high, the outputs of U2050 change state. Assuming the Q outputs are high, the capacitors in the four rc networks (that are connected to the Q outputs of U2050) start to charge. The capacitor voltage on each network is compared via U2051 to a reference voltage developed across R2065, R3060, and R3061. When the input signal again goes high, the outputs of the comparators are latched in U2042. Simultaneously, the outputs of U2050 go low to discharge the capacitors in the rc networks in preparation for the next cycle.

If the period of the input is more than half the RC time constant, the capacitor voltage will be above the threshold and the comparator output is high at the transition. See Fig. 3-2. Discrimination of half decades is obtained by selecting the appropriate RC network via a CMOS switch (U2060) and comparing it to a higher reference voltage at pin 6 of U2051B. The last column in Table 3-1 shows the inputs for U2060. If the input frequency is below the band switch point of the selected decade (about 2.8 kHz for the 1 kHz to 10 kHz band) the output of U2051 is low. Resistors R2054, R3052, R2052, and R2050 provide a slight hysteresis at each decade edge, while R1515 provides hysteresis at half decade points. This hysteresis prevents random band switching when measuring signals close to the transition frequencies.

A bounce eliminator, U2041, prevents random band changes caused by grossly non-periodic signals. Capacitor C1041 sets the internal clock frequency of U2041 to approximately 7 Hz. The input state to U1400 must be stable for four clock cycles or 0.6 seconds for any change in output to occur.

Table 3-1  
TRUTH TABLE FOR U2042 OUTPUTS

Fin (Hz)	Q 2042A pin 3	Q U2042C pin 10	Q U2042D pin 15	Q U2042B pin 7	U2060 input pin no.
10-28	L	H	H	H	4
28-95	H	H	H	H	4
95-280	L	H	H	L	12
280-950	H	H	H	L	12
950-2.8k	L	H	L	L	14
2.8k-9.5k	H	H	L	L	14
9.5k-28k	L	L	L	L	13
28k-100k	H	L	L	L	13



6592-8

Fig. 3-2. Frequency band discriminator.



### Notch Filter Control 3

The notch filter is controlled by demodulating the in-phase and quadrature phase (shifted 90 degrees) components of the notch filter output referenced to the input fundamental signal. See Fig. 3-1. The in-phase reference inputs to pin 2 of U1020A, and the quadrature phase reference inputs to pin 6 of U1020B. When the notch frequency is correctly tuned, there is no quadrature phase component at the notch filter output. When the fundamental null (maximum amplitude rejection) is adjusted correctly, there is no in-phase component in the notch filter output.

The notch filter output is amplified by U3010B and U1011B. A total of 50 dB of gain is provided by these amplifiers. Differential input to the demodulators (U1010) is provided by U1011A. The output of this amplifier stage is rectified by CR1010 and CR1011. This signal is amplified by Q2010 and filtered by C2011 to control the resistance of FET Q2011, thus providing automatic gain control. This loop serves to optimize and level the input to the demodulators that generate the tuning and nulling error voltages. The amplifier gain is raised by Q2012 in all but the lowest fundamental frequency decade.

As stated earlier, the in-phase component of the fundamental derived from the output of the bandpass filter U4020 (located on diagram 2) feeds pin 2 of U1020A. This circuitry forms a CMOS compatible logic signal to drive the CMOS multiplexer, U1010. The quadrature component of the fundamental derived from U3020A (diagram 2) similarly feeds pin 6 of U1020B. The switching arrangements of U1010 are shown in Table 3-2. The input to U2020A is switched between the inverted (pins 1 and 13) and the normal (pins 2 and 12) output of the notched filter at rate and phase determined by the in-phase signal at pin 10. The input to U2020B is also switched between the normal and inverted inputs to U1010 at a rate and phase determined by the quadrature signal at pin 11. The outputs of U1010 represent the synchronously demodulated in-phase and quadrature components of the fundamental, present in the notch output signal.

These outputs are integrated by U2020A, for the amplitude control loop and U2020B for the frequency control loop, buffered by Q2021 and Q2024, to drive the respective LDR opto-isolators in the notch filter. The net dc polarity of the signals at pins 15 and 14 determine, after passing through integrators U2020A and U2020B, the direction of frequency change and amplitude change necessary to properly set the notch frequency and null the fundamental. Adjustments R1023 and R1030 trim out the effects of offsets in the operational amplifiers enabling adjustment of the loops for best nulling of the fundamental frequency. When stabilized, the dc signal at pins 14 and 15 of U1010 is essentially 0 V.

The gain of the frequency control integrator is increased by Q2023 in all but the lowest frequency decade. Components VR2022, VR2023, R2018, C2010, CR2024, and CR2025 help speed the frequency control integrator for large control errors. VR4010 linearizes the open loop gain of the frequency control loop.

**Table 3-2**  
**INTERNAL CONNECTIONS IN U1010 DEPENDING**  
**ON LOGIC STATES OF PINS 10 AND 11**

Logic Level Pins 11, 10	Internal Connections Pins
0 0	12 to 14 & 2 to 15
1 0	13 to 14 & 2 to 15
0 1	12 to 14 & 1 to 15
1 1	13 to 14 & 1 to 15

### Distortion Amplifier 4

This circuitry amplifies the distortion components from the THD notch filter or the IMD section, as well as providing additional gain for the three lowest input ranges in level function.

Multiplexer U2040, selects the input source for the distortion amplifier. The four sources are: input stage pins 5 and 14, input stage less 10 dB pins 1 and 13 (through R2033 and R2032), THD notch filter pins 12 and 15, and IMD pins 2 and 4. Control of U2040 is through the level and IMD switches, as well as the output of U3021A as shown on the schematic. In the IMD mode, Q2042 turns on. This action shorts the THD input to U2040 to prevent possible crosstalk. In both the THD and IMD, Q2041 also turns off, to prevent crosstalk.

The distortion amplifier gain is controlled by multiplexer U2031. The input to U2030B, attenuated by R2036, R2037 or R2041 is supplied from U2031. See Table 3-3. A gain of +46 dB is provided by U2030A and B. The output of U2030A supplies a 4 V rms full scale signal to the filters.

**Table 3-3**  
**GAIN AND SWITCHING THROUGH U2031**

Logic Level Pins 9 10	Total Gain Through Dist Amp	U2041 Gain	Internal Connections pins
0 0	+6 dB	0 dB	13 to 12 and 3 to 1
0 1	+26 dB	0 dB	13 to 14 and 3 to 5
1 0	+46 dB	0 dB	13 to 15 and 3 to 2
1 1	+66 dB	+20 dB	13 to 11 and 3 to 4

**Filters and AC-DC Converters (Standard and Option 01 Instruments Only) 6**

The output of the distortion amplifier enters the main board through J1042 driving the weighting filters and the distortion amplifier ranging level detector. The detector, composed of U4030A and U4030B, full wave rectifies and filters the distortion amplifier output. This dc signal goes to the logic board to control auto-ranging of the distortion amplifier.

The weighting filters consist of U2023A, U2023B, U3021B, U3021A and associated resistors and capacitors. The signal from the distortion amplifier passes through the 330 kHz filter before passing to the remaining filters. Output from the filters is multiplexed by U1021 to the input of buffer, U4020A. Table 3-4 is a truth table for U1021.

**Table 3-4**  
**TRUTH TABLE FOR U1021**

B	A	ON CHANNELS		
0	0	X0	Y0	WEIGHTING
0	1	X1	Y1	30 kHz LOWPASS (Bandpass Option 02 only)
1	0	X2	Y2	80 kHz LOWPASS
1	1	X3	Y3	330 kHz LOWPASS

The highpass filter (three pole 400 Hz Butterworth) is composed of U4020B, C4012, C4011, C4010, R4012, R4010, and R4011. This filter is driven by U4020A. When the highpass filter is disabled, U3020 connects pins 1, 13, 14, and 15 thus shorting the output of U4020A directly to the input of U4020B. R4013, R4014, and C4013 provide 10 Hz response compensation for low frequency accuracy.

Output from the highpass filter, U4020B, connects to the front panel Function output connector and the Cy channel of U3020. The AUXILIARY INPUT on the front panel connects

to the Cx input through protection components R3022, CR4020, and CR4021. U2030B connects to either the AUXILIARY INPUT or the output from U4020B depending upon the state of the EXT control signal.

After filtering, the signal is converted to a dc voltage by both rms and average techniques. Rms conversion is accomplished in U3031 (pin 10 out) using an implicit computing approach. The averaging capacitor is C3032. A low pass filter, U2040A, reduces readout jitter due to low frequency noise or ripple.

The averaging rectifier is U2030A with diodes CR2031 and CR2032. The rectified output is smoothed and filtered by U2040B, C1040, and associated components. The average detector output connects to U2040A via Q3040 in the average response mode, overriding the rms converter.

**Filters and AC-DC Converters (Option 02 Instruments Only) 6a**

The output of the distortion amplifier enters the main board through J1042 to drive the filters and the distortion amplifier ranging level detector. This detector, composed of U4030A and U4030B, full wave rectifies and filters the distortion amplifier output. This dc signal goes to the logic board to control the distortion amplifier autoranging.

The filters consist of U2023A, U2023B, U2021B, U2040A, U2040C, and U2040D with associated resistors and capacitors. The signal from the distortion amplifier passes through the 330 kHz filter before passing to the 80 kHz LO PASS and AUDIO BAND PASS filters. The weighting filter input is taken directly from the distortion amplifier output. R2035 provides gain calibration adjustment for the CCIR weighting filter. Output from the filters are multiplexed by U1021 to the input of buffer U4020A. Table 3-4 is a truth table for U1021.

The high pass filter (three pole 400 Hz Butterworth) is composed of U4020B, C4012, C4011, C4010, R4012, R4010, and R4011. This filter is driven by U4020A. When the high pass filter is disabled, U3020 connects pins 1, 13, 14, and 15, shorting the output of U4020B directly to the input of U4020B. Components R4013, R4014, and C4013 provide 10 Hz response compensation for low frequency accuracy.

Output from the high pass filter, U4020B connects to the front panel FUNCTION OUTPUT connector and the Cy channel of U3020. The AUXILIARY INPUT, on the front panel, connects to the Cx input through protecting components R3022, CR4020, and CR4021. U2030B connects to either the AUXILIARY INPUT or the output from U4020B, depending upon the state of the EXT control signal.

After filtering, the signal is converted to a dc voltage by both rms and quasi-peak techniques. Rms conversion is accomplished in U3031 (pin 10 out) using an implicit computing approach. The averaging capacitor is C3032. A low pass filter, U2021A, reduces readout jitter due to low frequency noise or ripple.

The quasi-peak convertor consists of full wave rectifier U2040B, peak detector U4031 and U3030A, and averager U3030B and their related circuitry. The input to the full wave rectifier is normally connected through R2022, except for the special case of simultaneous CCIR weighting filter and quasi-peak response selections. In this case, Q2021 turns on directly connecting the output of the CCIR weighting filter from U2040A to the full wave rectifier. This causes a gain calibration shift of the weighting filter, depending upon the response selection. With RMS response, the 0 dB frequency is nominally 2.0 kHz. However, with quasi-peak response, it shifts to 1.0 kHz.

The output from the full wave rectifier, U2040B, passes to pin 2 of U4031. This circuitry rapidly charges C3053 to the peak value of the input waveform. This peak voltage is referenced to the input through U3030A with R4055, providing gain calibration adjustment. U3030B, C3052, and R3033 low-pass filter the charged peaks on C3053 and pass the signal on to the peak hold circuit, composed of U3030D and U3030C.

The purpose of the peak hold circuit is to allow short peak pulses to be accurately measured and displayed on the digital readout. Capacitor C3038 is charged to positive peaks through CR4033 until U3030D inputs at pins 12 and 13 are nearly equal. C4031 is also charged through CR4034. When the peak disappears, CR4033 reverse biases, and C3038 maintains the peak voltage which is buffered through U3030C and connected to the convertor output through Q3040 and U2021A. The voltage across

C4031 decays through R4035 generating approximately 1 second time delay. The voltage across C3038 remains constant until the voltage across C4031 drops to about 7 V below the level on C3038. C3038 then discharges through Q4030, operating as a low leakage zener diode. The quasi-peak detector output connects to U2021A via Q3040, in the quasi-peak response mode, overriding the rms converter.

## dB Converter

The dB section is fed by the dc output voltage from the selected detector. Shown on this schematic are the dB converter, dB/Volts switch, offset generator, dB ratio circuit, and a voltage reference.

The dB converter consists of quad operational amplifier U4111, transistor array U5101 and associated circuitry. The input to the converter is a 0-4 V dc signal from the selected detector and a 6 V reference. The output is a dc signal at U4111 pin 1. This signal is proportional to the log of the ratio of the dc input signal to the reference voltage as described in the relationship:

$$E = K \times \log \frac{I_c \text{ for U5101A}}{I_c \text{ for U5101B}}$$

K is a constant and  $I_c$  is the noted collector current. The converter output is zero when the input voltage is 1.549 V, with a scale factor of  $-100$  mV/dB.

Operational amplifier U4111D provides a constant collector current in U5101B while holding the collector voltage at 0. The collector voltage of U5101A is held at 0 V by the action of U4111C. The collector current in U5101A varies with the input voltage. When the two collector currents are equal (at  $V_{in} = 1.549$  Volts), U5101A pin 2 is at 0 V and U4111C pin 8 is at 0 V. The offset voltage of the differential pair and U4111A is adjusted by R8101 (0 dB Adjust), which sets the 0 dB output level. Compensation for the offset voltage of U4111C ( $-40$  dB Adjust) is provided by R8091. This provides correct log conformity at low input voltages. Inversion of the dB output is provided by U4111A. Pin 1 of U4111A also provides the dB voltage to the bar graph display.

The three remaining transistors in U5101 serve as heaters to maintain the differential pair (U5101A and B) at a constant junction temperature. The voltage at U5101 pin 3 is proportional to the internal temperature of U5101. This voltage is compared with the reference voltage and any error is amplified by U4111B. The amplified error signal drives Q3111 which supplies current to the heater transistors. The  $-20$  dB Adjust, R2161, sets the internal junction temperature of the differential pair for the correct scale factor.

### dB Offset Generator 8

The offset generator consists of U4121, U7101 and R7101. This circuitry provides a dc offset voltage that is added to the log converter output at the input of operational amplifier U4121C. This voltage is set by input from the logic section and corrects dB measurements for the overall gain in the signal path.

The reference voltage is divided by R7101 into six offset voltages. Multiplexer U7101 selects one of these six voltages (or ground) and supplies it to U4121D. The gain setting resistor for U4121D, as well as a resistor in series with its output, is included in R7101. The offset output is supplied to U4121C through R8111.

This signal is routed to U2151, a multiplexer, which selects the dB-processed voltage (+10 mV/dB) or the voltage directly from the selected detector. This voltage is supplied to the DVM section. In the distortion modes, R3173 provides a small offset so that the 0 dB reference is changed from 0.775 V (0 dBm) to 1 V corresponding to 100%. In the dB ratio mode, U4121C also adds the stored reference voltage from the dBr section supplied via pin 5 of U2151.

### dB Ratio Circuitry 8

The dB ratio circuitry allows selection of any input voltage as the 0 dB reference. This is accomplished by adding a dc offset voltage from pin 15 of R7121 to pin 9 of U4121 through multiplexer U2151C. This causes 0 V at pin 8 of U4121C at the desired reference input voltage.

Amplifiers U6121C and D with resistor network R7121 form a digital-to-analog converter which supplies the dc offset to the input of U4121C. This converter is driven by an 11 bit binary counter composed of U6111 and U7111. This counter is controlled by dual flip-flop U7161B which is supplied with a clock signal from the gated oscillator composed of U7151A and B.

When the dB ratio button is pushed (grounded), a debounce circuit, composed of U7151C and D, causes pin 3 of U7161A to go high. A short time later, determined by R8131 and C8135, pin 4 of U7161A goes high, terminating the high at pin 1. A positive pulse appears at U7161 pin 1, resetting counters U6111 and U7111 and flip-flop U7161B. This allows the oscillator to start. The oscillator increments the counters changing the voltage offset. When the 0 dB reference button is pushed, the counter starts with the most negative voltage offset and increments in the positive direction. The output of U4121C connects to comparator U6121B. When the output of U4121C is 0 V, U6121B pin 7 goes high, causing U7161B pin 12 to go low at the next clock pulse. This action stops the oscillator. Future dBr

readings are referenced to this voltage. Pin 1 of U6121A goes positive a short time before U6121B pin 7. This switches the oscillator to a lower frequency through Q8161 and C7135 to prevent the circuits from overshooting the correct value.

### 6 V Reference 8

A 6 V reference voltage to the dB converter, offset generator, dBr section, and dvm is provided by U4121A and VR2143.

### DVM/Interface 14

The DVM section accepts the dc voltage from the dB converter or directly from the selected ac to dc converter and drives the digital display. The dvm input is proportional to the input signal voltage, the percent distortion or the log (dB) of the selected function. An LSI analog-to-digital converter with display drivers, U2041, drives the respective segments in LED display. Overrange indication is supplied internally in U2041. Reference voltage adjustment for the correct full scale reading is provided by R2057. Other external components support the internal operation of U2041.

The most significant LED module, DS1022, is controlled by U1051D and Q1047. This digit displays blank, 1 or 0. The 0 is displayed only in the 0.2% distortion range.

If a decimal point is needed in LED display DS1021, pin 2 of U1051A is low. This assures that pin 11 of U1051D is also low and illuminates the two segments comprising the one (1) in the most significant digit module, DS1022. Pin 19 of U2041 is high when a 0 is required and low when a 1 is required. The one is changed to a zero by illuminating an additional four segments of DS1022. The minus sign to the left of the most significant digit is used only in the db mode. Q1025 prevents the minus sign from illuminating in any other mode.

The ten operational amplifiers, U4021A, B, U4031 and U4041 comprise the drivers for the bar graph display. The analog signal from the dB converter is applied to the negative inputs of these amplifiers. The input resistance dividers are selected so that only one operational amplifier at a time is operating in the linear region. There is approximately 2.5 dB between each segment, with a slight overlap from one segment to the next.

P4011 is used for factory test interfacing only.

## Display Board

The four LED digit display modules and the sign module are illuminated by lowering the cathode voltages. The display module anodes and the state LEDs are operated from +5 V.

Pins 11 through 20 of DS1010, the bar graph display, are connected to -15 V. Pins 1 through 10 are driven by operational amplifiers in conformance with the analog signal strength.

## Logic Circuitry

The input signals to the logic section come from the front panel switches, the input stage level detector, and the distortion amplifier level detector. The logic circuitry controls the gain of the input stage and distortion amplifier, the dB offset generator, location of the decimal points and the function annunciator LEDs.

Diagram 10 shows the logic switching circuitry.

On diagram 11 a presettable up-down counter, U7011, controls the gain of the input stage. In the manual ranges, the preset inputs are enabled by S4171-4. The proper input level range signals are supplied by S4171-1, 2, and 3. In the auto range position, the counter accepts clock inputs from level comparators U5081A and B. These signals pass from U7011 to U3011. They are decoded in U3011, a bcd-to-decimal decoder, to drive the input stage gain control lines.

A dc signal, proportional to the input signal amplitude, appears at pin 4 of U5081A. The bias voltages on pins 5 and 6 of U5081A and B are such that pin 2 of U5081A goes low when the input signal is higher than the range the input stage is presently in. This low appears at pin 10 of U7011 which causes the binary up-down counter to count down. If the input attenuator is in the least sensitive range, a high exists on pin 1 of U7021A. A low then exists on pin 3 of U7021A which prevents the underrange LED from being illuminated. Pin 1 of U5081B is low when the input signal is lower than the input attenuator range. Pin 6 of U7021B is high in the most sensitive range. The up-down counter counts only when pin 5 is low. This occurs when the input signal level is higher than the attenuator range and the unit is not in the least sensitive position, or when the input signal is lower than the input attenuator range and the unit is not in the most sensitive range. The overrange and underrange LEDs are illuminated through Q2181 and Q2183 respectively. When the bases of these transistors are high, through the outputs of U7021A and U7021B, the lights are illuminated. The increase range and decrease range lights are also controlled by the distortion amplifier gain in the level mode.

U3021 decodes the odd 10 dB steps in the input stage gain and supplies this information to the distortion amplifier control and to U5011 for decimal point and offset formatting purposes.

Distortion amplifier gain is controlled in a manner similar to the input circuitry gain. U5081C, and U5081D are the level comparator and U7071A, U7071B, and U7071D perform the enable gating function.

The gain control input for the distortion amplifier is selected by U7041, a 4 bit and/or selector. In the level mode pin 9 is high, pin 14 is low, and pins 6, 4, and 2 are routed to the outputs. This selects the Input Level Range Switch, S4171, as the gain control input. In the distortion modes, pin 14 is high, 9 is low and 7, 5, and 3 are connected to the output. The distortion range switches now control the gain.

The signals from and to U7021C control the switching of U7041. A dc voltage proportional to the output of the distortion amplifier connects to pin 11 of U5081D. The operation of U5081 and U7071 are identical as described for the input stage up/down counter. These gates control up/down counter, U7061, for the distortion amplifier gain. A three-to-eight decoder driver, U5071, supplies decimal output for the distortion amplifier gain control circuitry.

A binary adder, U5011, shown on schematic 12, sums the gain of the input stage and the distortion amplifier. Pins 7, 5, 3 and 6 provide input stage gain information. Pins 4 and 2 provide distortion amplifier gain information. This sum is decoded by U5021, and passes through CR5031, CR5033 and CR5037. These diodes drive U3021B and U4061 to operate the  $\mu$ V, mV, and Volts annunciator LEDs. The control source for the decimal points is selected by U3041, a 4 bit and/or selector which operates as a multiplexer. In the volts mode, the decimal points are controlled by the decoded decimal information from U5021 and the diodes. In the distortion modes, the decimal points are controlled by the distortion amplifier gain. Gain information from the distortion amplifier appears at 1, 3, 5 and 7. In the dB modes, U3041 is disabled, and Q2063 is turned on by U4071A or U4071B. This illuminates the proper decimal point for all dB displays.

A 4 bit and/or selector (U5061) operating as a multiplexer, selects the control source for the dB offset generator. In the lever mode, the offset is controlled by the sum at the output of U5011. In the distortion modes, U5061 is controlled by the distortion amplifier gain.

## Power Supplies

There are three operating voltages in the AA 501A: + and -15 V dc and +5 V dc. The  $\pm 15$  V supplies the operational amplifiers, linear circuitry and CMOS, while +5 V is used for the logic and display circuitry.

The +5 V dc supply is derived from the +8 V dc supply in the mainframe. A three terminal voltage regulator, U4040, provides +5 V and includes built-in current limiting. Additional overcurrent protection is provided by F4062. R3047 provides adjustment of the voltage to a nominal value of +5.25 V measured at TP3041.

The +15 V dc supply is regulated from the +26 V dc mainframe supply. The reference voltage, against which the regulator output, divided down by R3043 and R3044 is compared, is supplied by VR3041. Errors between the reference voltage and divided output are amplified by U4041B and Q4050. The mainframe NPN transistor and Q3051 form a Darlington series-pass transistor. Frequency compensation for stability is provided by R4050 and C4050. Current limiting is accomplished by Q3050 which senses the voltage across R3053. When the current delivered by the +15 V supply exceeds about 500 mA, Q3050 turns on. This shunts base drive current from Q3051 lowering the output voltage. Fuse F4060 provides additional protection.

The -15 V is supplied from the -26 V dc in the mainframe. Amplifier U4041A compares the regulated +15 V supply with the -15 V through R4041 and R4042. Voltage differences are amplified by U4041 and Q4051. The mainframe PNP transistor and Q4052 form a Darlington series-pass transistor. Frequency compensation for stability is provided by R4054 and C4051. Current limiting is accomplished by Q4044 which senses the current through R4053. When the current delivered by the -15 V supply exceeds about 500 mA, Q4053 turns on. This shunts base drive current away from Q4052 and lowers the output voltage of the power supply. Fuse F4061 provides additional protection.

## IM Analyzer (Option 01 and Option 02 only) 13

The IMD Analyzer is block diagrammed in Fig. 3-3. In the difference frequency distortion mode (CCIF) the analyzer is a 1.1 kHz 9-pole Butterworth low pass filter. Two poles of this filter are provided by U3081B and associated components. The CCIF signal then passes to the level sensor composed of Q7071, CR5083 and C6071. Depending on the position of jumper P1053 and the amplitude of low frequency components at the anode of CR5083, multiplexer U8051 selects the output from the SMPTE/DIN demodulator at pin 2 or the partially filtered CCIF signal at pin 3. If approximately 1 V or more of low frequency signal is present at the anode of CR5083, Q7071 turns on. If the jumper is in the automatic position, the collector of U7071 goes low. This lowers pins 9, 10, and 11 of U1240 and connects pin 2 to pin 14, the output. In the CCIF mode, there is little power below 1.0 kHz. Under these conditions Q7071 is off, and pin 3 is connected to pin 14 of U8051.

The output of U8051 feeds buffer U6051B. The signals then pass through the remaining 7 poles of the 1.1 kHz low pass filter, comprised of U6051A, U6041A and U6041B, to the distortion amplifier.

In the SMPTE/DIN mode, the input signal passes through 7 poles of a 2 kHz high pass filter to remove the low frequency tone. This filter is composed of U3081A, U3061B and U3061A. The signal is full-wave rectified by U3041A and applied to the input of a voltage controlled amplifier U3041B. To maintain a constant signal amplitude of 3.6 V dc, U3031A integrates the difference between this signal and a dc reference voltage. The current through the LED in gain control resistor U2041 maintains the gain of U3041B so that the output is at 3.6 Vdc. The rectifier signal contains the demodulated SMPTE/DIN IM distortion product and passes through a 30 Hz two pole high pass filter comprised of C2021, C2011, R3021 and R3023 to the input of U3031B. This amplifier, along with C5021, C5023, C3031, and C3033 forms the first two poles of the 9-pole 1.1 kHz low pass filter. Pin 7 of U3031B connects to multiplexer U8051. From this point, the signal is processed exactly the same as the CCIF signal.

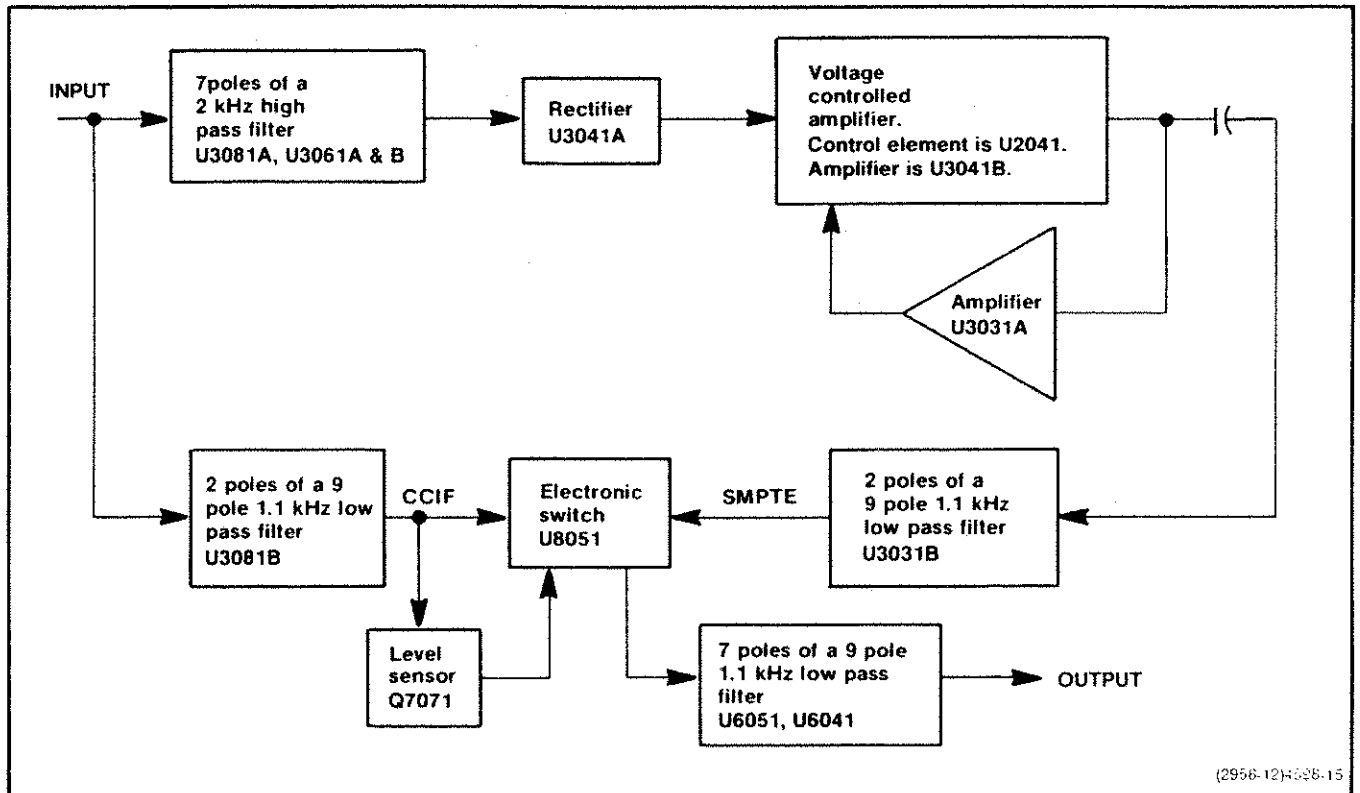


Fig. 3-3. Intermodulation distortion analyzer block diagram.





# CALIBRATION

## PERFORMANCE CHECK

### Introduction

This procedure checks the electrical performance requirements as listed in the Specifications section of this manual and may be used in an incoming inspection facility to determine acceptability of performance. If the instrument fails to meet the requirements given in this Performance Check section, the Adjustments Procedure section should be performed. Refer to the Parts Location Grid in the pull-out pages for the following Checks and Procedures. This procedure can be performed at any ambient temperature between 0°C to 50°C. Allow 20 minutes warm-up time (60 minutes after storage in a high humidity environment) before beginning the Performance Check.

### Performance Check Interval

The performance check should be performed at the following intervals:

- At incoming inspection

- After 2000 hours of operation or every 12 months, if used infrequently
- After repair or accidental abuse.

### Services Available

Tektronix, Inc. provides complete instrument repair facilities at local field service centers and at the factory service center. Contact your local Tektronix Field Office or representative for more information.

### Test Equipment Required

The test equipment, or equivalent (except as noted) listed in Table 4-1 is suggested to perform the Performance Check and the Adjustment Procedure in this manual.

Table 4-1  
Suggested Test Equipment

Description	Minimum Requirements	Example
Low distortion Sinewave oscillator(s)	$\leq 0.0008\%$ THD 20 Hz to 20 kHz; $\leq 0.0018\%$ , 10 Hz to 20 kHz and 20 kHz to 50 kHz; $\leq 0.0032\%$ 50 kHz to 100 kHz. 60 mV to $\geq 6$ V rms, 10 Hz to 100 kHz; IM test signal capability (Option 01 and Option 02 only)	Tektronix SG 505 oscillator for standard AA 501A or two SG 505 oscillators (one must have Option 01) for AA501A Option 01 and 02 instruments
Function generator	10 Hz to 500 KHz sinewave, triggerable tone burst capability	Tektronix FG 501A or FG 504
AC Voltage Calibrator	100 $\mu$ V to 180 V; 10 Hz to 100 KHz	<sup>a</sup> Fluke 5200A and 5205A
General Purpose Digital Multimeter	0.5% AC volts at 1 KHz, 0.2% dc volts and ohms	Tektronix DM 501A
General Purpose Counter	10 Hz to 500 KHz, 0.01%	Tektronix DC 509 or DC 504A
Adapter, BNC female to dual Banana adapter		Tektronix Part No. 103-0090-00
BNC T-adapter		Tektronix Part No. 103-0030-00
BNC connectors, 50 $\Omega$ coaxial cables 42 inch, 2 ea.		Tektronix Part No. 012-0057-01
6 inch banana-to-banana Patch Cord		Tektronix Part No. 012-0024-00
50 $\Omega$ Feedthrough Termination		Tektronix Part No. 011-0049-01
50 $\Omega$ 10X Attenuator, 3 ea.		Tektronix Part No. 011-0059-01
1 M $\Omega$ /20 pF input Normalizer		Tektronix Part No. 067-0538-00

<sup>a</sup>Model 5101B-03 may be substituted for the 5200A; however its specified accuracy derates to 2.0% at 1 mV (20 Hz to 20 kHz). Amplitude accuracy should be independently verified.

### Performance Check Steps

- |   |   |
|---|---|
| <ol style="list-style-type: none"> <li>1. Check Input Impedance</li> <li>2. Check Common Mode Rejection</li> <li>3. Check Volts Accuracy</li> <li>4. Check dBm Accuracy and Flatness</li> <li>5. Check Bandwidth</li> <li>6. Check Filters Response Accuracy</li> <li>7. Check Residual Noise</li> <li>8. Check THD + N Accuracy</li> <li>9. Check SMPTE/DIN IM Accuracy (Option 01 and Option 02 only)</li> <li>10. Check CCIF IM Accuracy (Option 01 and Option 02 only)</li> </ol> | <ol style="list-style-type: none"> <li>11. Check Residual THD + N</li> <li>12. Check Residual SMPTE/DIN IMD (Option 01 and Option 02 only)</li> <li>13. Check Residual CCIF IMD (Option 01 and Option 02 only)</li> <li>14. Check Q-PK Response Dynamic Characteristic (Opt. 02 only)</li> <li>15. Check Input Monitor</li> <li>16. Check Function Output</li> <li>17. Check Auxiliary Input</li> </ol> |
|---|---|

**NOTE**

The AA 501A has selectable measurement response. Unless specifically noted, all performance specifications and checks are valid using rms response only.

AA 501A Performance Check Summary

Serial Number: \_\_\_\_\_

Notes: \_\_\_\_\_

Date: \_\_\_\_\_

STEP #	CHECK	ALLOWABLE LIMITS	ACTUAL VALUE
1.	<b>Input Impedance</b> + Input - Input	98.0 to 102.0 k $\Omega$ 98.0 to 102.0 k $\Omega$	
2.	<b>Common Mode Rejection</b> 50 mV (200 $\mu$ V range) 50 mV (2 mV range) 50 mV (20 mV range) 100 mV (200 mV range) 300 mV (600 mV range) 1 V (2 V range) 3 V (6 V range) 10 V (20 V range) 30 V (60 V range) 100 V (200 V range)	$\leq$ 1.58 V $\leq$ 158 mV $\leq$ 15.8 mV $\leq$ 3.2 mV $\leq$ 1.0 mV $\leq$ 3.2 mV $\leq$ 1.0 mV $\leq$ 3.2 mV $\leq$ 1.0 mV $\leq$ 3.2 mV	
3.	<b>Volts Accuracy</b> A. 20 Hz to 20 kHz band 100 $\mu$ V (200 $\mu$ V range) 1.8 mV (2 mV range) 18 mV (20 mV range) 180 mV (200 mV range) 500 mV (600 mV range) 1.800 V (2 V range) 5.00 V (6 V range) 18.00 V (20 V range) 50.0 V (60 V range) 80.0 V (200 V range) B. 10 Hz to 100 kHz 100 $\mu$ V (200 $\mu$ V range) 1.8 mV (2 mV range) 18 mV (20 mV range) 180 mV (200 mV range) 500 mV (600 mV range) 1.800 V (2 V range) 5.00 V (6 V range) 18.00 V (20 V range) 50.00 V (60 V range) 180.00 V (200 V range)	20 Hz 1 kHz 20 kHz 97.9 to 102.1 $\mu$ V 1.763 to 1.837 mV 17.63 to 18.37 mV 176.3 to 183.7 mV 489 to 511 mV 1.763 to 1.837 V 4.89 to 5.11 17.63 to 18.37 48.9 to 51.1 176.3 to 183.7 10 Hz 100 kHz 95.8 to 104.2 $\mu$ V 1.727 to 1.873 mV 17.27 to 18.73 mV 172.7 to 187.3 mV 479 to 521 mV 1.727 to 1.873 V 4.79 to 5.21 17.27 to 18.73 47.9 to 52.1 172.7 to 187.3	

Calibration—AA 501A  
Performance Check

STEP #	CHECK	ALLOWABLE LIMITS	ACTUAL VALUE
4.	<b>dBm Accuracy and Flatness</b> A. 0.7746 V, 1 kHz 24.50 mV, 1 kHz B. Flatness 10 Hz 20 Hz 20 kHz 100 kHz C. 100 dB Ratio Accuracy	-0.3 to +0.3 dBm -30.3 to -29.7 dBm -0.5 to +0.5 dB -0.3 to +0.3 dB -0.3 to +0.3 dB -0.5 to +0.5 dB -100.8 to -99.2 dB	
5.	<b>Bandwidth</b>	≥300 kHz	
6.	<b>Filters Response Accuracy</b> A. 400 Hz HI PASS -3 dB 60 Hz rejection B. 80 KHz LO PASS -3 dB C. 30 kHz LO PASS -3 dB (Std and Option 01 only) D. AUDIO BANDPASS (Option 02 only) Upper -3 dB Lower -3 dB E. A WTG (std only) 100 Hz 1 kHz 10 kHz F. CCIR WTG (Opt 02 only) 100 Hz 1 kHz 10 KHz 20 KHz Q-PK 1 kHz cal RMS 2 kHz cal	380 to 420 Hz ≤ -40 dB 76 to 84 kHz 28.5 to 31.5 kHz  21.28 to 23.52 kHz 21.28 to 23.52 Hz  -20.1 to -18.1 dB -1.0 to +1.0 dB -6.5 to -0.5 dB  -20.8 to -18.8 dB -0.5 to +0.5 dB +7.3 to +8.9 dB -24.2 to -20.2 dB -0.2 to +0.2 dB -0.3 to +0.3 dB	
7.	<b>Residual Noise</b> 400 Hz -80 kHz A WTG (Std and Option 01 only) CCIR WTG (Option 02 only with Q-PK response)	≤3.0 μV ≤1.5 μV ≤5.0 μV	

STEP #	CHECK	ALLOWABLE LIMITS	ACTUAL VALUE	
8.	<b>Total Harmonic Distortion Accuracy</b> A. 20 Hz fundamental 40 Hz 60 Hz 80 Hz 1 kHz B. 1 kHz fundamental 2 kHz 3 kHz 4 kHz 10 kHz C. 20 kHz fundamental 40 kHz 60 kHz 80 kHz 100 kHz D. 10 Hz fundamental 20 Hz 100 Hz E. 100 kHz fundamental 200 kHz 300 kHz	 0.900 to 1.100% 0.900 to 1.100% 0.900 to 1.100% 0.900 to 1.100%  0.900 to 1.100% 0.900 to 1.100% 0.900 to 1.100% 0.900 to 1.100%  0.900 to 1.100% 0.900 to 1.100% 0.900 to 1.100% 0.900 to 1.100%  0.800 to 1.200% 0.800 to 1.200%  0.800 to 1.200% 0.800 to 1.200%		
9.	<b>SMPTE/DIN IM Distortion (Option 01 and Option 02 only)</b> Accuracy	0.900 to 1.100%		
10.	<b>CCIF IM Distortion (Option 01 and Option 02 only)</b> Accuracy	0.900 to 1.100%		
11.	<b>Residual THD+N (with SG 505)</b>  10 Hz 20 Hz 1 kHz 20 kHz 50 kHz 100 kHz	 ≤0.0071% ≤0.0032% ≤0.0032% ≤0.0032% ≤0.0071% ≤0.010%	- Input Grounded	+ Input Grounded

Calibration—AA 501A  
Performance Check

STEP #	CHECK	ALLOWABLE LIMITS	ACTUAL VALUE
12.	<b>Residual SMPTE/DIN IMD</b> (with SG505) A. 4 to 1 Ratio – Input Grounded + Input Grounded	$\leq 0.0025\%$ $\leq 0.0025\%$	
13.	<b>Residual CCIF IMD</b> (with SG 505 pair) – Input Grounded + Input Grounded	$\leq 0.0018\%$ $\leq 0.0018\%$	
14.	<b>Q-PK Response (Opt 02 only)</b> Single cycle 200 Hz tone burst with 10 Hz repetition rate relative response	–2.7 to –1.9 dB	
15.	<b>Input Monitor</b> Amplitude Output Impedance	0.90 to 1.10 V 950 to 1050 $\Omega$	
16.	<b>Function Output</b> Accuracy Output Impedance	0.97 to 1.03 V 950 to 1050 $\Omega$	
17.	<b>Auxiliary Input</b> Accuracy Input Impedance	0.97 to 1.03 V 95 to 105 k $\Omega$	

## PROCEDURE

### 1. Check Input Impedance

#### AA 501A Control Settings

FUNCTION	Level-Volts
INPUT RANGE	200 mV
FILTERS	None
RESPONSE	RMS

a. Connect the ac voltage calibrator to the input terminals of the AA 501A. Also connect a patch cord from the low or grounded side of the banana plug adapter to the ground terminal of the AA 501A so that it grounds out the — Input. Refer to Fig. 4-1.

b. Set the ac calibrator for an output frequency of 400 Hz and an amplitude of 110 mV. Adjust calibrator amplitude until the AA 501A display reads exactly 110.0 mV.

c. Insert the 1M $\Omega$ /20 pF Normalizer in series with the BNC to banana plug adapter and set the ac calibrator range for an output amplitude equal to 10 times the amount as determined in part b.

d. CHECK—That the AA 501A display readout is 98.0 to 102.0 mV, corresponding to an Input impedance of 98.0 to 102.0 k $\Omega$ .

e. Reverse the banana plug connections to the AA 501A so that the grounding connection shorts out the + Input.

f. CHECK—That the AA 501A display readout is 98.0 to 102.0 mV corresponding to an input impedance of 98.0 to 102.0 k $\Omega$ .

g. Remove the 1 M $\Omega$ /20 pF Normalizer.

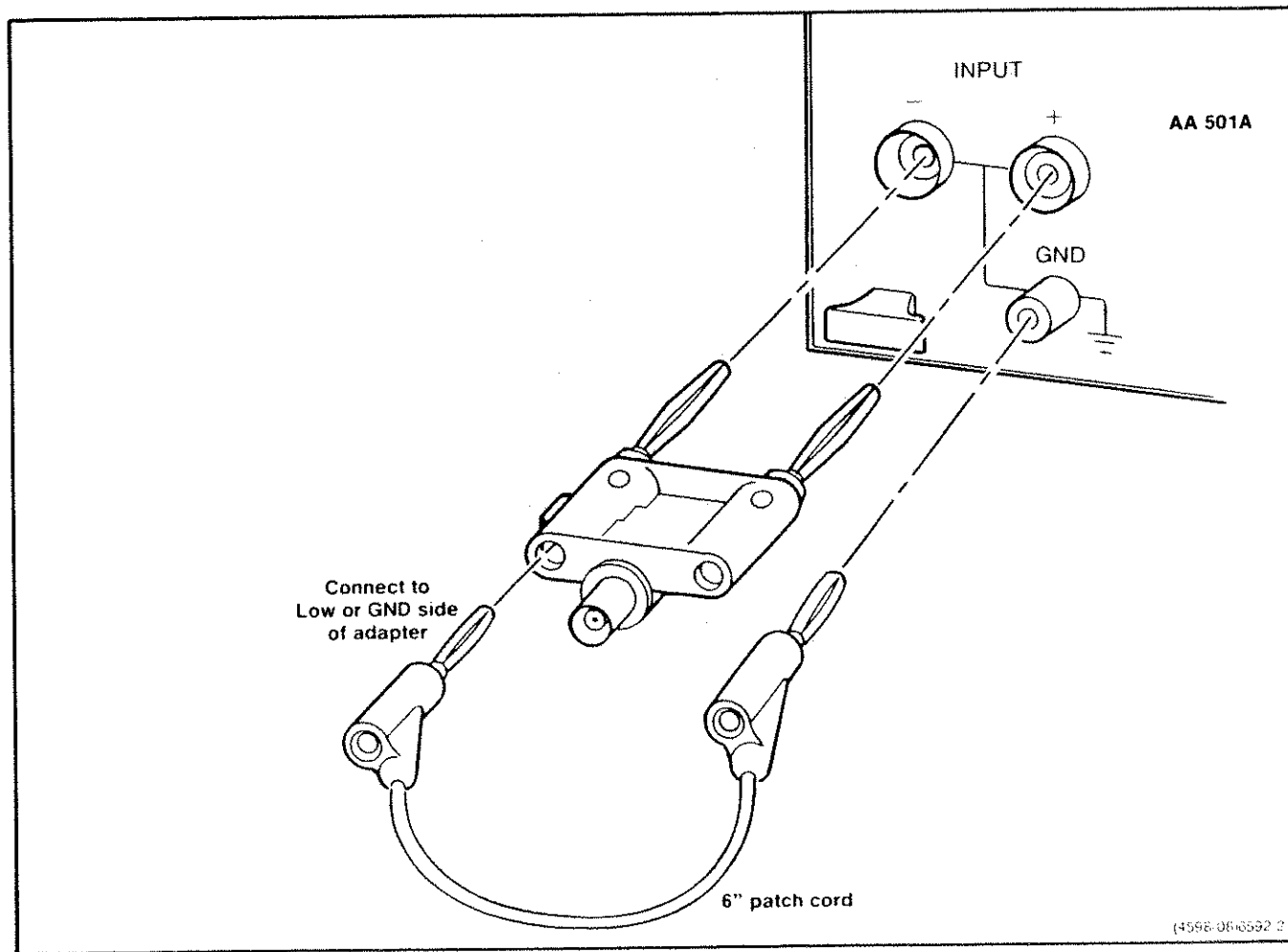


Fig. 4-1. AA 501A grounded unbalanced input connection.

## Calibration—AA 501A

### Performance Check

#### 2. Check Common Mode Rejection

a. Connect the ac calibrator to the input terminal of the AA 501A as shown in Fig. 4-2.

b. Connect the digital multimeter to the AA 501A Function Output and adjust it to measure AC volts.

c. Set the ac calibrator for an output frequency of 50 Hz (or 60 Hz) and an amplitude of 50 mV.

d. Set the AA 501A INPUT RANGE switch to 200  $\mu$ V.

e. CHECK—that the digital multimeter display readout is 1.580 volts or less.

#### NOTE

The internal gain from the AA 501A INPUT to the FUNCTION OUTPUT is 80 dB ( $\times 10,000$ ) on the 200  $\mu$ V range. With 50 mV of common mode signal, 50 dB rejection would correspond to an equivalent input signal of 158  $\mu$ V. This is amplified by 80 dB to 1.58 V. Other input ranges decrease this gain in inverse proportion to their value.

f. CHECK—that when using Table 4-2, the digital multimeter readings are acceptable for the listed input conditions.

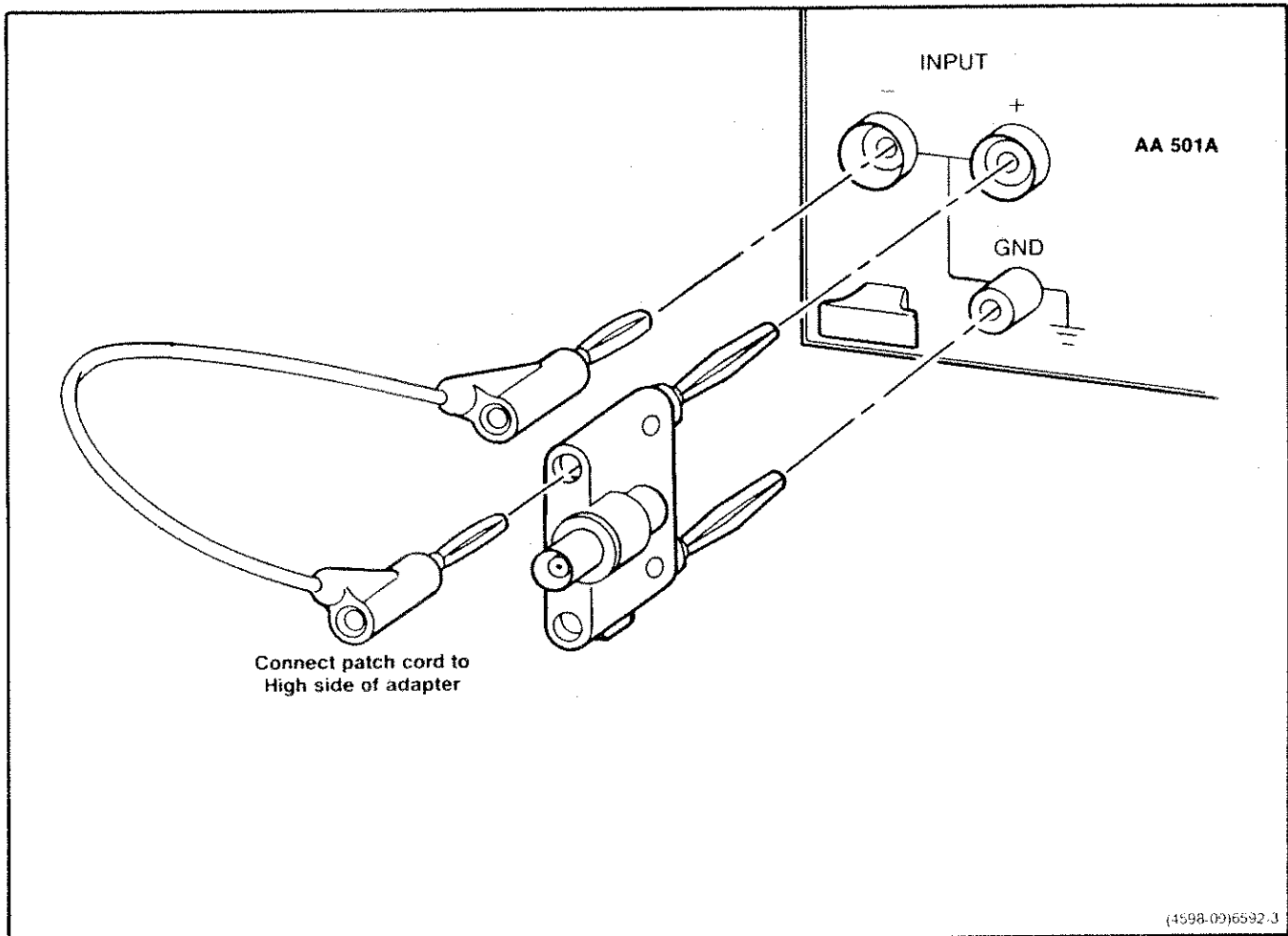


Fig. 4-2. AA 501A common mode input connection.



Table 4-2  
Common Mode Rejection CHECK

AA 501A Input Range	Input Common Mode Voltage	Maximum DVM Reading
200 $\mu$ V	50 mV	1.58 V
2 mV	50 mV	158 mV
20 mV	50 mV	15.8 mV
200 mV	0.1 V	3.2 mV
600 mV	0.3 V	1.0 mV
2 V	1 V	3.2 V
6 V	3 V	1.0 mV
20 V	10 V	3.2 mV
60 V	30 V	1.0 mV
200 V	100 V	3.2 mV

b. Set the voltage output of the ac calibrator and the AA 501A INPUT RANGE switch as shown in Table 4-2.

c. CHECK—that the displayed voltage readings are within the limits shown in the following table using 10 Hz, 20 Hz, 1 kHz, 20 kHz, and 100 kHz frequencies.

NOTE

*The operational range and/or specified accuracy of most commercially available ac calibrators is not adequate to directly check the AA 501A performance at 100  $\mu$ V. If desired, an accurate 100  $\mu$ V signal may be obtained by connecting a 1 k $\Omega$  0.1% resistor shunting the AA 501A INPUT and a 100 k $\Omega$ , 0.1% resistor in series with the ac calibrator set for 10.20 mV. The resistor divider ratio (including AA 501A input impedance effects) will be 102 to 1 causing the required 100  $\mu$ V at the input terminals.*

3. Check Level Function Volts Accuracy

a. Connect an ac calibrator to the AA 501A INPUT. Also connect a patch cord from the low side of the banana plug adapter to the ground terminal referring to Fig. 4-1 (same setup as in step 1).

d. Maintain test setup for next check.

Table 4-3  
Level Function Volts Accuracy

AA 501A Input Range	Calibrator Setting	Reading Limits	
		20 kHz – 20 kHz	10 Hz – 100 kHz
200 $\mu$ V	100.0 $\mu$ V	97.9 to 102.1	95.8 to 104.2
2 mV	1.800 mV	1.763 to 1.837	1.727 to 1.873
20 mV	18 mV	17.63 to 18.37	17.27 to 18.73
200 mV	180 mV	176.3 to 183.7	172.7 to 187.3
600 mV	500 mV	489 to 511	479 to 521
2 V	1.800 V	1.763 to 1.837	1.727 to 1.873
6 V	5.00 V	4.89 to 5.11	4.79 to 5.21
20 V	18.00 V	17.63 to 18.37	17.27 to 18.73
60 V	50.0 V	48.9 to 51.1	47.9 to 52.1
200 V	180.0 V	176.3 to 183.7	172.7 to 187.3

## Calibration—AA 501A

### Performance Check

#### 4. Check dBm Accuracy and Flatness

a. Connect an ac calibrator to the AA 501A as shown in step 3 (referring to Fig. 4-1).

b. Set the ac calibrator output frequency to 1 kHz with an amplitude of 0.7746 V.

c. Change the AA 501A INPUT RANGE switch to AUTO RANGE and the LEVEL FUNCTION to dBm 600  $\Omega$ .

d. CHECK—that the dBm reading is  $-0.3$  to  $+0.3$ .

e. Set the ac calibrator for an output frequency of 1 kHz and any valid voltage  $\geq 100 \mu\text{V}$  and 1 kHz. Calculate the dBm equivalent of this voltage using the formula:

$$\text{dBm} = 20 \times \log_{10} \frac{\text{Input V}}{0.7746}$$

For example 24.50 mV would correspond to  $-30.0$  dBm.

f. Select the dBm 600  $\Omega$  display mode.

g. CHECK—that the dBm reading is within  $\pm(0.3 \text{ dB} + 0.5\% \times \text{Reading})$  of the calculated result in part 4e.

Using the same example of 24.50 mV corresponding to  $-30.0$  dBm, the tolerance would be  $\pm(0.3 + 0.06) = \pm 0.3$  dB rounded off to the nearest 0.1 dB of displayed resolution.

h. Select dB RATIO display mode and PUSH TO SET 0dB REFERENCE set button.

i. CHECK—that the dB reading is  $-0.3$  to  $+0.3$  at 20 Hz and 20 kHz, and  $-0.5$  to  $+0.5$  at 10 Hz and 100 kHz frequency settings of the ac calibrator.

j. Set the ac calibrator to 100.0 V and 1 kHz and PUSH TO SET 0 dB REFERENCE set button.

k. Set the ac calibrator to 1.000 mV.

l. CHECK—that the dB reading is  $-99.2$  to  $-100.8$ .

#### 5. Check Bandwidth

a. Connect function generator to AA 501A input using a 50  $\Omega$  terminator and BNC-to-dual banana plug adapter. Also connect the digital counter to the AA 501A Input Monitor or the function generator, if desired, and adjust for a stable frequency readout.

b. Set function generator output to 1 kHz and any convenient amplitude, such as 1 V.

c. Select the dB RATIO display mode and PUSH TO SET 0 dB REFERENCE set button.

d. Increase the frequency of the function generator until the display readout indicates  $-3.0$  dB.

e. CHECK—that the digital counter frequency readout indicates  $\geq 300$  kHz.

#### 6. Check Filters Response Accuracy

a. Connect the sinewave oscillator to the AA 501A INPUT.

b. Set the oscillator frequency to 1 KHz and any convenient amplitude, such as 1 V.

c. Select dB RATIO display mode and PUSH TO SET 0 dB REFERENCE set button.

d. Press the 400 Hz HI PASS filter button.

e. Decrease the frequency of the sinewave oscillator until the display readout indicates  $-3.0$  dB.

f. CHECK—that the counter readout indicates between 380 Hz and 420 Hz.

g. Decrease the frequency of the generator to 60 Hz.

h. CHECK—that the AA 501A display readout indicates 40 dB or more attenuation.

i. Release the 400 Hz HI PASS filter and select the 80 kHz LO PASS filter.

j. Increase the frequency of the oscillator until the display readout indicates  $-3.0$  dB.

k. CHECK—that the counter reads 76 kHz to 84 kHz.

l. Release the 80 kHz LO PASS filter and select the 30 kHz LO PASS filter (STD and Option 01 only).

m. Decrease oscillator frequency until the display readout indicates  $-3.0$  dB.

n. CHECK—that the counter indicates 28.5 kHz to 31.5 kHz.

o. Release the 30 kHz LO PASS filter and select the AUDIO BAND PASS filter (Option 02 only).

p. Decrease the frequency of the oscillator until the display readout indicates  $-3.0$  dB at the upper cutoff frequency.

q. CHECK—that the counter reads 21.28 kHz to 23.52 kHz.

r. Decrease the frequency of the oscillator until the display readout indicates  $-3.0$  dB at the lower cutoff frequency.

s. CHECK—that the counter display readout is 21.28 Hz to 23.52 Hz.

**NOTE**

*Follow steps 6t through 6z for standard and Option 01 instruments only. Perform steps 6aa and following for Option 02 instruments only. Steps 6t through 6z spot check the response of the A weighting filter. For more information, refer to ANSI S 1.4 1971 (revised 1976) or IEC Recommendation 179 for type 1 sound level meters.*

t. Release the previously selected filter and select the A WTG filter.

u. Set frequency of the oscillator to 100 Hz.

v. CHECK—that the AA 501A display readout indicates  $-20.1$  dB to  $-18.1$  dB.

w. Set oscillator frequency to 1 kHz.

x. CHECK—that the AA 501A display readout indicates  $-1.0$  dB to  $+1.0$  dB.

y. Set oscillator frequency to 10 kHz.

z. CHECK—that the AA 501A display readout indicates  $-6.5$  dB to  $-0.5$  dB.

**NOTE**

*The following steps spot check the response of the CCIR WTG filter (Option 02 instruments only). For more information, refer to CCIR Recommendation 468-2 or DIN 45405. The CCIR weighting characteristic exhibits a very sharp rolloff at high frequencies. Exercise care to avoid small errors in setting frequency that can translate to significant amplitude (response) errors.*

aa. Release all previously selected filters and select the CCIR WTG filter to check the Option 02 instruments.

bb. Set the oscillator output frequency to 1.0 kHz and the output amplitude to approximately 0.8 V.

cc. Select dB RATIO mode and PUSH TO SET 0 dB REFERENCE set button.

dd. Increase oscillator output frequency to 6.30 kHz and readjust the output amplitude to obtain an AA 501A display readout of exactly  $+12.2$  dB. (CCIR response accuracy is referenced to  $+12.2$  dB at 6.3 kHz.)

ee. Set the oscillator output frequency to 100 Hz.

ff. CHECK—that the AA 501A display readout indicates  $-20.8$  dB to  $-18.8$  dB.

gg. Set the oscillator output frequency to 1.00 kHz.

hh. CHECK—that the AA 501A display readout indicates  $-0.5$  dB to  $+0.5$  dB.

ii. Set the oscillator output frequency to 10.0 kHz.

## Calibration—AA 501A

### Performance Check

jj. CHECK—that the AA 501A display readout indicates +7.3 dB to +8.9 dB.

kk. Set the oscillator output frequency to 20.0 kHz.

ll. CHECK—that the AA 501A display readout indicates -24.2 dB to -20.2 dB.

#### NOTE

*The following steps check the overall gain calibration of the CCIR WTG filter with both quasi-peak and rms detector responses. These gain calibrations are intentionally different with the 0 dB reference frequencies being 1.00 kHz and 2.00 kHz respectively.*

mm. Release CCIR WTG filter (flat response) and select Q-PK response.

nn. Set the oscillator output frequency to 1.00 kHz and the amplitude to approximately 0.8 V.

oo. Select dB RATIO mode and PUSH TO SET 0 dB REFERENCE set button.

pp. Select CCIR WTG filter.

qq. CHECK—that the AA 501A display readout indicates -0.2 dB to +0.2 dB.

rr. Release the CCIR WTG filter (flat response) and select RMS response.

ss. Set the oscillator output frequency to 2.00 kHz.

tt. PUSH TO SET 0 dB REFERENCE set button.

uu. Select CCIR WTG filter.

vv. CHECK—that the AA 501A display readout indicates -0.3 dB to +0.3 dB.

## 7. Check Residual Noise

a. Disconnect all cables from the AA 501A. Connect a shorting bar across the + and - Input terminals.

b. Set the AA 501A INPUT RANGE to 200  $\mu$ V or the Auto Range position. Select VOLTS display, RMS RESPONSE and both 400 Hz HI PASS and 80 kHz LO PASS filters.

c. CHECK—that the display readout indicates  $\leq 3.0 \mu$ V.

d. Release the 400 Hz HI PASS and 80 kHz LO PASS filters.

#### NOTE

*For standard and Option 01 instruments perform steps 7e and 7f only. For Option 02 instruments, perform steps 7g and 7h only.*

e. Select the A Wgt filter.

f. CHECK—that the display readout indicates  $\leq 1.5 \mu$ V.

g. Select CCIR WTG filter and Q-PK response.

h. CHECK—that the display readout indicates  $\leq 5.0 \mu$ V.

## 8. Check Total Harmonic Distortion Accuracy

a. Connect test equipment as shown in Fig. 4-3.

b. Select Input AUTO RANGE, LEVEL FUNCTION (VOLTS display mode), rms response, with no FILTERS.

c. Turn the oscillator output off.

d. Set the function generator output frequency to 7.00 kHz (sinewave) and adjust its output amplitude for an AA 501A display readout of approximately 3.00 mV.

e. Turn on the oscillator output and set its frequency to 400 Hz and amplitude for an AA 501A display readout of 300 mV (or exactly 100 times the value set in part 8d).

#### NOTE

*Do not disturb the oscillator or function generator output amplitudes for the remainder of this step. The resultant composite two tone signal comprises a calibrated 1.00% distortion source.*

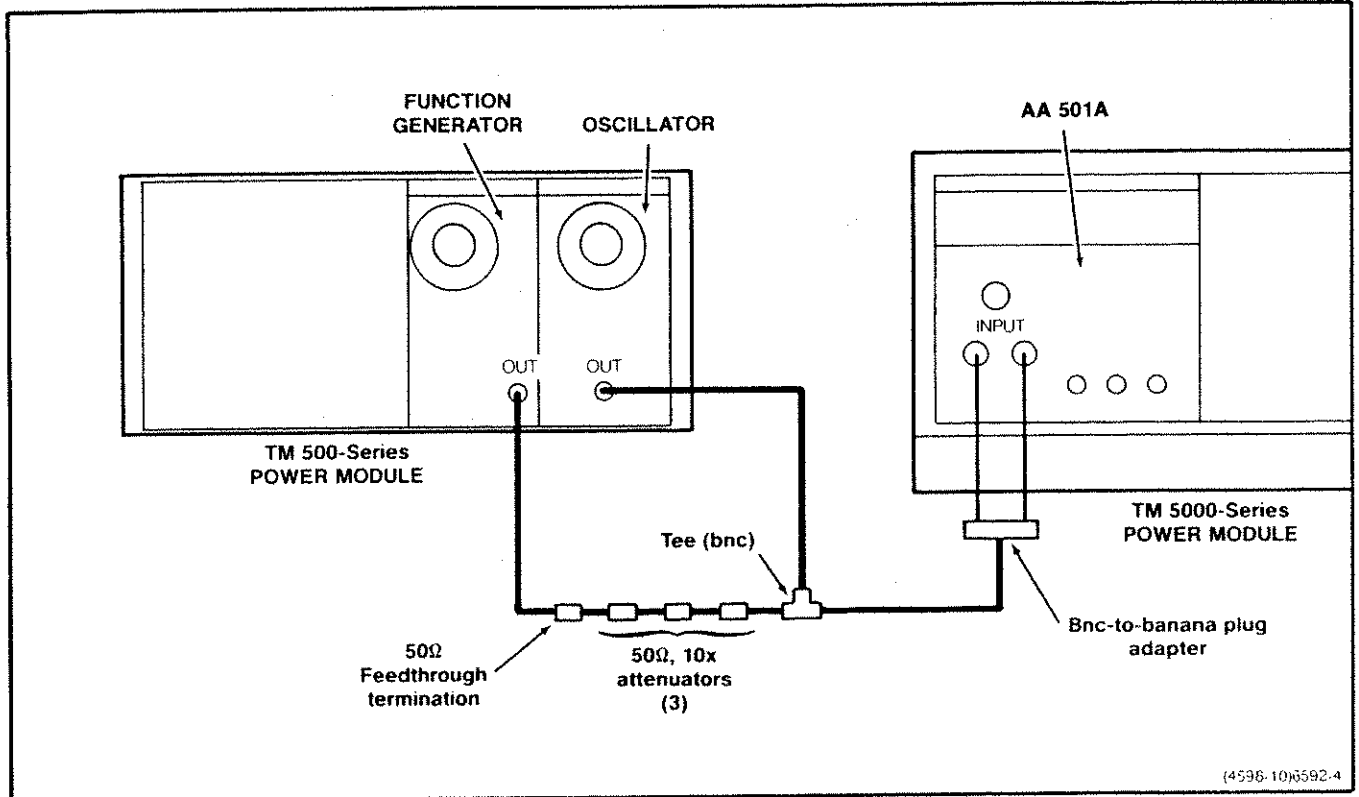


Fig. 4-3. AA 501A check/adjust step.

f. Select THD+N FUNCTION and AUTO RANGE.

g. CHECK—that the displayed distortion readout is within the limits at the various suggested frequency combinations as shown in Table 4-4.

**NOTE**

*When checking measurement accuracy, carefully set the test frequency as close to an exact harmonic ratio with the fundamental frequency. Beat frequency related display jitter can occur if the test frequency is offset by 0.1 Hz to 5 Hz from an exact harmonic. This is caused by the AA 501A automatic tuning operation and nulling control loops and the relatively fast response of the response detectors. A Lissajous waveform, formed by an X-Y display of the Input Monitor and Function Output signals may be helpful in setting the frequencies for exact harmonic ratios.*

h. Maintain test setup for next check.

**Table 4-4**  
**Total Harmonic Distortion Accuracy CHECK**

Fundamental (Oscillator)	Test Frequency (Function Generator)	Reading Limits
20 Hz	40 Hz 60 Hz 80 Hz	0.900% to 1.100%
1 kHz	1 kHz 2 kHz 3 kHz 4 kHz 10 kHz	
20 kHz	40 kHz 60 kHz 80 kHz 100 kHz	0.800% to 1.200%
10 Hz	20 Hz 100 Hz	
100 KHz	200 kHz 300 kHz	

**Calibration—AA 501A  
Performance Check**

**9. Check SMPTE/DIN IM Distortion Accuracy  
(Option 01 and Option 02 Only)**

a. Select Input AUTO RANGE LEVEL FUNCTION, VOLTS display mode, using no FILTERS.

b. Turn the oscillator output off.

c. Set the function generator output frequency to 7.00 kHz and adjust its output amplitude for an AA 501A display readout of 0.800 mV.

d. Turn on the oscillator output, select the 60 Hz IM test signal, and set the output frequency to 7.20 kHz.

e. Select the 400 Hz HI PASS FILTER to reject the 60 Hz component of the IM test signal and adjust the oscillator output amplitude for an AA 501A displayed readout of 80.0 mV.

f. Select the IMD FUNCTION and AUTO RANGE % mode, then release the 400 Hz HI PASS Filter.

g. CHECK—that the AA 501A display readout indicates 0.900% to 1.100%.

h. Leave test equipment setup for next step.

**10. Check CCIF IM Distortion Accuracy (Option 01 and Option 02 Only)**

a. Select the AA 501A LEVEL (VOLTS and release any FILTERS previously selected (flat response).

b. Turn the oscillator output off. Turn off the oscillator IM test signal.

c. Set the function generator output frequency to 250 Hz and adjust its output amplitude for an AA 501A display readout of 3.00 mV.

**NOTE**

*CCIF distortion is referenced to the level of either component of two equal amplitude test tones. This procedure simplifies test instrumentation requirements by omitting one of the two test tones. Subsequently, the averaging response of the automatic set-level circuitry of the AA 501A will cause readings to be high by a factor of exactly  $(4\pi)$  or 1.273. To compensate for this effect, the 250 Hz test tone amplitude is reduced proportionately from 300 mV to 382 mV.*

d. Turn on the oscillator output and set its frequency to 14 kHz and amplitude for an AA 501A display readout of 382 mV.

e. Select IMD FUNCTION.

f. CHECK—that the AA 501A display readout indicates 0.900% to 1.100%.

**11. Check Residual THD+N**

a. Connect the SG 505 oscillator output to AA 501A Input with the grounded connection to the –Input (refer to Fig. 4-1) and perform the following settings:

**SG 505 Control Settings**

Vrms	any setting $\geq$ 250 mV,
GND-FLTG	FLTG
ON-OFF	ON

**AA 501A Control Settings**

INPUT RANGE	AUTO
FUNCTION	THD+N
%	Auto Range

b. CHECK—that the AA 501A displayed readout does not exceed the limits as shown in the following table for the frequencies specified and for the AA 501A filter used.

SG 505 Freq.	AA 501A Filter	AA 501A THD+N Reading Limit
10 Hz	None	0.0071%
20 Hz	80 kHz	0.0032%
1 kHz	80 kHz	0.0032%
20 kHz	80 kHz	0.0032%
50 kHz	None	0.0071%
100 kHz	None	0.010%

c. Reverse the polarity connection to the AA 501A Input so that the grounding connection shorts out the + Input.

d. CHECK—(repeat step 11b).

e. Maintain test setup for next check.

**12. Check Residual Intermodulation Distortion in the SMPTE/DIN Mode (Option 01 and 02 only)**

a. Connect the test equipment as shown in Fig. 4-4.

b. Make certain the INPUT LEVEL RANGE switch is in the AUTO RANGE position.

c. Make certain the FUNCTION LEVEL, VOLTS, and AUTO RANGE pushbuttons are pressed. All other pushbuttons out. On Option 02 instruments press the RESPONSE pushbutton.

d. Set the output of the SG 505 to 7 kHz and turn on the intermodulation test signal set to 60 Hz or the output to 8 kHz and the intermodulation test signal to 250 Hz. See the Maintenance section for jumper selection information.

e. Set the output amplitude of the SG 505 to any value  $\geq 250$  mV.

f. Press the IMD pushbutton.

g. CHECK—that the display reads  $\leq 0.0025\%$ .

h. Reverse the polarity of the connection to the AA 501A Input.

i. CHECK—that the display reads  $\leq 0.0025\%$ .

j. Remove these connections for the next step.

**13. Check Residual Intermodulation Distortion in the CCIF Difference Tone Test Mode (Option 01 or 02)**

a. Connect the test equipment as shown in Fig. 4-5.

b. Turn the first SG 505 output off.

c. Make certain the 60 Hz or 250 Hz IM test signal is off.

d. Set the output frequency of the second SG 505 to 14 kHz.

e. Set the INPUT LEVEL RANGE to the AUTO RANGE position.

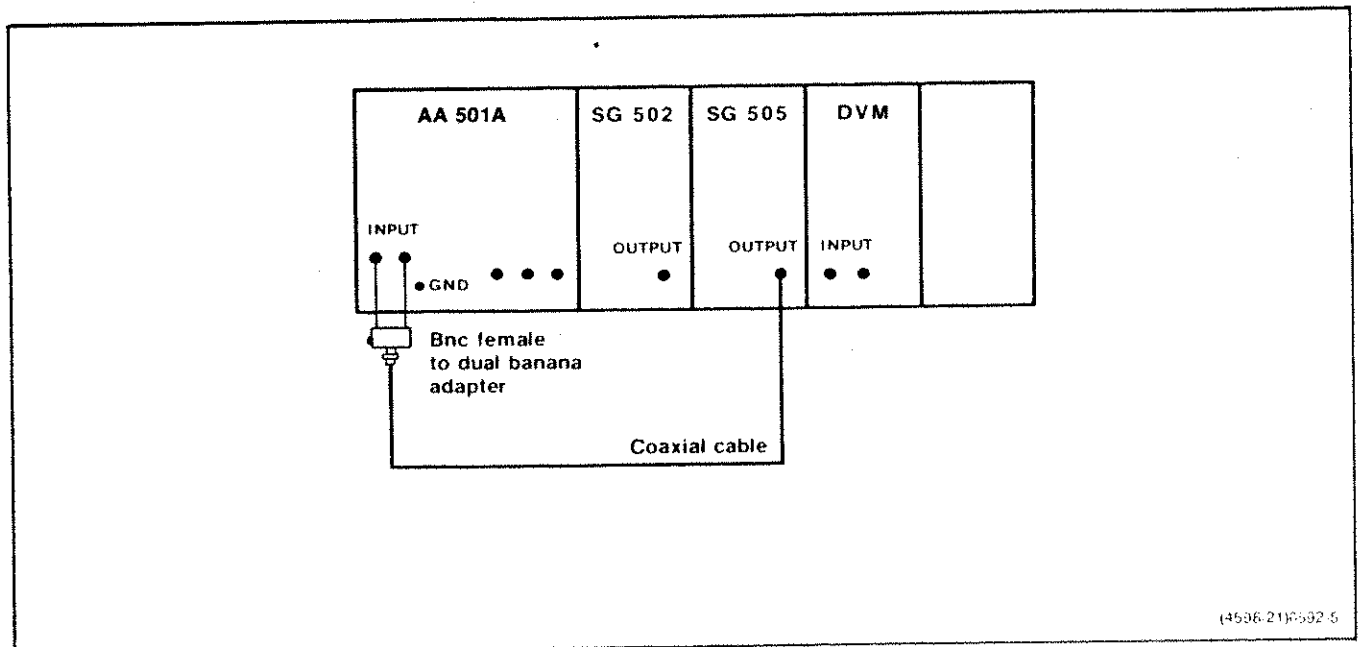


Fig. 4-4. SMPTE residual intermodulation distortion check/adjust.

**Calibration—AA 501A  
Performance Check**

f. Press the FUNCTION LEVEL, VOLTS, AUTO RANGE and RESPONSE RMS pushbuttons. All other pushbuttons out.

g. Set the output amplitude of the second SG 505 to any voltage above 177 mV. Note the output amplitude as read on the AA 501A display.

h. Turn the first SG 505 output on.

i. Set the output frequency of the first SG 505 to 15 kHz and the output amplitude so the AA 501A display reads 1.414 times the amplitude noted in step g.

j. Press the IMD pushbutton.

k. CHECK—that the display reads  $\leq 0.0018\%$ .

l. Reverse the polarity of the connection to the AA 501A input.

m. CHECK—that the display reads  $\leq 0.0018\%$ .

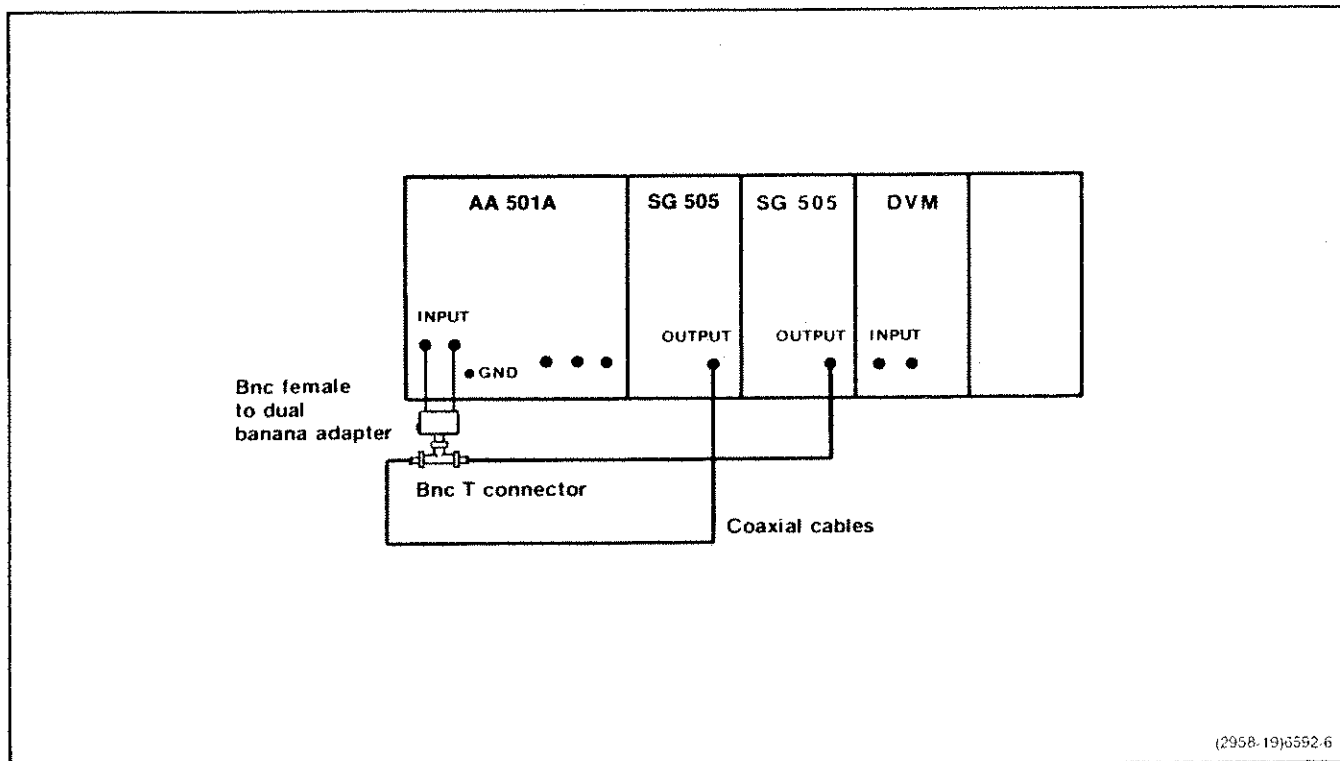
n. Remove all connections.

**14. Check Q-PK Response Dynamic Characteristic (Option 02 only)**

**NOTE**

*The following procedure is optional and spot checks the peak hold dynamic characteristic of the Q-PK detector circuitry. It verifies proper operation and is provided in lieu of the complex and lengthy procedures defined in CCIR Recommendation 468-2 or DIN 45405. This procedure checks the relative response of the Q-PK detector to a single cycle 200 Hz tone burst with a 10 Hz repetition rate. If desired, the SG 5010 Programmable Oscillator may be substituted for the suggested triggerable function generator and SG 505 using ON cycles = 1 and OFF cycles = 19 to obtain the required tone burst.*

a. Select the AA 501A 2 V INPUT RANGE, LEVEL FUNCTION (volts mode) and Q-PK Response. Make certain all FILTERS are off.



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Fig. 4-5. Total harmonic SMPTE and CCIF distortion and CCIF residual IM distortion check/adjust.



b. Connect the output of the triggerable function generator to the input of the AA 501A. Connect the output of the SG 505 oscillator to the trigger input of the function generator.

c. Set the output of the function generator for a 200 Hz sinewave in its free run mode.

d. Adjust the function generator output amplitude for an AA 501A display readout of approximately 1.60 V.

e. Select dB RATIO mode and PUSH TO SET 0 dB REFERENCE button. Note the display readout indicates 0.0 dB.

f. Set the output frequency of the SG 505 to 10 Hz with maximum output amplitude (approximately 6 V rms).

g. Change the function generator to triggered mode and make certain the phase control setting is near 0°. (The output signal should now be a single cycle 200 Hz burst starting at 0° phase with a 10 Hz repetition rate.)

h. CHECK—that the AA 501A display readout is -2.7 dB to -1.9 dB.

### 15. Check Input Monitor

a. Connect the SG 505 oscillator to the AA 501A INPUT and the digital multimeter to INPUT MONITOR.

b. Set the SG 505 output frequency to 1.00 kHz and approximately 1 V rms.

c. Select the 2 V INPUT RANGE and LEVEL FUNCTION.

d. Set the digital multimeter to measure AC volts.

e. CHECK—that the digital multimeter display readout is 0.90 to 1.10 V rms.

f. Turn the SG 505 oscillator output off.

g. Set the digital multimeter to measure  $\Omega$ .

h. CHECK—that the digital multimeter display readout is 950 to 1050  $\Omega$ .

### NOTE

*A slight dc offset may be present at the Function Output and will affect an ohm reading. To prevent measurement error, take the average of two readings reversing the digital multimeter connections between readings.*

### 16. Check Function Output

a. Adjust the test setup so that the digital multimeter is connected to the FUNCTION OUTPUT.

b. Set the digital multimeter to measure AC volts.

c. Turn on the SG 505 oscillator output and adjust its amplitude for an AA 501A display readout of 0.998 V to 1.002 V.

d. CHECK—that the digital multimeter display readout is 0.97 to 1.03 V.

e. Turn the SG 505 oscillator output off.

f. Set the digital multimeter to measure  $\Omega$ .

g. CHECK—that the digital multimeter display readout is 950 to 1050  $\Omega$ .

### NOTE

*A slight dc offset may be present at the FUNCTION OUTPUT and will affect an ohm reading. To prevent measurement error, take the average of two readings reversing the digital multimeter connections between readings.*

### 17. Check Auxiliary Input

a. Connect an ac calibrator to the AA 501A AUXILIARY INPUT. Set the calibrator output frequency to 400 Hz and 1.000 V amplitude.

b. Select 2 V INPUT RANGE, LEVEL FUNCTION (VOLTS mode), and Auxiliary FILTER (Input).

c. CHECK—that the AA 501A display readout is 0.970 to 1.030.

**Calibration—AA 501A**

**Performance Check**

d. Adjust calibrator amplitude until the AA 501A display readout indicates exactly 1.100 V.

e. Insert the 1 M $\Omega$ /20 pF Normalizer in series with the Auxiliary Input.

f. CHECK—that the AA 501A display readout is 0.095 to 0.105 V, corresponding to an input impedance of 95 to 105 k $\Omega$ .

# ADJUSTMENT PROCEDURE

## Introduction

This procedure need not be performed unless the instrument fails to meet the performance requirements of the electrical characteristics listed in the Specification section of this manual. To ensure instrument accuracy, perform the adjustment of the instrument every 2000 hours of operation or every 12 months if used infrequently. Adjustment may be required after a repair has been made. If adjustment of internal controls does not bring the instrument performance within the limits listed in the Specification section, troubleshooting is indicated. Adjustments should be made with the instrument operating at an ambient temperature of +20°C to +30°C.

## Test Equipment Required

Test equipment used for adjustment of the AA 501A is listed at the beginning of the Performance Check section of this manual.

## Preparation

To gain access to the test points and adjustable components, remove the instrument side covers (refer to the Maintenance section for instructions). Some adjustments are accessible through the top and bottom covers. See Fig. 4-6.

Connect the AA 501A to the power module via the extender cable. Connect the test equipment and the power module to a suitable line voltage source.

Turn on the power module and test equipment; allow at least 30 minutes warm-up time for the AA 501A.

## PROCEDURE

### 1. + 5.25 V (R3047) ADJUST

a. Connect a test cable from the digital voltmeter with the positive lead to the +5.25 V test point (TP 3041) and the negative lead connected to ground (TP 3044).

b. ADJUST—R3047, located on the Main board, for a digital readout of 5.25 V,  $\pm 0.1$  V.

c. Remove all cable connections.

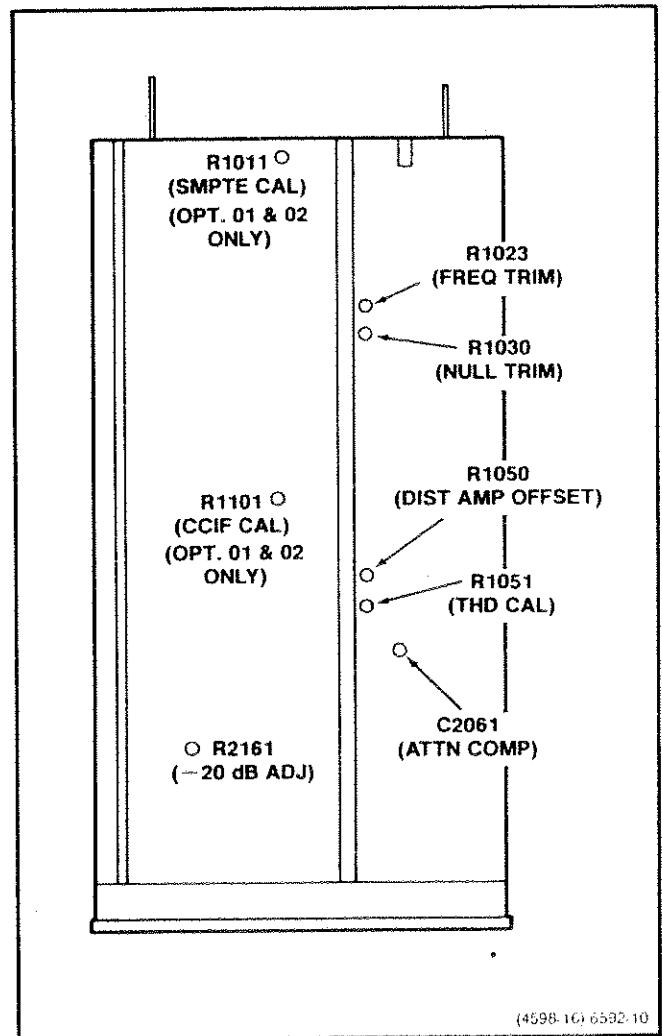


Fig. 4-6. AA 501A top cover adjustment access.

### 2. Distortion Amp Offset (R1050) ADJUST

#### AA 501A Settings

FUNCTION	THD+N
AUTO RANGE	0.2%
FILTERS	80 kHz LO PASS
INPUT RANGE	2 V

a. Short the AA 501A INPUT terminals using the dual banana shorting bar.

**Calibration—AA 501A  
Adjustment Procedure**

b. Connect a test cable from the oscilloscope vertical plug-in to the AA 501A FUNCTION OUTPUT connector.

c. Set the oscilloscope system for 200 mV/div, dc coupling (vertical) and 200 ms/div (horizontal). Adjust timebase for auto trigger and position the displayed baseline near center screen.

d. Press the AA 501A AUTO RANGE 2% button and note the jump and recovery of the displayed waveform baseline.

e. ADJUST—R1050, accessible through a hole in the top cover (see Fig. 4-6) and located on the Input/Notch Filter board, while alternately pressing the 0.2% and 2% AUTO RANGE buttons for a jump amplitude of less than 100 mV.

f. Remove all connections.

**3. Rms Zero (R1030), Avg Zero (R1035) or Q-PK Zero (R4037) ADJUSTS**

a. Press the AA 501A FUNCTION LEVEL and VOLTS buttons. Make certain the INPUT RANGE switch is set to 2 V.

b. Connect a test cable from the calibrator output to the AA 501A INPUT terminals. Set the AC Calibrator for a 15.00 mV, 1 kHz (sinewave) output.

c. Press the AA 501A RESPONSE button (RMS position).

d. ADJUST—R1030, located on the Main board, for a display readout of .014; then slowly adjust R1030 until .015 reading is attained.

e. Press the FUNCTION dBm 600  $\Omega$  button, and note the display readout.

f. Release the RESPONSE button.

g. ADJUST—R1035 in standard and Option 01 instruments, or R4037 in Option 02 instruments (located on the Main board), for the same reading as noted in step 3e.

h. Maintain same test setup.

**4. Rms Cal (R2064), Avg Cal (R1040) or Q-PK Cal (R4055) ADJUSTS**

a. Change the AA 501A FUNCTION to LEVEL and VOLTS, and make certain the INPUT RANGE switch is set to 2 V.

b. Press the RESPONSE button (RMS position).

c. Set the AC Calibrator for a 1.500 V rms output.

d. ADJUST—R2057, located on the DVM/Interface board, for a display readout of 1.500,  $\pm 0.001$ .

e. Release the RESPONSE button.

f. ADJUST—R1040 in standard instruments, or R4055 in Option 02 instruments (located on the Main board), for a display readout of 1.500,  $\pm 0.001$ .

g. Maintain same test setup.

**5. Attn Comp (C2061) ADJUST**

a. Make certain the FUNCTION LEVEL, VOLTS, and RESPONSE (RMS position) buttons are pressed and all FILTER buttons are out (off).

b. Make certain the INPUT RANGE switch is set to 2 V.

c. Set the AC Calibrator for a 1.00 V, 60 kHz (sinewave) output.

d. Note the display readout.

e. Change the INPUT RANGE switch to 20 V.

f. Change the AC Calibrator to 10.00 V (60 kHz).

g. ADJUST—C2061, accessible through hole in the top cover (see Fig. 4-6) and located on the Input/Notch Filter board, (using an insulated low capacitance screwdriver) for a display readout equal to exactly ten times the reading noted in step 5d.

h. Maintain same test setup.

### 6. 0 dB (R8101), -20 dB (R2161), and -40 dB (R8091) ADJUSTS

- a. Make certain the FUNCTION LEVEL button is pressed.
- b. Press the FUNCTION dBm 600  $\Omega$  button.
- c. Change the INPUT RANGE switch to 2 V.
- d. Press the RESPONSE (RMS position) button.
- e. Change the AC Calibrator for a 0.7746 V rms, 1 kHz output.
- f. ADJUST—R8101, located on the Logic board, for a display readout of exactly 00.0.
- g. Reduce the calibrator amplitude to 77.46 mV rms.
- h. ADJUST—R2161, accessible through hole in the top cover (see Fig. 4-6) and located on the Logic board, for a display readout of exactly -20.0.
- i. Reduce the calibrator amplitude to 7.746 mV rms.
- j. ADJUST—R8091, located on the Logic board, for a display readout of -40.0,  $\pm 0.2$ .
- k. INTERACTION—Repeat steps 6e through 6j, until the display readouts are correct.
- l. Maintain same test setup.

### 7. Offset Gain (R8111) ADJUST

- a. Change the INPUT RANGE switch to 20 mV.
- b. Change the calibrator output signal to 7.746 mV rms.
- c. ADJUST—R8111, located on the Logic board, for a display readout of exactly -40.0.
- d. Maintain same test setup.

### 8. dBr Zero (R8153) ADJUST

- a. Press the AA 501A FUNCTION dB Ratio button and change the Input Range switch to 2 V.
- b. Set the calibrator output for 0.7746 V rms at 1 kHz.
- c. Press and release the PUSH TO SET 0 dB REF button.
- d. ADJUST—R8153, located on the Logic board, if the display readout is not exactly 00.0. To correct for a - error, adjust (slightly) R8153 clockwise; for a + error correction, adjust counterclockwise.
- e. Interaction—Repeat steps 8c and 8d until the display readout indicates 00.0.
- f. Remove all connections.

### 9. Null (R1030), Freq Trim (R1023), and Ldr Balance (R5025) ADJUSTS

#### NOTE

*In these steps, although unnecessary, a dual channel oscilloscope system may be used. Connect the channel 1 to the AA 501A INPUT MONITOR, and the channel 2 to the FUNCTION OUTPUT (triggering on channel 1 signal). Channel 1 indicates the fundamental frequency. R1030 and R1023 are adjusted for minimum fundamental at the FUNCTION OUTPUT, while R5025 adjusts for minimum harmonics.*

- a. Change the INPUT RANGE switch to 2 V and press the THD + N, 0.2%, and 80 kHz LO PASS buttons.
- b. Connect the SG 505 oscillator to the AA 501A INPUT through a BNC to banana plug adapter as shown in Fig. 4-1. Make certain the SG 505 output is floating.
- c. Set the SG 505 oscillator output frequency to 400 Hz at approximately 0 dBm (1.55 V rms) amplitude.
- d. ADJUST—R1030, accessible through hole in the top rail (see Fig. 4-6) and located on the Input/Notch Filter board, for the lowest display readout.

**Calibration—AA 501A  
Adjustment Procedure**

e. ADJUST—R1023, accessible through the top cover hole (Input/Notch Filter board), for the lowest display readout.

f. INTERACTION—Repeat steps 9d and 9e to obtain the lowest display reading.

g. Change the oscillator frequency to 800 Hz.

h. ADJUST—R5025, accessible through hole in the bottom cover (Input/Notch Filter board), for the lowest display readout.

**NOTE**

*If R5025 has no effect on the display readout, leave the adjustment in the center position. If U4011 or U5010 have been replaced, this adjustment should be performed or rechecked after 24 hours of operation.*

i. Disconnect the oscillator.

**10. Dist Cal (R4042) ADJUST**

a. Change the INPUT RANGE switch to AUTO RANGE.

b. Press the FUNCTION LEVEL, VOLTS, RESPONSE and AUTO RANGE buttons. All other buttons are out (position).

c. Connect the test equipment as shown in Fig. 4-3.

d. Turn off the SG 505 oscillator output and make certain it is floating.

e. Adjust the function generator for a sinewave output frequency of 7 kHz and a AA 501A display of approximately 3.00 mV.

f. Turn on the SG 505 oscillator output and set the frequency to 400 Hz. Adjust the output level to 300 mV or exactly 100 times the level set in part 10e (as displayed on the AA 501A) and press the THD+N button.

g. ADJUST—R1051, accessible through the top cover hole (see Fig. 4-6) located on the Input/Notch Filter board, for a display readout of 1.000%.

h. Maintain same test setup.

**11. SMPTE Cal (R1011) ADJUST (Option 01 and Option 02 Only)**

a. Press the LEVEL button.

b. Turn off the SG 505 oscillator output.

c. Set the function generator output frequency to 7.00 kHz and adjust its output amplitude for an AA 501A display of 0.800 mV.

d. Turn on the SG 505 oscillator output, select the 60 Hz IM test signal mode, and set the output frequency to 7.20 kHz.

e. Press the 400 Hz HI PASS FILTER button to reject the 60 Hz component of the IM test signal and adjust the oscillator output amplitude for a AA 501A display of 80.0 mV.

f. Release the 400 Hz HI PASS Filter and press the IMD button.

g. ADJUST—R1011, accessible through the top cover hole (see Fig. 4-6) located on the IMD board, for a display readout of 1.000%.

h. Maintain the same test setup.

**12. CCIF Cal (R1101) ADJUST (Option 01 and Option 02 Only)**

a. Press the AA 501A LEVEL button and release any FILTERS previously selected.

b. Turn off the oscillator output. Turn off oscillator IM test signal.

c. Set the function generator output frequency to 250 Hz and adjust its output amplitude for an AA 501A display readout of 3.00 mV.

NOTE

*CCIF distortion is referenced to the level of either component of two equal amplitude test tones. This procedure simplifies test instrumentation requirements by omitting one of the two test tones. Subsequently, the averaging response of the automatic set-level circuitry of the AA 501A will cause readings to be high by a factor of exactly  $(4 \div \pi)$  or 1.273. To compensate for this effect, high frequency test tone amplitude is increased proportionally from 300 mV to 382 mV.*

d. Turn on the SG 505 oscillator output and set its frequency to 14 kHz and amplitude for an AA 501A display readout of 382 mV.

e. Press the IMD button.

f. ADJUST—R1101, accessible through the top cover (see Fig. 4-6) located on the IMD board, for a display readout of 1.000%.

g. Remove all connections.

13. CCIR Cal (Option 02 Instruments Only)

a. Connect SG 505 oscillator to AA 501A INPUT.

b. Select Level Function, Volts, and Q-PK response. Make sure all FILTERS are off.

c. Adjust oscillator output frequency to 1.000 kHz  $\pm$  1 Hz and amplitude for an AA 501A display readout of approximately 1.000 V.

d. Press the CCIR WTG button.

e. ADJUST—R2035, CCIR Cal located on the main board, for a display readout equal to that observed in step 13c.

f. Disconnect all test equipment.

This completes the Adjustment Procedure.

