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IE-10A

Audio Spectrum Analyzer

Owners and Operators Manual

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IE-10A WARRANTY

The IE-10A is warranted against defects in materials and workmanship for one (1) year from the date of purchase. During the warranty period Ivie Electronics will repair, or at its option, replace components which prove to be defective provided the analyzer is returned shipping prepaid to an authorized Ivie Electronics service facility. Defects caused by modifications, misuse or accidents are not covered by this warranty. No other warranties are expressed or implied. Ivie Electronics is not liable for consequential damages. All requests for repairs and information should include the instrument serial number to assure rapid service.

INTRODUCTION

In the past, real-time analysis of the audio spectrum has been an expensive process requiring a substantial investment in test equipment. The benefits of such analysis have long been appreciated, but the process has been so costly that only those with sufficiently large operating budgets have been able to afford it.

The IE-10A Spectrum Analyzer is a versatile piece of test equipment that is capable of making both relative and absolute measurements in the audio spectrum. Frequency response, amplifier gain, insertion loss, sound pressure levels, dBm and voltage testing represent a few of the IE-10A measurement applications. Unlike a typical voltmeter, the IE-10A simultaneously displays the octave frequencies of the signals being measured. The user can select a detector response for pink noise averaging or a fast response for real time signal monitoring. Many valuable uses can also be made of the built-in precision preamplifier.

Every IE-10A is built to last. The case is aluminum, fusion bonded with nylon, and internal construction is 100% modular. Every IE-10A is thoroughly and painstakingly tested to assure complete performance. Each unit is then heat tested in an oven for 72 hours at 125°F to assure reliability. Any unit that doesn't measure up doesn't leave the factory.

The following pages in this manual explain the many features and uses of the IE-10A. We suggest that it be read thoroughly.

With your IE-10A you should have received the following standard accessories pictured below:

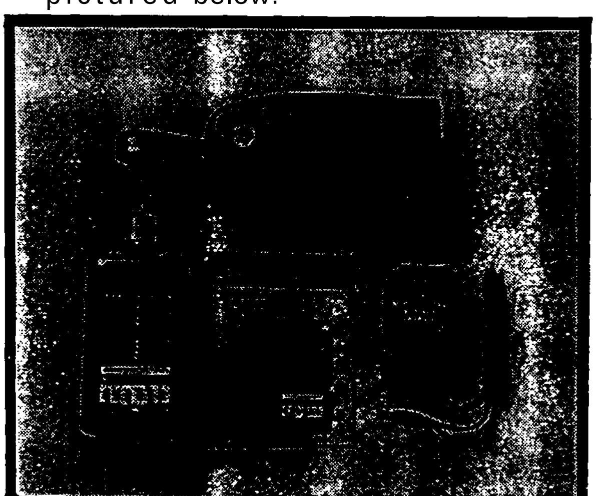


Figure 1

IE-10A Audio Spectrum Analyzer.

"Fast Charge" nickel cadmium batteries (mounted inside the IE-10A.)

AC adaptor/charger that provides continuous line operation.

Vinyl carrying case with belt loop.

Standard phono plug patch cord. (Not pictured)

Operator's Manual with illustrations and examples.

It is recommended that your IE-10A be charged for two to three hours after it is unpackaged. This will assure a full two hours of operating time before recharging is again necessary.

Make sure the voltage selection switch on the IE-165A Charger/Adaptor is in the correct position for the line voltage being used (either 115v. or 230 v. AC at 50-60 Hz).

OPERATION

OCTAVE FILTER CHARACTERISTICS

The ten octave filters in the IE-10A Spectrum Analyzer meet the requirements of the ANSI S1.II-1966 (R 1975) Class I filter standards. A plot comparing the second order Chebychev filters in the IE-10A with the ANSI standard curves can be seen in Figure 2.

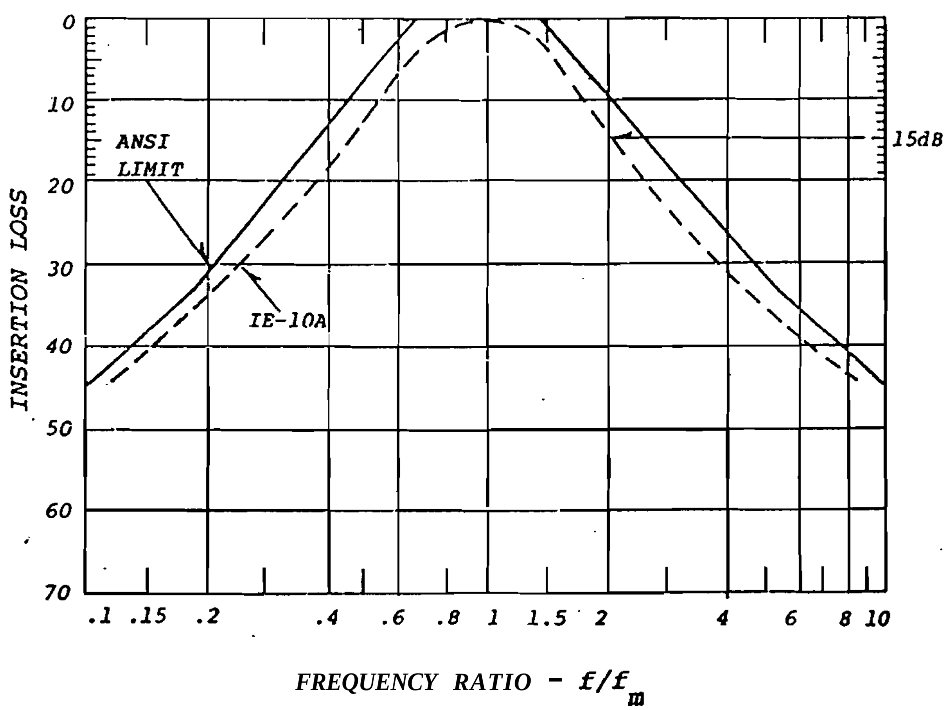


Figure 2

In the above plot of an octave width bandpass filter, the frequency scale (horizontal axis) has been normalized (f/fm) so that the same plot can be used to represent any one of the IE-10A octave filters. For example, the number 1 on the horizontal axis represents the filter center frequency fm, 2 is a frequency that is twice fm (the second harmonic) and 0.4 is a frequency that is four tenths that of the filter center frequency.

A well designed bandpass filter should allow passband information to be transmitted through it without significant energy loss while all frequencies outside the passband should be rejected or attenuated to some degree. Transmission loss (vertical axis of Fig. 2) is simply a measurement of the "attenuation" of energy (usually expressed in dB) as it passes through a device or circuit.

If we inject a pure 1 KHz tone into an octave filter having a center frequency of 1 KHz, the "transmission loss" would be minimal, or close to 0 dB. However, an out-of-band 2 KHz tone into the 1 KHz octave filter of the IE-10A would have a "transmission loss" of approximately 15 dB as can be seen by studying Fig. 2.

If all ten IE-10A filters are aligned in parallel they will have a frequency response similar to that shown in Fig. 3.

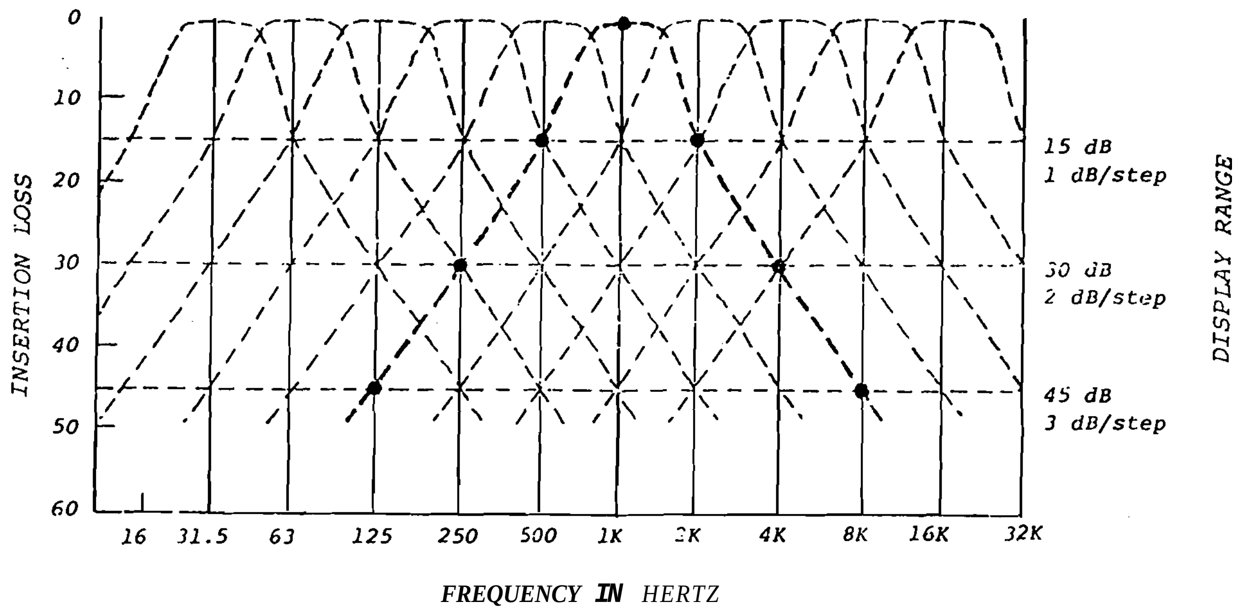
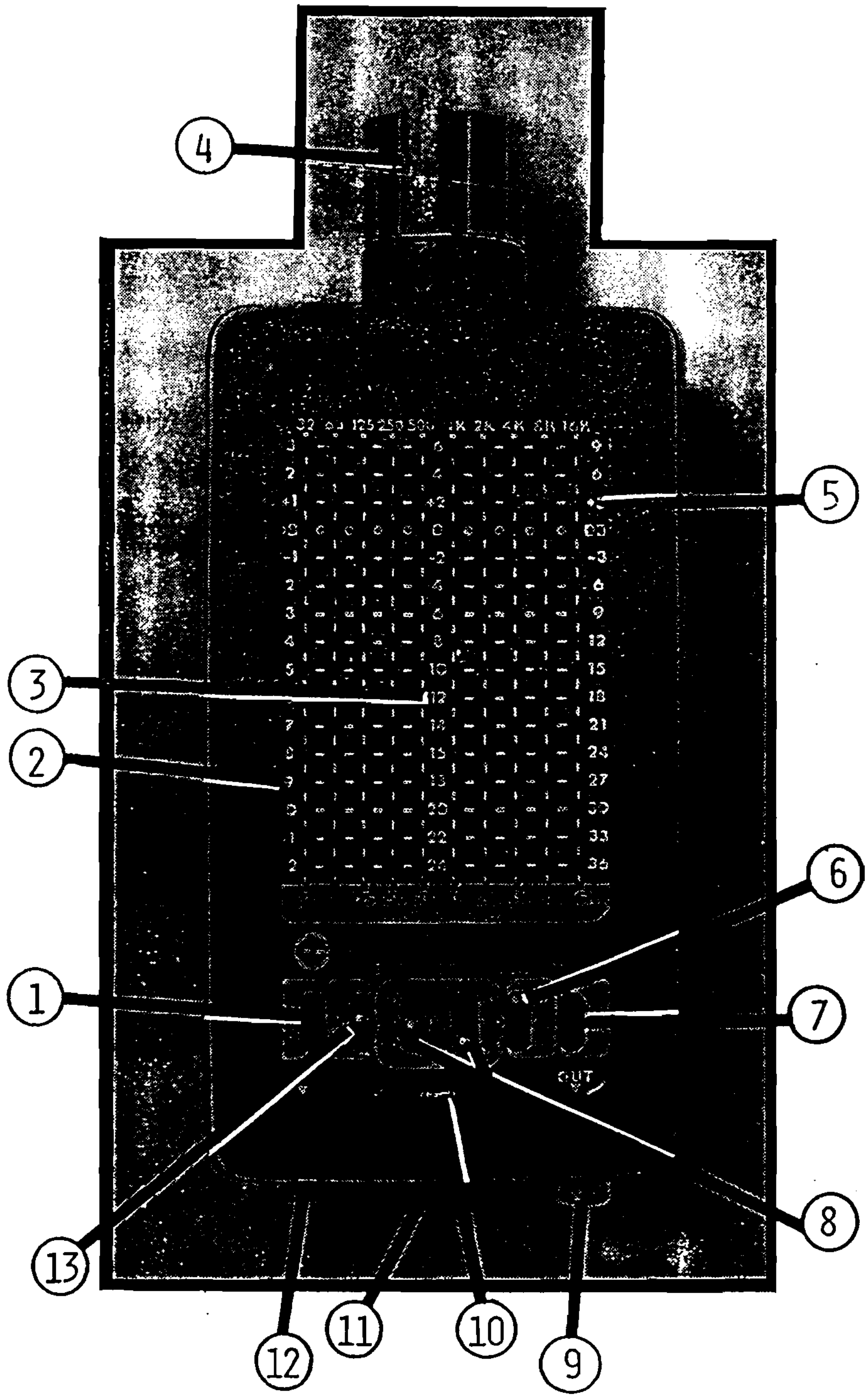


Figure 3

An interesting question might be:

> What kind of display would we expect to see on a real-time analyzer if we inject a pure sine wave signal at a frequency equal to one of the filter centers (ie. 1 KHz)?

Many people would assume that a 1 KHz frequency tone would cause energy to be displayed only at the 1 KHz filter position on the analyzer, but this is not true. Remember that bandpass filters can attenuate out of band energy but they cannot eliminate it completely. Filters that are close in frequency to 1 KHz also detect a small part of the incoming energy and they will display that energy on the analyzer at an attenuated level. Depending upon the display range selected, several filters could respond to a signal, even though the energy is at one single frequency. A 1 KHz signal fed into the filters of Fig. 3 will be displayed at the highest amplitude in filter number 6, which, of course, is the 1 KHz filter. Filters 3 through 9 also respond, in varying degrees, to the 1 KHz signal at a level where the individual filter skirts intercept the signal. Injecting a sine wave into the center frequency of one of the IE-10A filters results in a display of the shape of that exact same filter. This property is not unique to the IE-10A, but of all spectrum analyzers whether "real-time" or "swept tuned." We can view the filter shapes of every spectrum analyzer by injecting sine waves that are within the frequency range of the analyzer.



IE-10A FRONT PANEL AND CONTROLS

Figure 4

Referring to the picture of FIG. 4, the following number codes describe the various functions and controls of the IE-10A Real Time Analyzer.

(1) POWER ON/OFF Placing the power switch in the "ON" position applies power to all IE-10A circuits. Leaving this switch in the "OFF" position between measurements will extend the battery life between charges.

(2) DISPLAY GRATICULE. The left hand scale is calibrated to be used with the 1 dB/step setting of the display resolution switch (6) . Measurement range is +3 dB to -12 dB.

(3) DISPLAY GRATICULE. The center scale is calibrated to be used with the 2 dB/step setting of the display resolution switch (6) . Measurement range is +6 dB to -24 dB;

(4) MICROPHONE.. The omnidirectional condenser microphone is a professional quality Sound Level Meter type 2. The microphone becomes functional as the signal source for the IE-10A only when the INPUT switch (7) is set to internal (INT).

(5) DISPLAY GRATICULE. The right hand scale is calibrated to be used with the 3 dB/step setting of the display resolution switch (6) . Measurement range is +9 dB to -36 dB.

(6) DISPLAY RESOLUTION. Display resolution can be selected in steps of 1, 2 or 3dB providing the operator with display ranges of 15, 30, and 45dB respectively. Note that the correct display graticule must be used with the appropriate dB/step resolution setting. For example 1dB/step n should be used with display graticule (2) 6 and likewise 2dB/step and 3dB/step with (5) .

(7) INPUT SELECTOR SWITCH. When the input switch is set to internal (INT) the analyzer's built-in microphone (4) becomes the signal source for the IE-10A. Setting the input switch to external (EXT) allows the operator to inject other signals into the analyzer through the phono jack (12) marked "IN".

(8) SENSITIVITY SWITCHES. The sensitivity switches add gain in 10dB steps (to a total of 80dB) to the analyzer front end which changes the measurement range. To determine analyzer gain, add the absolute values of the two sensitivity switch settings as shown in the table below.

SENSITIVITY				
Switch 1 dB	+	*Switch 2 dB*	=	*IE-10A Gain dB*
0	+	*0*	=	*0*
10	+	*0*	=	*10*
20	+	*0*	=	*20*
0	+	*30*	=	*30*
10	+	*30*	=	*40*
20	+	*30*	=	*50*
0	+	*60*	=	*60*
10	+	*60*	=	*70*
20	+	*60*	=	*80*

Table 1

(9) PREAMP OUTPUT. The IE-10A has a built in, low-noise preamp circuit with gain adjustable in 10dB steps to a maximum of 80 dB. Input to the preamplifier is phono jack (12), the output is phono jack (9). For details and applications refer to the manual section about the preamplifier.

(10) BATTERY STATUS INDICATOR. This LED indicator has two important functions. It lights when the IE-10A is being charged, thus providing indication of a properly working battery charger. Its second function is providing indication of battery level. It illuminates when the Ni-Cad batteries are low and require charging.

(11) BATTERY CHARGER JACK. This jack is provided to recharge the Ni-Cad batteries in the IE-10A using the model IE-165A adaptor/charger.

(12) SIGNAL INPUT JACK. The phono jack marked "IN" is the signal port to be used with the input switch (7) set to "EXT". Having an input impedance of 100 K ohms, this external input will accept most of the microphones and signal generators available in the market today.

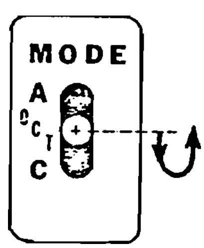
(13) MODE SELECTOR. Positions "A" and "C" select filters for Sound Level Meter applications, and "OCT" selects the ten octave bandwidth filters for Spectrum Analyzer operation. In the "OCT" mode the IE-10A has two selectable detector responses, one for pink noise measurements and the other for monitoring. Pink noise averaging is activated by switching the mode first to "C" and then to "OCT." The monitoring response is activated by switching the mode to "A" and then to "OCT." The monitoring detector response is activated when the power is first turned on.

SELECTING THE DETECTOR RESPONSE

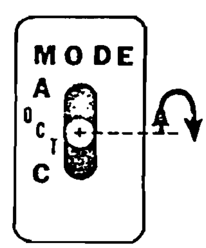
There are three different detector response modes used in the IE-10A filter circuits, two for the OCT filters and one for the A and C filters. For sound level meter applications using the A and C weighted filters, the detectors satisfy ANSI S1.4 1971, S2A, S2C and IEC 123 (1961) for the "slow" response. For the OCT mode of the IE-10A, you may select either the signal monitor mode, or the pink noise averaging mode. The signal monitor detectors have a very fast rise-time and fall-time response to enable the operator to view signal transients, impulses, oscillations, music signatures and other rapidly changing phenomenon. The pink noise averaging mode was designed mainly for tests using pink noise and other types of random signals.

The mode switch has only three toggle positions, but it is used to select A, OCT or C filters and also the detector responses. To select the signal monitor detectors, the mode switch is moved to the A filter and then returned to OCT. If the mode switch is moved to the C filter and then returned to the OCT position, the pink noise averaging detectors will be activated.

SELECTABLE DETECTOR RESPONSES



PINK NOISE MODE



MONITOR MODE

Figure 5

BATTERY AND LINE OPERATION

An IE-165A AC Adaptor/Charger has been supplied with your IE-10A Audio Spectrum Analyzer that will recharge the batteries in about 3 hours. The IE-10A will operate approximately 2 hours between charges, depending upon the ambient light level. The battery current drain varies because of the automatic, display intensifier circuits in the IE-10A. Normal room lighting will provide about 2½ hours of operating time with less than 2 hours available under bright stage lights or sunlight.

When the "CHARGE" LED lights indicating low batteries, recharging is immediately necessary. The IE-10A specifications cease to be accurate shortly after this LED illuminates.

CAUTION: Use of an AC adaptor/charger other than the IE-165A may cause damage to your IE-10A.

The IE-165A AC Adaptor/Charger is selectable for voltages of 115v. or 230v. AC at 50 to 60 Hz. Make sure the voltage switch on the IE-165A is in the correct position for the AC power line being used. Using the IE-165A with AC power other than 115v. or 230v. at 50-60 Hz. may cause damage to your IE-10A.

The IE-10A may also be operated directly from the AC power line using the IE-165A as an adaptor if the batteries have some charge in them. The IE-165A will not operate an IE-10A directly from the power line if the batteries in the IE-10A are discharged.

The Ni-Cad batteries in the IE-10A are of the highest quality and are capable of withstanding extended overcharging. It is recommended that they be completely discharged (until the "Charge" LED on the IE-10A illuminates) from time time to minimize the possibility of "memory effect" on the batteries. Ni-Cad batteries can lose their ability to give up 100% of their charge if they are only partially discharged on a frequent basis.

If permanent power line operation of the IE-10A is desired, it is recommended that the Ni-Cad batteries be removed and that a line operated DC power supply of 6v. and 250ma be provided in their place. The external power supply can be conveniently provided to the IE-10A through the charge jack ((11) Figure 4) (center pin is positive).

PINK NOISE TESTING AND THE IE-10A

There are a few fundamentals that the reader should be made aware of before doing pink noise testing. Pink noise is random noise that appears flat only after being time averaged by special detectors on a real-time analyzer. When used with pink noise, the detectors in the IE-10A should always be in the pink noise averaging mode. The rms voltage output of a pink noise generator must be measured by special means using sampling techniques and a true rms voltmeter. To an oscilloscope, pink noise appears to be a mass of random voltage spikes.

The output of the IE-20A Pink Noise Generator has been calibrated in volts rms. A very important specification on a pink noise generator is its "crest factor." Crest factor is simply the ratio of the peak voltage to the rms output voltage of the generator. For example, if we select an output level from the IE-20A equal to 30 mv rms, a crest factor of 3.75 predicts that there could be instantaneous voltage peaks in the output that are 3.75 times the magnitude of the rms output voltage. In this particular case, a 30 mv rms output will produce voltage peaks as large as 113 mv. Pink noise is one of the best signal sources available for doing rigorous testing of amplifier durability, and transient signal handling capabilities. Pink noise also approximates actual audio signals better than any other type of signal source.

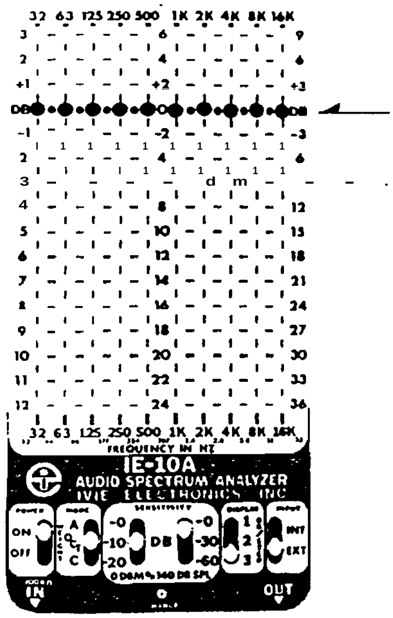
The IE-10A is calibrated to measure voltage and dBm for sine wave inputs using the external jack. With a pink noise input the IE-10A is only calibrated in dB for relative measurements like gain, loss and frequency response. For sound level measurements, using the IE-10A microphone, the analyzer is always calibrated in absolute dB-SPL whether the sound in the room is pink noise or another type.

CALIBRATING THE IE-20A TO THE IE-10A

The IE-10A filters are very flat electrically, to within a small fraction of a dB, as can be verified with a swept sine wave input signal. Likewise, the IE-20A is designed to provide very flat pink noise output into a real-time spectrum analyzer. Being designed flat "independently", any IE-20A will work with any IE-10A produced, and visa versa.

Many analyzer/pink noise combinations available in the audio marketplace use non-flat pink noise that is compensated for by adjusting the analyzer filters to be inversely non-flat so that the analyzer/pink noise combination will appear flat. This type of system is accurate only for relative measurements and cannot be used for accurate testing of absolute levels of voltage, dBm or dB-SPL. A further limitation is that the pink noise source and the analyzer cannot be interchanged with other units unless a complete recalibration is performed on the instruments.

To check proper operation of the IE-10A and the IE-20A, set the output attenuator on the IE-20A to zero and set the controls on the IE-10A as shown in Fig. 6. Next feed the IE-20A output into the IE-10A using one of the patch cords supplied. The signal should appear flat and at the 0 dB line on the IE-10A display as shown. If the pink noise is flat but does not appear at the 0 dB line on the IE-10A consult the IE-20A manual on adjusting the output reference level.



**Note settings of SENSITIVITY switches.*

IE-10A detectors should be in pink noise averaging mode.

Figure 6

Increase the IE-10A DISPLAY switch resolution to 2 dB per step, and then to 1 dB per step. The pink noise should remain at the 0 dB line, but if it does not, readjust the reference on the IE-20A. Now you are calibrated, and the output voltage on the IE-20A is equal to 940 mv rms.

Now try another experiment with the IE-10A/IE-20A. Set the dial attenuator on the IE-20A to 12 dB. As you switch the display resolution on the IE-10A between 1, 2, and 3 dB, note that the signal is 12 dB down from the calibration line (0 dB) on all three display scales. The resolution settings on the analyzer always expand around the 0 dB reference line.

As analyzer resolution reaches 1 dB per step it can be observed that pink noise in the low frequency filters appears less stable in amplitude when viewed on the IE-10A. This is a normal occurence with any pink noise source and analyzer, and is due to the random nature of pink noise and the fact that the low frequency filters have narrower bandwidths. If pink noise is averaged over a long period of time it will appear very flat with little variation in amplitude. Using a long detector time constant, we would be forced to wait for an excessively long time period for the analyzer to respond to a change in frequency response and we would have something less than a "real-time" analyzer. The IE-10A detectors are optimized for best stability versus fast response time of the displayed signal. High resolution measurements need not be less accurate if we simply observe the level at which the LEDs spend most of the time.

PINK NOISE GAIN/LOSS TESTING

Using pink noise as a signal source with the IE-10A will enable a measurement of frequency response and gain (or loss) simultaneously. The simplest way to describe the procedure is through the use of a few examples.

1st EXAMPLE

Measure the gain' and the frequency response of a preamplifier with 10 mv input signal.

Procedure;

1. Using the table on page 9 of the IE-20A operator's manual, set the output level of the IE-20A to 10 mv. An attenuator setting of 40 dB will provide a 9.4 mv signal.

2. Initially set the switches on the IE-10A as shown. Display resolution is set to 2 dB per step for this example.

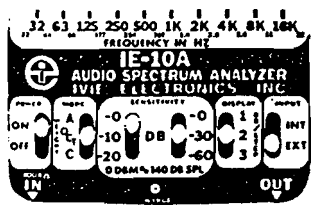


Figure 7

3. Set the IE-10A detectors in the pink noise averaging mode. This is accomplished by moving the MODE switch to the C filter position and then back to OCT.

4. Using the patch cable provided, connect the IE-20A output to the IE-10A input as shown. The signal from the IE-20A should appear at the -20dB line on the IE-10A (2 dB per step scale). Notice that the signal was purposely displayed near the bottom of the screen because the signal gain from the amplifier will cause the display to rise.

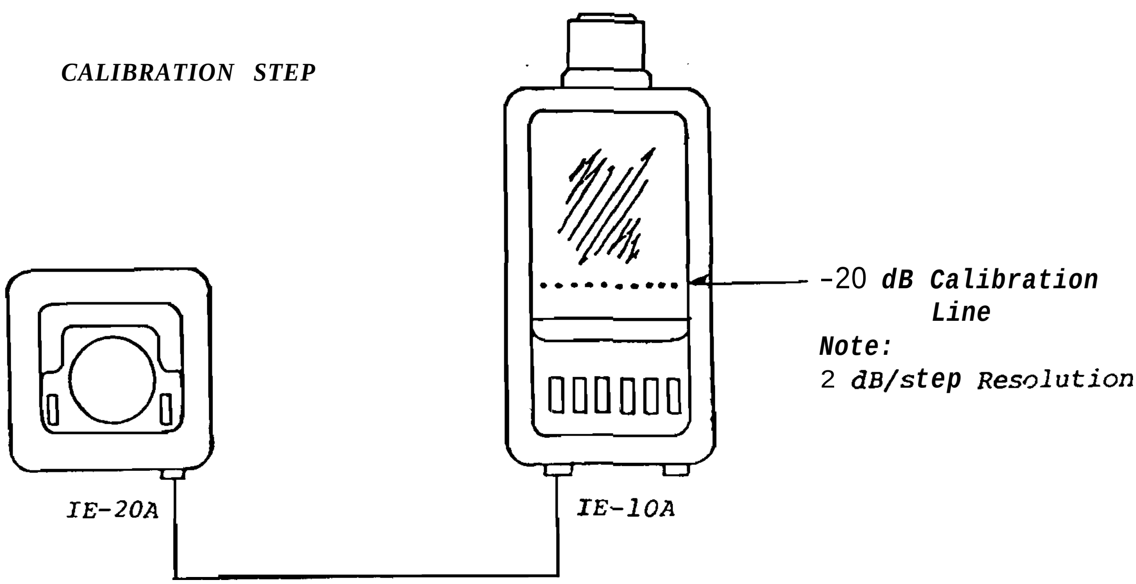


Figure 8

5. Connect the test amplifier between the IE-20A and the IE-10A as shown below.

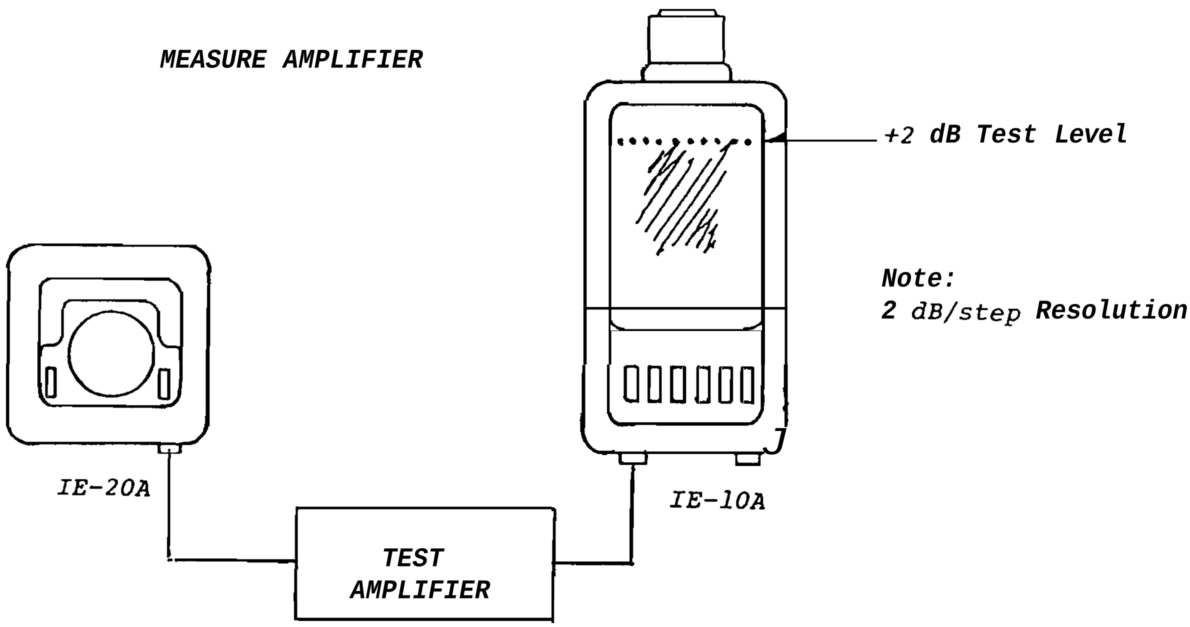


Figure 9

6. Gain of the test amplifier is determined by calculating the dB difference between the two display readings on the IE-10A. The dB range between -20 dB and + 2 dB represents a test amplifier gain of 22 dB.

7. Any deviation from amplitude flatness on the display is caused by the test amplifier's frequency response. If desired, display resolution can be increased for improved measurement accuracy of the frequency response.

2nd EXAMPLE

A manufacturer specifies his audio device to, have less than 10 dB insertion loss at any frequency from 60 Hz to 4 KHz. Acceptable input levels are 10 mv to 100 mv rms. Verify his claim.

Procedure:

1. Set attenuator on IE-20A for an acceptable signal output level. Referring to the table on page 9 of the IE-20A manual, 30 dB of attenuation will provide a 30 mv rms signal output.

2. Initially set the switches on the IE-10A to the positions shown below. Always begin a measurement with both analyzer sensitivity switches set to 0 dB.

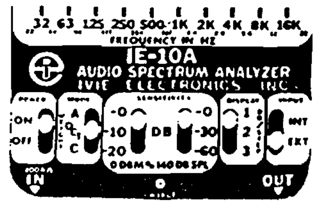


Figure 10

3. Feed the IE-20A signal into the IE-10A as shown below and add sufficient gain to the IE-10A to bring the calibration signal high on the display. **It** does not have to be at the 0 dB line as shown.

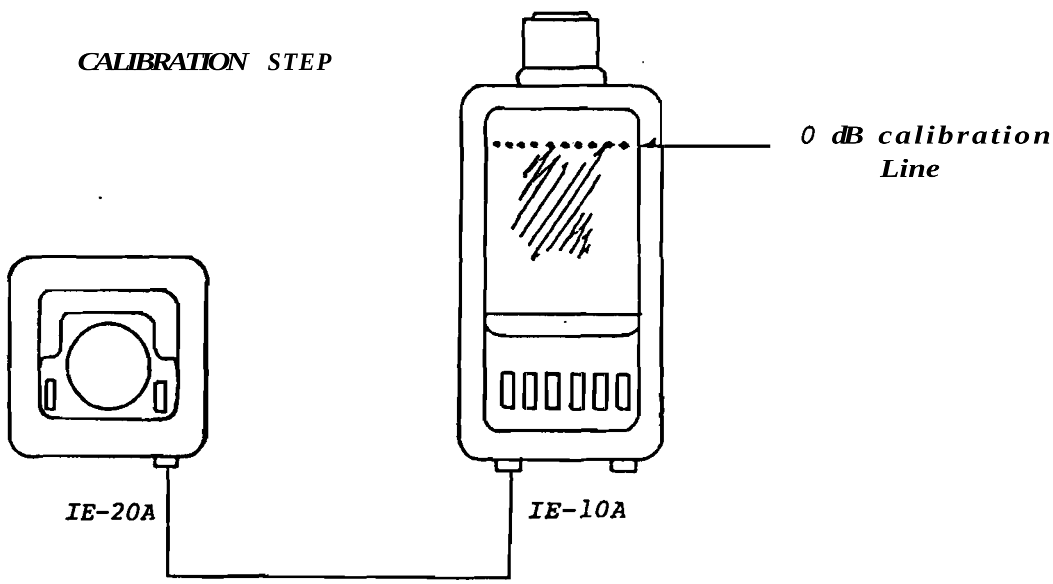


Figure 11

4. Insert the audio test device between the IE-20A and the IE-10A. Record the signal levels at each frequency because the insertion loss may be different at each frequency.

TEST STEP

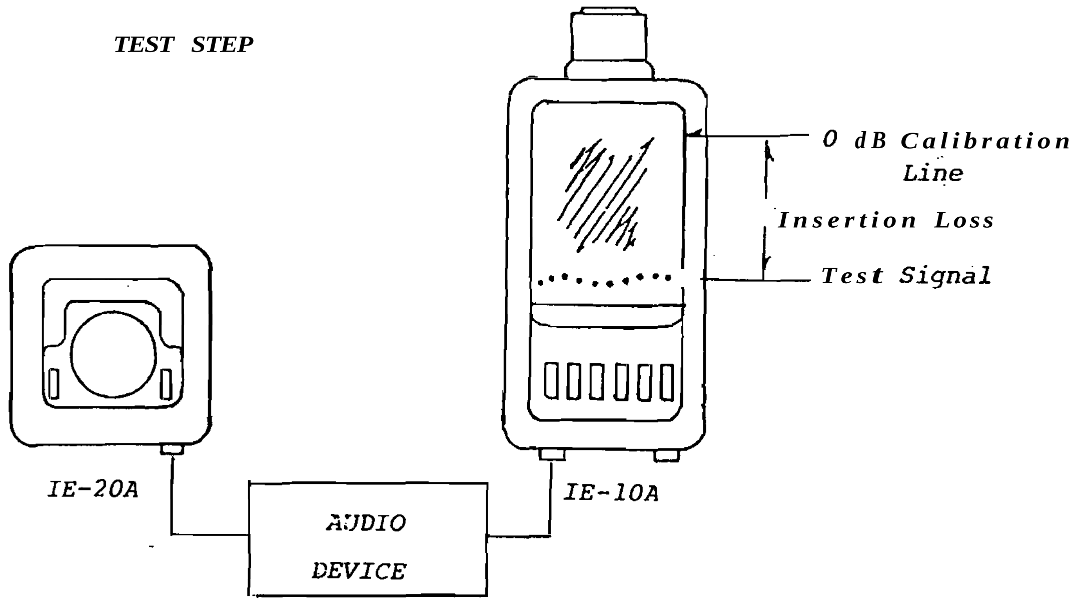


Figure 12

5. The insertion loss can now be measured by calculating the dB difference between the two signal levels.

6. Again, as in the first example, any deviation from amplitude flatness on the IE-10A display will be due to the frequency response of the audio device. The manufacturer's specification will be met if insertion loss at all frequencies is less than 10 dB.

ROOM RESPONSE TESTING

A very significant portion of pink noise and real-time analyzer testing is measuring the frequency response of speakers, microphones and other audio devices in their operating environments. Speakers and microphones are normally characterized for frequency response in anechoic chambers, and yet few of these devices are ever used in anechoic chambers. Anechoic chambers do not represent the typical "real world" environments of speakers and microphones. Temperature, humidity, room size, room shape, room materials and myriads of other factors help to shape the overall frequency response.

There is a typical response plot of the IE-10A microphone in the specifications section of this manual. The microphone has a free-field response and was designed to be pointed directly at the sound source being analyzed.

To measure frequency response with the IE-10A using the built-in microphone, simply:

1. Set all audio system tone controls to their flat positions. Set volume controls to their normal listening positions.

2. To begin, the IE-20A should be switched to maximum attenuation and its output plugged into the system to be tested. Pink noise can be injected into an audio system ahead of the preamp, or directly into the power amplifier driving the speakers.

3. Increase the pink noise output from the IE-20A until room signal is slightly above normal listening levels.

4. Set IE-10A controls initially as shown below with the detectors in the pink noise averaging mode. Add gain to the IE-10A front end (using sensitivity controls) until the displayed signal is just below the 0 dB line on the display screen.

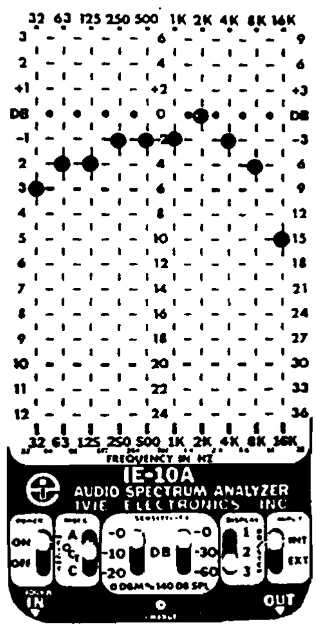


Figure 13

5. Standing in front of the speakers at a normal listening position in the room, point the IE-10A microphone directly at the speaker source being tested.

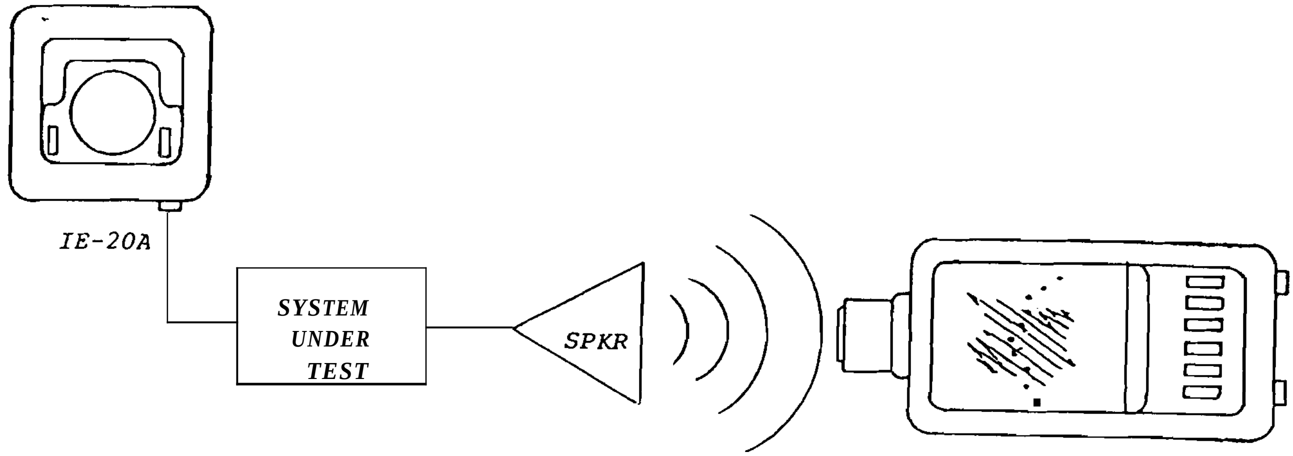


Figure 14

6. The IE-10A can be switched to a higher resolution if desired. You are now seeing the combined frequency response of the audio system and the room.

The IE-10A can be held at different positions in the room so that the speaker dispersion and room characteristics can be measured. When doing frequency response testing, all environmental sounds other than the pink noise should be minimized, or the IE-10A will average them together.

If equalizers are to be used in a stereo system, each channel should be characterized for frequency response independently. After both equalizers have been adjusted to the desired response, an overall dual-channel response can be analyzed by putting pink noise into both channels at the same time.

The transducers to be used with a particular installation (tape deck, microphones, .turntables, etc.) can be equalized as part of the overall system if test tapes and records with pink noise are available. Ofttimes the microphone to be used with the installation is equalized as part of the system. Microphone equalization is achieved by using the audio system microphone as the signal input to the IE-10A as shown below. The only IE-10A changes that must be made to use an external microphone are:

1. change the input switch to EXT, and

2. adjust the gain as needed to bring the pink noise response to a convenient level on screen.

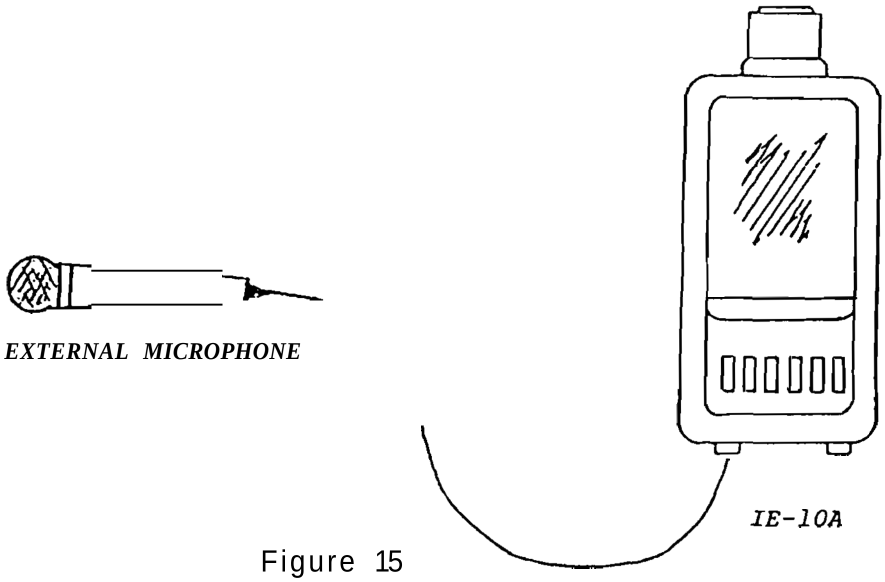


Figure 15

Using the system microphone for the IE-10A response test includes the microphone's response in the overall measurement. Any equalization that is done will also compensate for the microphone.

SOUND LEVEL TESTING

INTRODUCTION TO SOUND LEVEL MEASUREMENTS

The decibel (dB) scale has been adopted internationally for use with sound level meter testing. The scale begins at a reference of 0 dB in sound pressure level (0dB-SPL) which corresponds to the smallest sound that can be heard by a healthy human ear, and is equal to $2uN/m^2$. Following is a chart which shows some various sound pressure levels (SPLs) relative to typical environmental sounds.

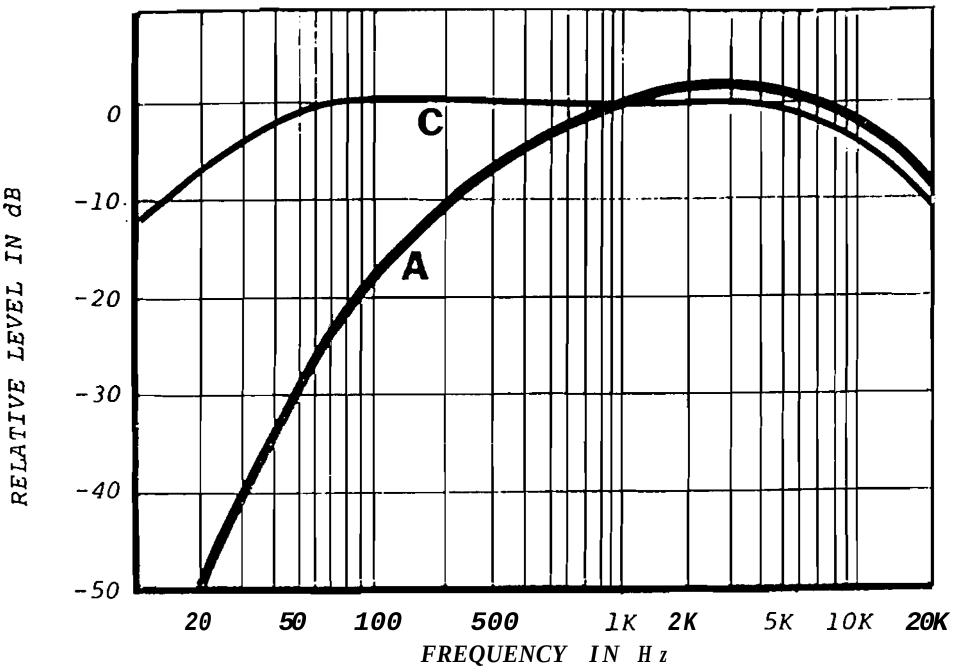
NOISE LEVEL (IN DECIBELS)

Threshold of Pain	*140*	
	130	
	120	*Small Aircraft Engine*
	110	
Jackhammer	*100*	
	90	
	80	*Automobile Horn*
Average Conversation	*70*	
	60	
	50	
	40	*Quite Office*
Very Soft Whisper	*30*	
	20	
	10	*Outdoors in the Country*
Threshold of Hearing	*0*	

Figure 16

Of major importance to the understanding of sound measurements is the study of the response characteristics of the human ear. Our ears do not respond equally to all the frequencies in the audible range. At low SPLs we hear best in the range of 2KHz to 5KHz, while the very high and very low frequencies are attenuated. At high SPLs, however, the ears become more sensitive to the frequency highs and lows.

Sound level meters have frequency filter curves which approximate the response characteristics of the human ear. The A curve in the next figure approximates ear response at low SPLs and the C curve generally approximates ear response at high SPLs.



ANSI S1.4-1967 (R1976) Standard for Sound-level Meters

Figure 17

The IE-10A will measure dB SPL with either an A curve or a C curve weighting (dB(A) and dB(C)). The dB(A) scale will likely be used most often since OSHA and the Walsh-Healey Act require nearly all SPL readings to be made with an A weighted scale. Noise causing hearing damage has been found to correlate more closely with the A weighted scale, which explains why this particular curve is used most of the time in noise analysis.

The following permissible noise exposure table is specified by the Walsh-Healey Public Contracts Acts as revised in 1970. It is subject to government revisions.

PERMISSIBLE NOISE EXPOSURES

Hours Duration Per Day	dB(A) SPL Slow Response
8	90
6	92
4	95
3	97
2	100
1½	102
1	105
½	110
¼	115

Figure 18

Sound level measurements are usually made in different types of environments ranging from free-fields to diffuse-fields. A free-field is an environment that is free of reflections, and is typical of anechoic chambers (sound absorbing rooms) that have acoustically padded walls, floors, and ceilings.

Diffuse-fields are created in reverberation chambers that have been designed to cause as much reflection between ceilings, walls, and floors as possible. A diffuse-field is one in which the sound is uniformly distributed throughout the room. Machine noise tests are more often made in reverberant chambers, as they are less costly to build than anechoic chambers.

Typical sound measurement environments, however, are usually some combination between free-fields and diffuse fields, and great care must be taken with the measurements to help assure that accurate results are obtained. Errors can occur when determining the noise from a single source if tests are made too close (near-field) to the source being measured (see figure 19). The near-field SPL can change dramatically with small position changes of the sound level meter. To avoid near-field errors, the sound level meter should be located away from the source by at least a distance equal to one wavelength of the lowest frequency radiated from the source, or more than twice the distance of the largest dimension of the source, whichever distance is greater..

If you make the measurement too far away from the sound source, room reflections and other room noises may interfere with the readings.

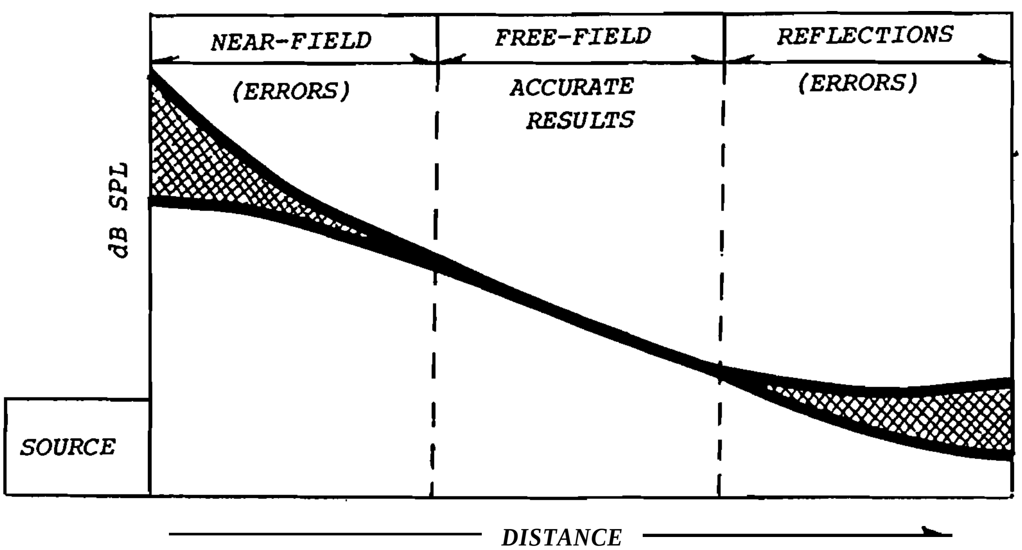


Figure 19

The most desirable condition for noise testing would be to perform all tests in a reverberant chamber (diffuse-field) or an anechoic chamber (free-field). Since this is usually not possible, the next best alternative is.to find a free-field as close to the object being tested as possible. It is quite easy to determine whether a free-field exists because the inverse-square law holds true there. The inverse square law describes the movement of sound waves through air in a free-field. When the distance from the sound source doubles, the SPL will drop 6dB. If you are standing 10 feet from the sound source and you move to 20 feet, the SPL will drop 6 dB. If you move to 40 feet, the SPL will drop another 6dB. If this relationship occurs, the sound waves are traveling unobstructed from the source to you, and by definition, you are standing in a free field.

If the purpose for taking a sound level reading is to measure employee hearing exposure, then the microphone on the sound level meter should be placed at the position where the worker's ears would be under normal conditions. For this type of test we want to measure the total SPL that the worker's ears are exposed to, including any reflections in the area.

For free-field measurements, either one of two types of microphones can be used. One is a free-field microphone and the other is a pressure microphone. The two microphones are designed to be held at different angles to the sound source. The free-field microphone is calibrated to measure noise with a 0^o incidence, and a pressure microphone is calibrated to measure noise at 90^o incidence.

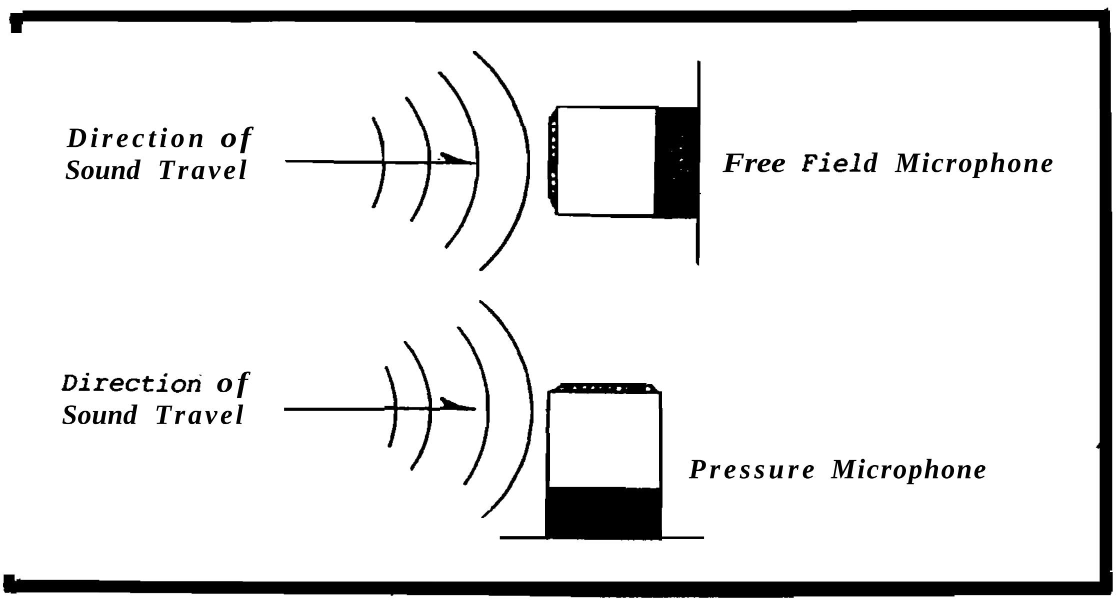


Figure 20

The internal microphone of the IE-10A is a free-field microphone, and for all free-field measurements, the microphone should be pointed directly at the sound source. This applies whether dB(A), dB(C), or octave bandwidth measurements are being made.

If the IE-10A is used in a diffuse-field with uniform sound throughout the room, the microphone will receive equal energy when pointed at any angle. The IE-10A meets the ANSI specifications for type 2 sound level meters for either free-field or diffuse-field testing.

BODY EFFECTS ON SOUND MEASUREMENTS

Something which must be considered when making sound measurements with a hand-held analyzer, is the effect of the operator's body on the readings. The operator's body may detract substantially from the accuracy of the measurements. At frequencies around 400 Hz, sound reflecting from the body could cause up to 6dB of error, if measurements are made within three feet of the operator. To minimize this effect, the IE-10A should be held as far away from the body as possible.

CORRECTING FOR BACKGROUND NOISE

Often the need arises to make SPL measurements in the presence of background noise. This can be easily done as long as the SPL of the primary source is at least 3dB greater than the background noise. Following are the steps for making such a measurement.

1. Measure the total noise. (background & primary source)

2. Turn off the primary noise source and measure the background noise only. Both tests should be made with the IE-10A in the same location.

3. Calculate the difference between the two readings measured on the IE-10A. If the difference is less than 3dB, accurate measurements cannot be made. If the difference is between 3dB and 10 dB, the following chart can be used to make the needed correction.

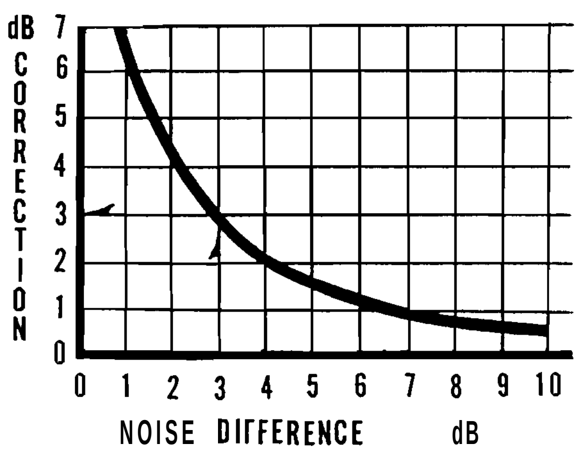


Figure 22

To use the chart, locate the difference of the two measurements on the horizontal axis. From that point, go up to intersect the curve, and then left to the vertical axis. Then subtract the value on the vertical axis from the total noise level first measured.

Example: Total noise = 75 dB
Background noise = 72 dB
Difference = 3 dB
Chart correction = 3 dB
Primary source noise =
75dB - 3dB = 72 dB.

If the noise difference between the background noise and the primary noise is greater than 10 dB, no correction is necessary.

ADDING SOUND LEVELS

If two primary sources are measured independently, it is possible to determine what the sound level would be if both sources were operating together. The following chart can be used to determine this, when both tests are made with the IE-10A in the same location.

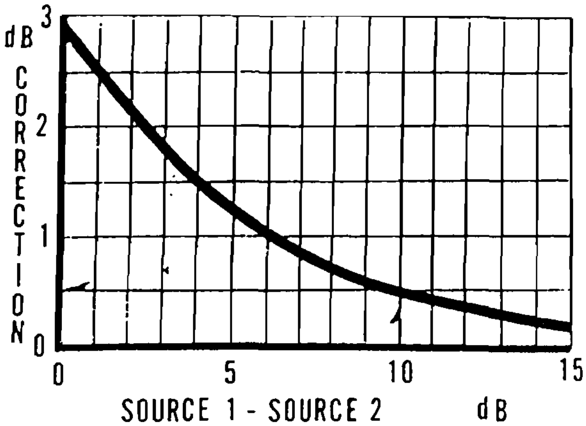


Figure 22

To use the chart, first measure the levels of the two sources independently and then find the difference between the two levels. Locate the difference on the bottom of the chart. Go up until the curve is intersected, and then go left to the vertical axis. Then add the correction in dB indicated by the vertical axis to the value of the highest reading made. This number indicates the combined SPL of the two sources.

Example: Source 1 = 79 dB
Source 2 = 69 dB
Difference = 10 dB
Chart correction = .5 dB
Total noise = 79.5 dB

Operation of the IE-10A for dB-SPL measurements is very straight forward. The control panel of the IE-10A has been color coded to make the operator aware of the analyzer functions that are commonly used together. Directly below the sensitivity switches on the IE-10A front panel there are two colored reference levels, 0 dBm in blue and 140 dB-SPL in red. Note that the INPUT switch is also color coded with blue for an external (EXT) signal source and red for internal (INT), indicating that the IE-10A built-in microphone is the signal input. With both sensitivity switches set to 0 dB and the INPUT switch set to INT, the 0 dB graticule line is 140 dB-SPL as shown in Fig. 23. The built-in microphone is calibrated to measure signals in dB-SPL in all three filter modes A, C, and OCT.

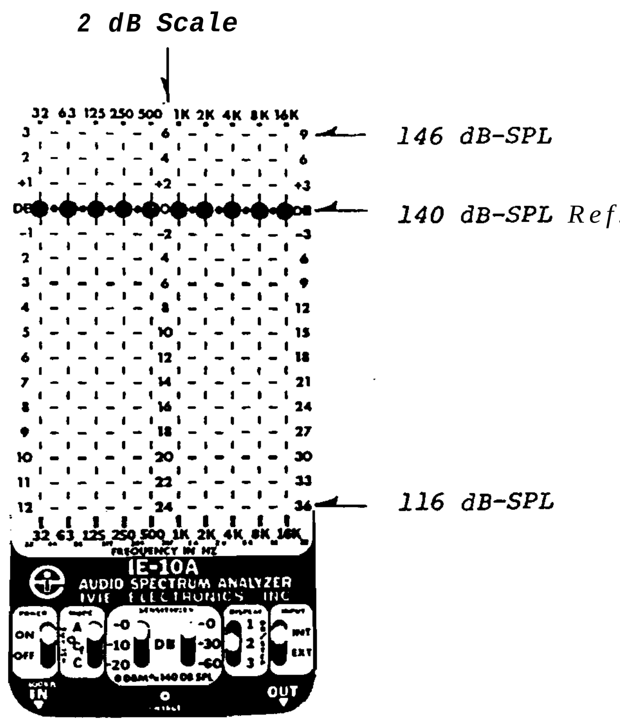


Figure 23

Determining what the dB-SPL reference level is on the analyzer simply requires that we add the two switch settings of the sensitivity control (including their minus signs) and then add their value to the 140 dB-SPL number. Referring to Fig. 24, note that one sensitivity switch is set to -10 dB and the other is set to -60 dB for a total of -70 dB. Adding this number to 140 dB-SPL, 140 dB plus -70 dB sets the new reference to 70 dB-SPL. Note that the DISPLAY switch is set to 3 dB per step and that we must use the corresponding 3 dB scale on the display readout.

Note that the reference line changes only when the sensitivity switches are changed. The value of the reference and its position on the 0 dB graticule line remains unchanged when resolutions of 1, 2, or 3 dB per step are selected. The DISPLAY switch alters only the measurement range of the IE-10A, not the reference.

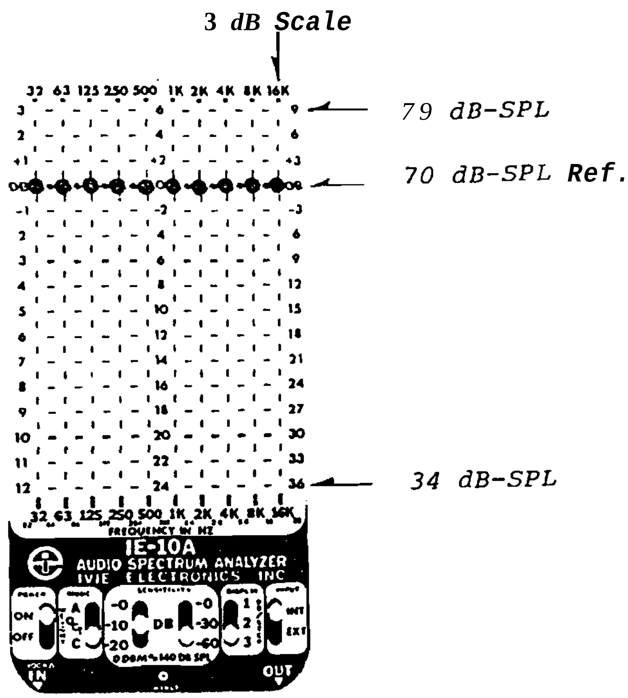


Figure 24

Measuring the SPL of a signal of unknown amplitude is a simple procedure using the IE-10A analyzer. As in the previous examples of SPL measurements, the input switch must be set to "INT" with the mode switch set to either the A, C, or OCT filter mode. It is recommended initially that both sensitivity switches be set to 0 dB, the least sensitive position of the analyzer, and that the 3 dB/step resolution be selected. If a signal does not appear on the display screen, this implies that the signal is much smaller than 140 dB-SPL. Analyzer sensitivity can be increased in 10 dB steps until the signal appears on the display at a convenient level. Once found, the unknown signal can be viewed with greater resolution than 3 dB per step to improve the accuracy of the measurement.

It is important to note that the display graticule is marked in plus dB above the 0 dB reference line and minus dB below the reference line. When determining signal amplitudes, the graticule reading in dB, with its appropriated sign, must be added to the reference setting. Determining the amplitudes of unknown signals will become easy after an example or two. The three basic steps are:

1. Add the SENSITIVITY switch settings to determine the REFERENCE value of the 0 dB line on the graticule. Be sure to include the minus signs. Add the switch settings to 140 dB-SPL.

2. Determine which graticule scale is to be used by observing the DISPLAY resolution switch setting.

3. Add to the reference level the number of dB that the signal is above or below the reference line, and be sure to include the correct sign.

1ST EXAMPLE

With one of the sensitivity switches set to -0 dB and the other set to -60 dB, the 0 dB line on the IE-10A display changes to a reference level of 80 dB SPL (140 dB - 60 dB = 80 dB SPL) as in Figure 25.

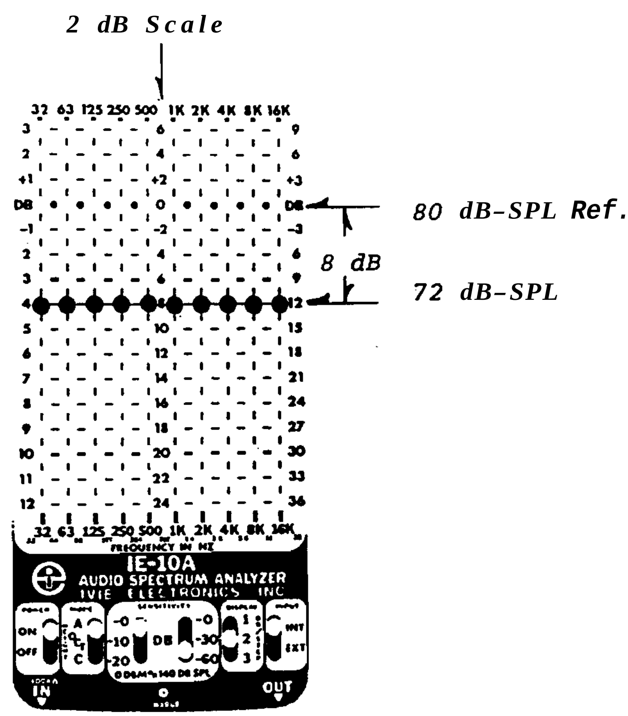


Figure 25

The display resolution switch is in the 2 dB per step mode and signal readings are measured using the center graticule scale which is marked in 2 dB steps. A signal is located -8 dB below the reference setting of 80 dB-SPL at a level of 72 dB-SPL (80 dB -8 dB = 72 dB-SPL).

2ND EXAMPLE

The DISPLAY switch in Fig. 26 is set to 1 dB per step and so the 1 dB resolution graticule scale should be used. Adding the SENSITIVITY switches, the REFERENCE line is (140dB -50dB) equal to 90 dB-SPL. The signal is + 2 dB above the reference line at a level of (90 dB plus +2 dB) 92 dB-SPL.

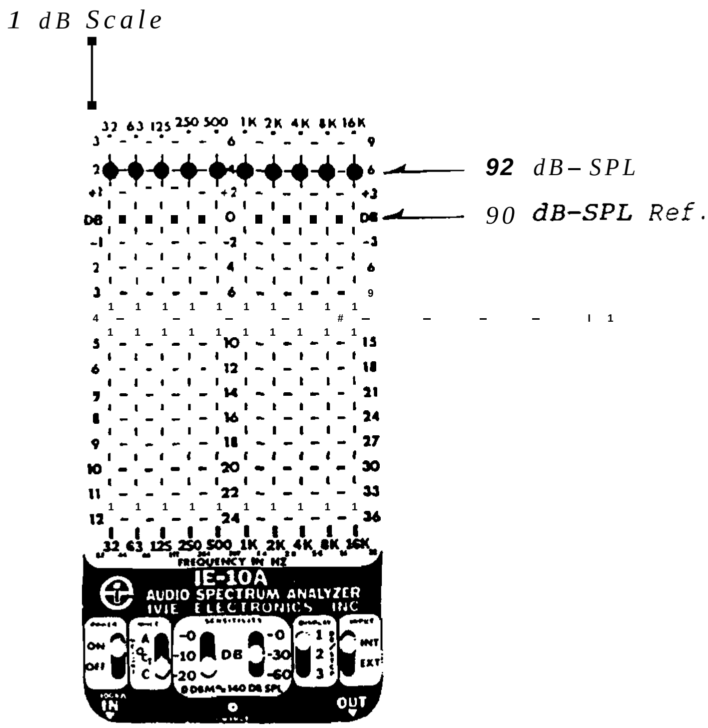


Figure 26

MAKING dBm MEASUREMENTS

The vast majority of the real-time audio analyzers available in the world market do not provide the capability to measure directly in dBm at each frequency. Competitive analyzers are normally designed to make measurements that are purely "relative," thus providing no capability to measure the power or voltage in audio circuits. The IE-10A not only provides relative information in dB, but it also measures in dBm for a sine wave signal source having an impedance of 600 ohms (0dBm = 1 mw into 600 ohms). Having the ability to measure in dBm provides the operator with many new applications for testing power and voltage that are usually reserved for very expensive test equipment. To learn more about measuring voltages consult the operator's manual under "Measuring voltage with the IE-10A."

Operation of the IE-10A for dBm measurements is very straight forward. The control panel of the IE-10A has been color coded to make the operator aware of the analyzer functions that are commonly used together. Directly below the sensitivity switches on the IE-10A front panel, there are two colored reference levels, 0 dBm in blue and 140 dB-SPL in red. Note that the INPUT switch is also color coded with blue for an external (EXT) signal source and red for internal (INT) indicating that the IE-10A built in microphone is the signal input. With both sensitivity switches set to 0 dB and the INPUT switch set to EXT, the 0 dB line on the display graticule is 0 dBm as shown in Fig. 27. Likewise, with the sensitivity switches set to 0 dB and the INPUT switch set to INT, the 0 dB graticule line is 140 dB-SPL. More generally, external inputs are measured in dBm in the OCT filter mode, while the built in microphone measures signals in dB-SPL in all three filter modes A, C, and OCT. Details on dB-SPL measurements are provided in another section of this manual.

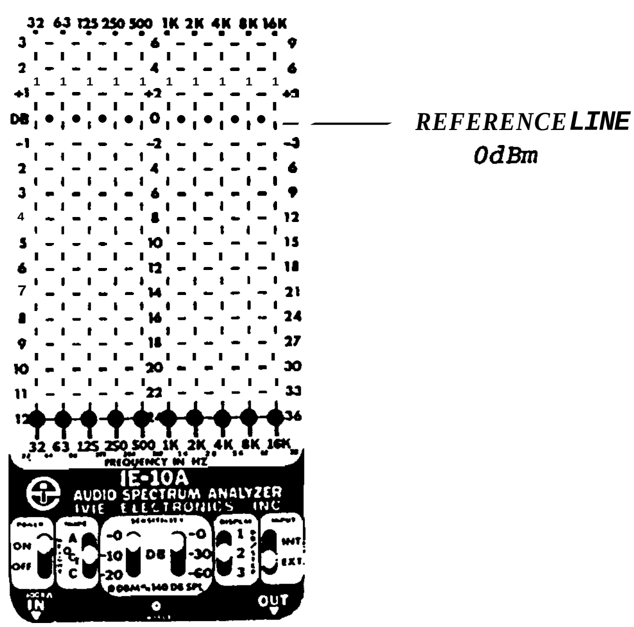


Figure 27

Note that the reference line changes only when the sensitivity switches are changed. The value of the reference and its position on the 0 dB graticule line remains unchanged whether resolutions of 1, 2, or 3 dB per step are selected. The DISPLAY switch alters only the measurement range of the IE-10A, not the reference.

For making calibrated dBm measurements with the IE-10A, the operator must set the INPUT switch to external (EXT) and feed the signal into the phono jack marked IN. With the switches set as shown in Fig. 28, the 0 dB line on the analyzer display represents a 1 KHz sine wave with an amplitude of 0 dBm. The IE-10A has the same reading and accuracy whether the detector response selected is for signal monitoring or pink noise averaging. It is recommended, however, that for sine wave testing, the fast response mode be used to save time. Normally, the much slower averaging mode is used with random signals like pink noise.

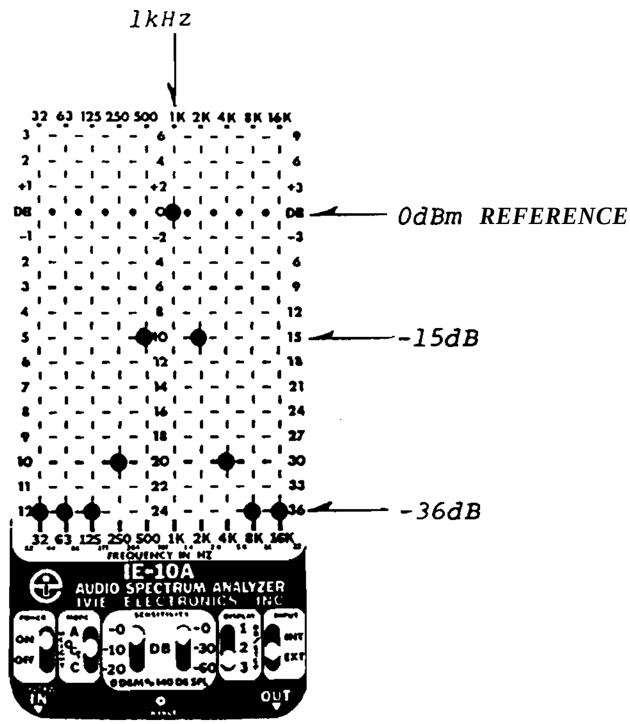


Figure 28

Determining what the reference level is on the analyzer simply requires that we add the two switch settings of the sensitivity control. Referring to Fig. 28, note that both sensitivity switches are set to 0 dB. Adding them together we get a reference level of 0 dBm absolute.

Because the display controls are set to 3 dB per step on the IE-10A, we must use the graticule scale on the right hand side of the display marked in 3 dB increments. Knowing that the 0 dB line on the display represents 0 dBm absolute, the total measurement range is +9 dBm to -36 dBm for the IE-10A switch positions shown. To find out why a single frequency input to the IE-10A causes responses in more than one filter, consult the operator's manual on "Octave filter characteristics."

To duplicate the 0 dBm measurement of Fig. 28 with the switches set as shown, the operator must use a properly terminated, 600 ohm sine wave generator, set to a frequency of 1 KHz. A 0 dBm power output will be reached when the 1KHz LED on the IE-10A is at the 0 dB graticule line.

IDENTIFYZNG THE LEVELS OF UNKNOWN SIGNALS

Measuring the power level of a sine wave signal of unknown amplitude is a fairly simple procedure using the IE-10A analyzer. As in the previous examples of dBm measurements the input switch must be set to "EXT" with the mode switch set to "OCT". The unknown signal is then fed into the analyzer at the phono jack marked "IN". It is recommended that both sensitivity switches initially be set to 0 dB, the least sensitive position of analyzer, as a test to see how large the unknown signal is. If a signal does not appear on the display screen, this implies that the signal is much less than 0 dBm, and the analyzer sensitivity can be increased in 10 dB steps until the signal appears on the display at a convenient level. It will also be useful to initially select the 3 dB per step resolution to allow the maximum display range of 45 dB while locating the signal. Once found, the unknown signal can be viewed with greater resolution than 3 dB per step to improve the accuracy of the measurement.

It is important to note that the display graticule is marked in plus dB above the 0 dB reference line and minus dB below the reference line. When determining signal amplitudes, the graticule reading in dB, with its appropriated sign, must be added to the reference setting. Determining the amplitudes of unknown signals will become easy after an example or two. The three basic steps are:

1. Add the SENSITIVITY switch settings to determine the REFERENCE value of the 0 dB line on the graticule. Be sure to include the minus signs.

2. Determine which graticule scale is to be used by observing the DISPLAY resolution switch setting.

3. Add to the reference level the number of dB that the signal is above or below the reference line, and be sure to include the correct sign.

1ST EXAMPLE

With one of the sensitivity switches set to -10 dB and the other set to -30 dB, the 0 dB line on the IE-10A display changes to a reference level of -40 dBm (-10 dB plus -30 dB = -40 dBm) as in Figure 29.

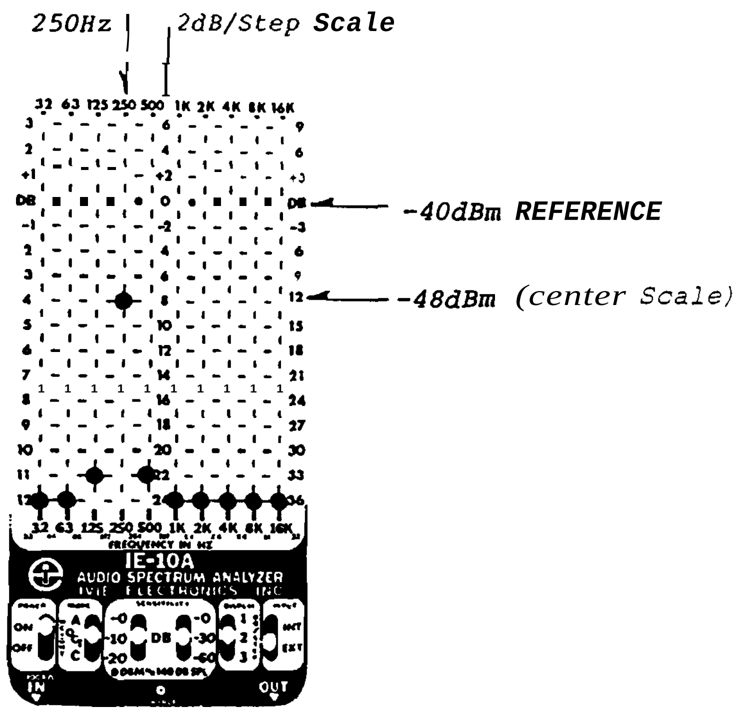


Figure 29

The display resolution switch is in the 2 dB per step mode and signal readings are measured using the center graticule scale which is marked in 2 dB steps. A 250 Hz signal is located -8 dB below the reference setting of -40 dBm at a level of -48 dBm (-40 dBm plus -8 dB).

2ND EXAMPLE

The DISPLAY switch in Fig. 30 is set to 1 dB per step and so the 1 dB resolution graticule scale should be used. Adding the SENSITIVITY switches, the REFERENCE line is (-60 plus -0) equal to -60 dBm. The 4 KHz signal is.+ 2 dB above the reference line at a level of (-60 dBm plus +2 dB) -58 dBm.

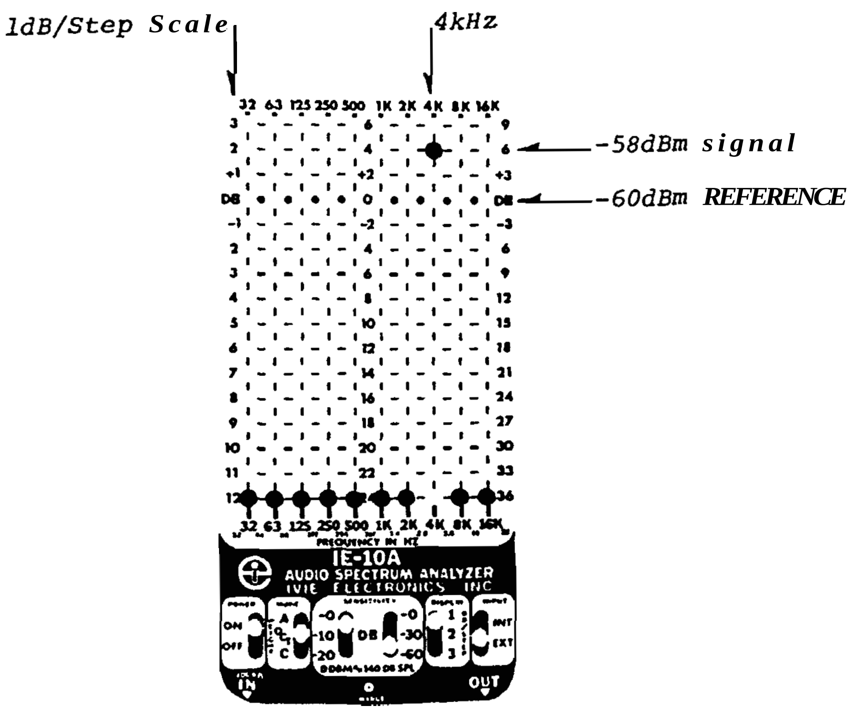


Figure 30

There is no upper limit to measuring large voltages with the IE-10A, providing a large enough attenuator is available. With the optional 51AD adaptor and a 10:1 oscilloscope divider probe, the IE-10A can measure up to 218.3 volts rms (+49 dBm) over the frequency range of 25 Hz to 20 KHz. The excellent isolation of the IE-10A will allow the measurement of power line voltages and will, in addition, display the octave frequency of the line. One thousand volts AC or DC can be applied directly to the external input of the IE-10A without circuit damage. Using external attenuators, this damage limit can be extended well above one thousand volts.

The smallest voltage that can be measured on the IE-10A is determined by the noise floor of the analyzer. In FIG. 31 the typical noise floor of the IE-10A is shown to be equal to 1.23 microvolts (-116 dBm) from 32 Hz to 4 KHz, and is equal to 3.46 microvolts (-107 dBm) in the widest bandwidth at 16 KHz. For octave or fractional octave real-time analyzers, the noise floor increases by 3 dB per octave toward the upper frequencies. We would expect this to happen because noise power doubles for each doubling of the filter bandwidth. The 16 KHz filter displays the highest noise level because it has the widest bandwidth. Having bandwidths much narrower than those found in oscilloscopes enables the IE-10A to measure signals much smaller than could be measured with oscilloscopes and most voltmeters.

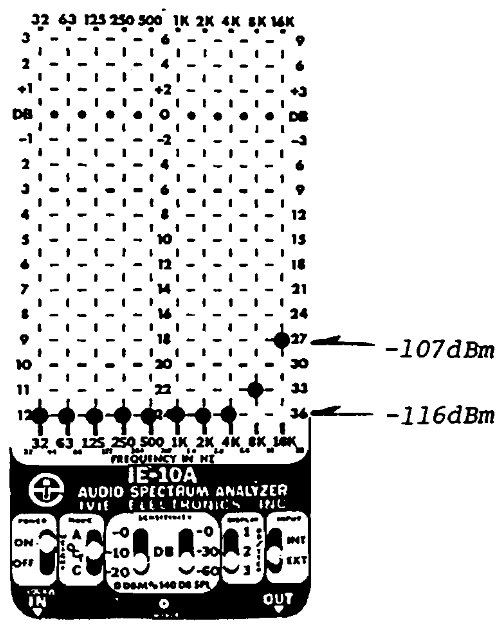


Figure 31

Due to the high sensitivities of the IE-10A, shielded coax cable should always be used for test leads. The unshielded probe leads should be kept as short as possible. A simple, but useable circuit probe could consist of an all metal phono plug with coaxial cable and alligator clips. The input impedance of this type of cable, at audio frequencies, would be the 100K ohm impedance of the IE-10A.

IMPEDANCE CONVERTERS/ATTENUATORS

To prevent the loading of high impedance circuits, the IE-10A input impedance can be increased to 1.0 megohm, using the 51AD adaptor, or to 10 megohms by adding a standard 10:1 oscilloscope divider probe. The 51AD adaptor is basically a 20 dB attenuator as is the 10:1 divider oscilloscope probe. Input sensitivity, equal to the value of the attenuator, is sacrificed any time an attenuator is used with a signal receiving device. For example, if a 20 dB attenuator were used with an IE-10A having a -116 dBm noise floor, then a signal of -96 dBm would be the smallest detectable signal. Attenuators should only be used when it is necessary to view large signals.

USING EXTERNAL ATTENUATORS

The IE-10A can analyze signals as large as + 9 dBm (2.2 Vrms) without the use of external attenuators. When an external attenuator is used, however, the displayed signal on the IE-10A requires compensation for the effect of the attenuator. Figure 32 below shows a signal being fed into an IE-10A through a 20 dB attenuator. The analyzer is measuring the input signal after it has been attenuated by 20 dB, so we must add the attenuator value to the signal level displayed on the IE-10A in order to determine the true signal level. In the example of Fig. 32, the analyzer is displaying a signal level of +4 dBm after 20 dB of attenuation. The actual signal level is +24 dBm (+4 dBm +20 dB), or, using the voltage conversion table is equal to 12.3 Vrms.

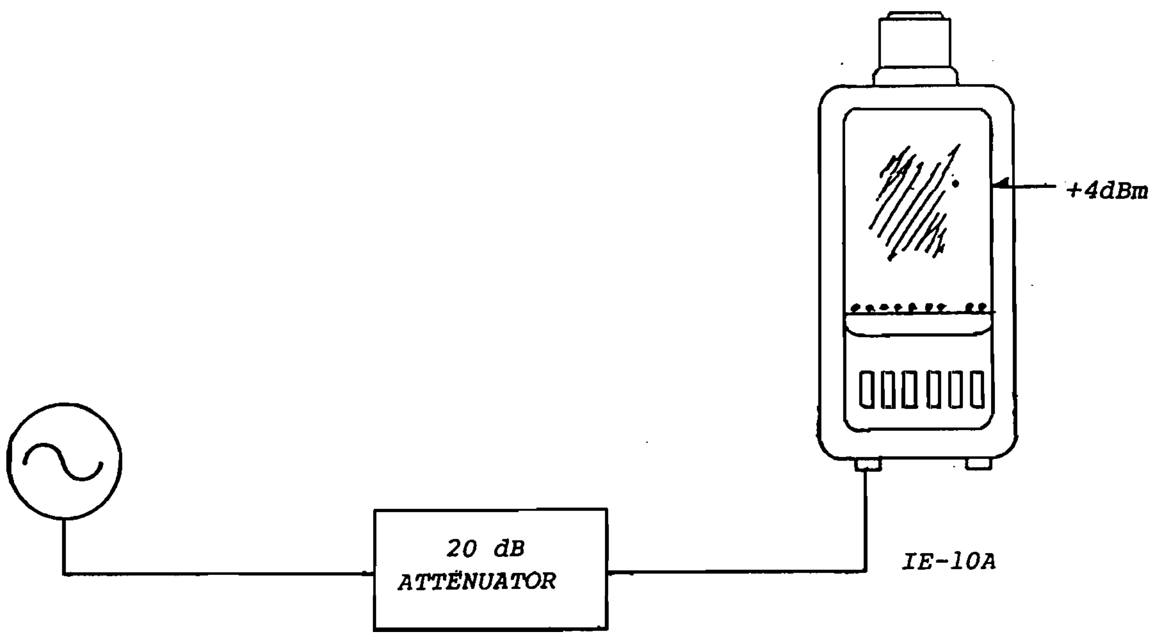


Figure 32

One more example of the use of external attenuators should help to clarify the procedure. A signal is sent through a 40 dB attenuator and then into an IE-10A which displays a signal level of -16 dBm. How large is the real signal? We simply add the reading of the IE-10A, including the correct sign, to the attenator value being used. In this example the true signal level is 24 dBm (-16 dBm + 40 dB), or 12.3 Vrms.

Simply stated, the measurement range of the IE-10A is extended by the value of the attenuator being used. As mentioned previously, the maximum external signal directly measureable with the IE-10A is + 9 dBm. A 20 dB attenuator will extend this range to + 29 dBm and a 40 dB attenuator will allow calibrated measurements to + 49 dBm (218 Vrms). The model 51AD oscilloscope probe adaptor from Ivie Electronics will provide 20 dB of attenuation, and when used with a 10 megohm 10:1 divider probe will provide 40 dB of attenuation to the input of an IE-10A.

The dynamic range and the sensitivity of the IE-10A make it an ideal instrument to measure hum and noise in amplifiers and also the ripple in d.c. power supplies. Since it is a frequency selective voltmeter, all d.c. components will be rejected and only time-varying signal components from 20 Hz to 20 KHz will be detected.

MEASURING OUPUT POWER

Measuring the output power of an audio system is nothing more than a simple mathematical extension of measuring voltage. Power is an impedance related measurement. If we know the impedance of the load and also the rms voltage across the load, then power is calculated by squaring the voltage and dividing it by the impedance (in ohms) as shown in the equation below.

$$Power_{rms} = \frac{(Voltage_{rms})^2}{Load_z}$$

Amplifier power is normally measured by replacing the speakers with a resistive load capable of handling the rated amplifier power. The input voltage required for the full rated output power is usually specified by the amplifier manufacturer along with a test frequency, or range of frequencies.

It is recommended that the 51AD adaptor and a 10:1 divider oscilloscope probe be used for all output power measurements. This combination 40' dB attenuator offers a 10 megohm probe impedance over a measurement range of .123 mv rms to 218 Vrms. These voltages across a 4 ohm load are equivalent to a power measurement range of from hundredths of microwatts to more than 11,000 watts rms.

EXAMPLE

A manufacturer specifies his amplifier output power to be 100 watts rms into a 4 ohm load for a 1 volt rms input signal. The test frequency given is 1 KHz.

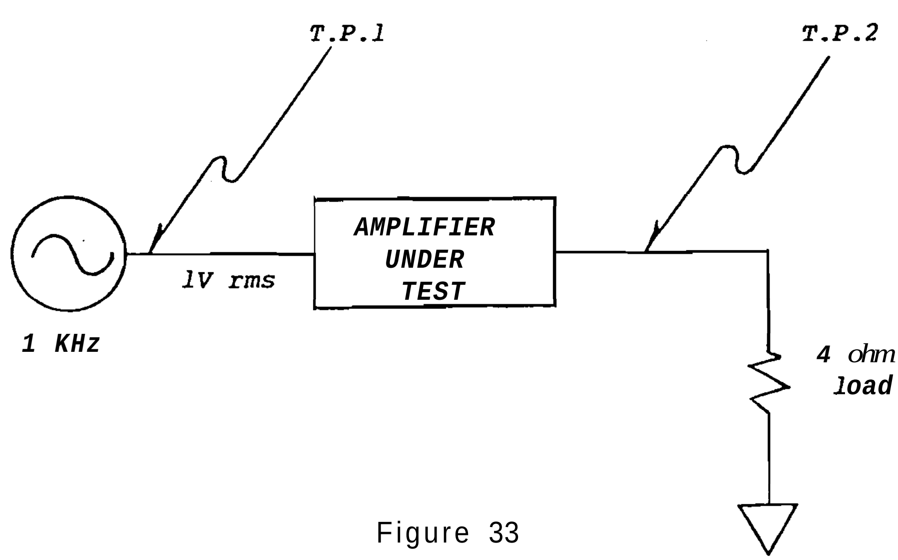


Figure 33

Procedure

1. Connect a 100 watt rated 4 ohm load to the output terminals of the amplifier to be tested.

2. Tune a sine wave function generator to a frequency of 1 KHz and initially set its ouput voltage to zero. Plug the generator output into the signal input jack of the test amplifier.

3. Connect the probe of the IE-10A to the output of the sine wave generator, test point 1 (T.P.1), and adjust the output signal to a level of 1.0 Vrms (+2 dBm). Remember, when using a 40 dB attenuator with the IE-10A, a displayed signal level of -38 dBm is equal to a true signal level of +2 dBm (-38 dBm + 40 dB). The generator should remain connected to the test amplifier through this step..

4. Next, connect the IE-10A probe to T.P.2 and measure the' voltage across the 4 ohm load at the output of the test amplifier.

5. Mathematically square the measured voltage and divide the result by 4 ohms. You have just calculated the output power of the amplifier in watts rms.

For this particular example if we assume that the measured voltage across the 4 ohm load is 21.8 Vrms the output power is equal to $(21.8)^2/4 = 119$ watts.

MEASURING GAIN/LOSS IN AUDIO SYSTEMS

Gain and loss measurements are usually considered to be relative measurements. That is, gain and loss are not described in absolute units like volts, dBm or dB-SPL. Gain and loss measurements are comparisons of the output signal divided by the input signal and are usually expressed in dB, a unitless measure.

Using the IE-10A, gain and loss can be measured with either a sine wave generator, or with a pink noise generator. The advantage of using a precision pink noise generator, like the IE-20A, is that both gain (or loss) and frequency response are displayed simultaneously. For greater detail on pink noise applications and tests, refer in the operator's manual to the sections about pink noise.

1st EXAMPLE

Measure the gain of a preamplifier with a 10 mv input signal at a frequency of 2 KHz.

Procedure:

1. Set up the equipment as shown with the output level of the sine-wave generator set to zero.

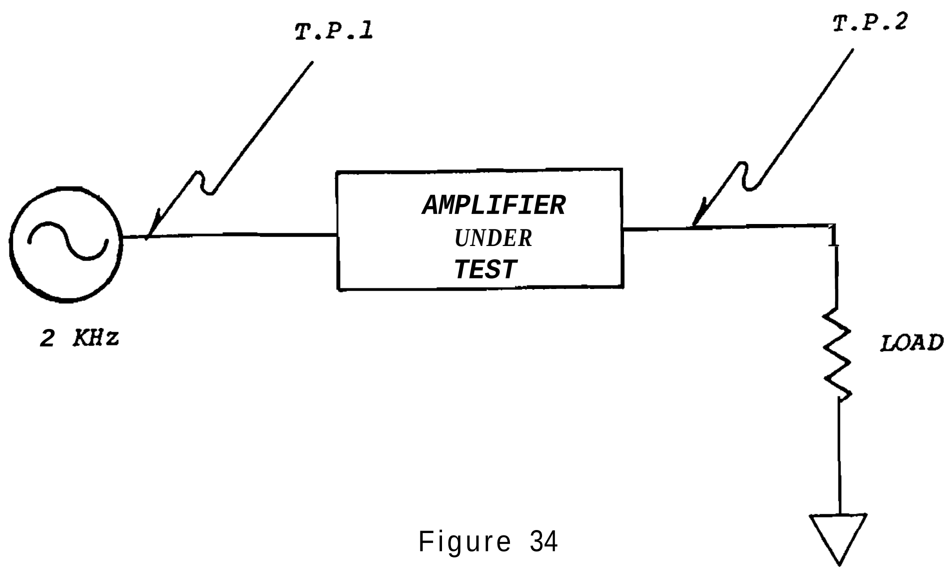


Figure 34

2. Most preamplifiers have a very low output impedance and do not usually require a terminating load. Power amplifiers should always be terminated with an appropriate load when measuring the power, gain or frequency response.

3. A 10 mv input is equivalent to an IE-10A reading of -38 dBm as can be seen using table 2 p. 34. Connect the IE-10A to test point 1 (T.P.1) and adjust signal source for a -38 dBm output.

4. Measure the dBm level at T.P.2 at the output of the test amplifier. For this example, the output is equal to -12 dBm. If gain exists in the amplifier, the signal level at T.P.2 will be larger than the signal at T.P.1.

5. Subtract the reading at T.P.1 from the reading at T.P.2, observing the signs.

GAIN = - 12 dB minus (-38 dB) = 26 dB

The amplifier gain is 26 dB at 2 KHz for the 10 mv input signal.

For gain and loss testing we are only interested in the difference between the dB readings taken on the IE-10A. It is not correct to say that the gain is equal to 26 dBm. Gain is a relative measurement, not absolute, and is usually expressed in dB.

Measuring the gain of amplifiers with output voltages in excess of 2 volts will require external attenuators on the IE-10A. It is recommended that the 51AD adaptor and a 10 megohm oscilloscope probe be used for these applications.

2nd EXAMPLE

A manufacturer specifies his audio device to have less than 10 dB of insertion loss from 60 Hz to 4 KHz. Verify his claim.

This test, like gain, represents another perfect application for pink noise and the IE-10A because all critical frequencies can be viewed simultaneously. The test can be made using sine waves, but the task is more tedious if you must verify the insertion loss at several frequencies, one at a time.

Procedure:

1. Set up the equipment as shown in Fig. 35 below.

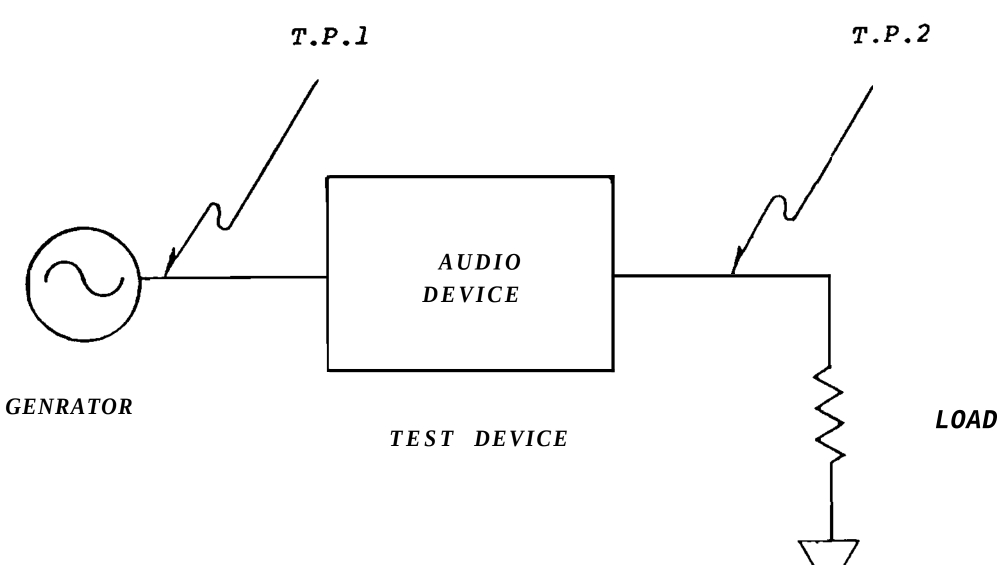


Figure 35

2. Set the IE-10A DISPLAY switch to 1 dB per step for best resolution and accuracy. Connect the IE-10A to T.P. 1 and adjust signal generator output to be within the manufacturer's device specifications for input level. Also, if possible, adjust the generator level to be at the 0 dB line on the IE-10A display graticule as shown in Fig. 36 below. It isn't necessary for the signal level to be at 0 dB on the analyzer display, but it does serve as a convenient calibration line for most insertion loss measurements.

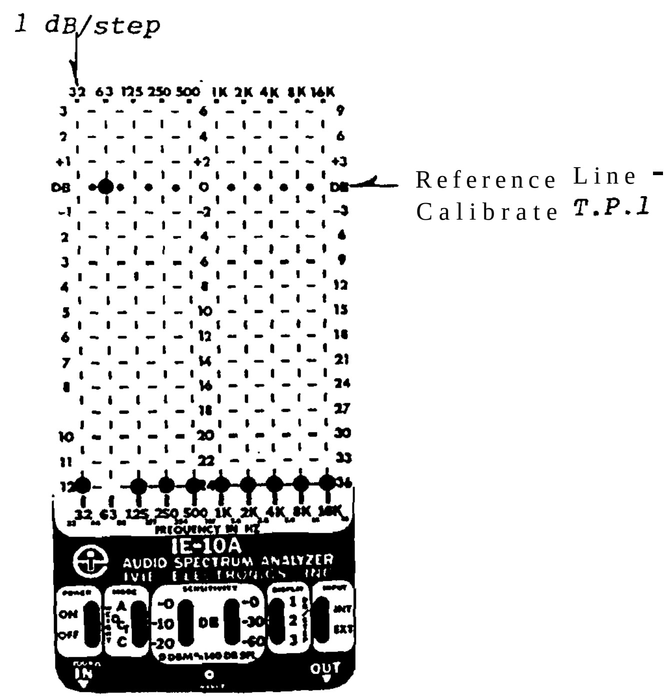


Figure 36

3. Next move the analyzer test probe to T.P.2 and note the decrease in the displayed signal level due to the insertion loss in the test device (see Fig. 37).

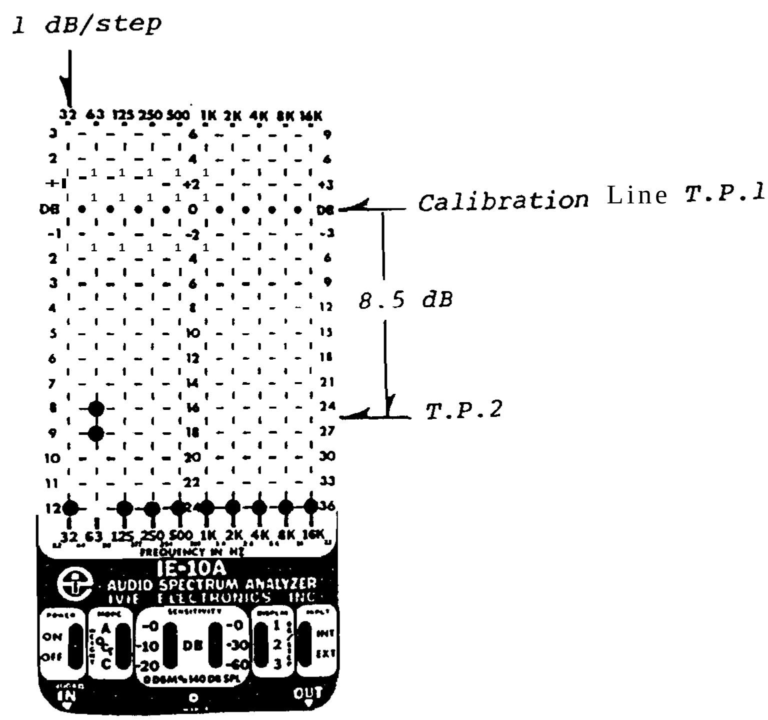


Figure 37

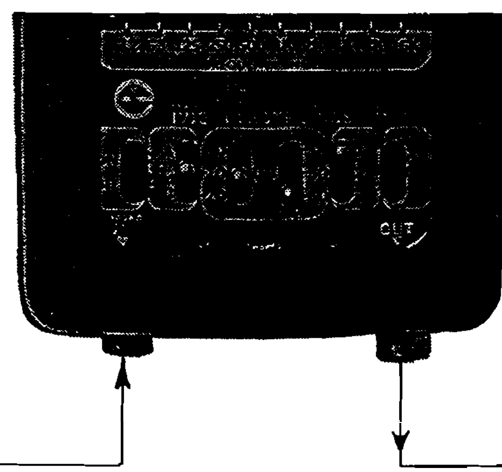
Notice that two LEDs are lighted at 63 Hz. This indicates that our signal is between -8 dB and -9 dB down from the 0 dB calibration line. Insertion loss is equal to 8.5 dB, and so our test device meets specifications at 63 Hz. To be more rigorous with the testing we should tune the sine wave generator to several other IE-10A filter frequencies between 60 Hz and 4 KHz and measure insertion loss.

OPERATING THE PRECISION PREAMPLIFIER

There are many situations in audio system testing when it is desireable to have a separate preamplifier or signal source to substitute for faulty circuits, to aid in the isolation of system problems. The IE-10A contains a calibrated 0-80 dB gain (10 dB/step) preamplifier circuit with a 100 K ohm input impedance that is capable of handling signals over the range of 20 uV to 2.0 V rms with negligible distortion (see Figure 38). The preamplifier module has a frequency response of 20 Hz - 20 KHz with +/- 0.5dB flatness, and a bandwidth of 10 Hz - 40 KHz.

Only three analyzer controls affect the operation of the preamplifier; these are: POWER, SENSITIVITY (controls gain of preamp), and INPUT.

Gain of the preamplifier is determined by addinq the <u>absolute</u> values of the two SENSITIVITY switch settings. In FIG. 38 the sensitivity switches are set at -20 dB, and 0 dB for a total preamp gain of 20 dB. As another example, if 70 dB of gain is desired, one sensitivity switch would be set to 10 dB and the other switch to 60 dB.



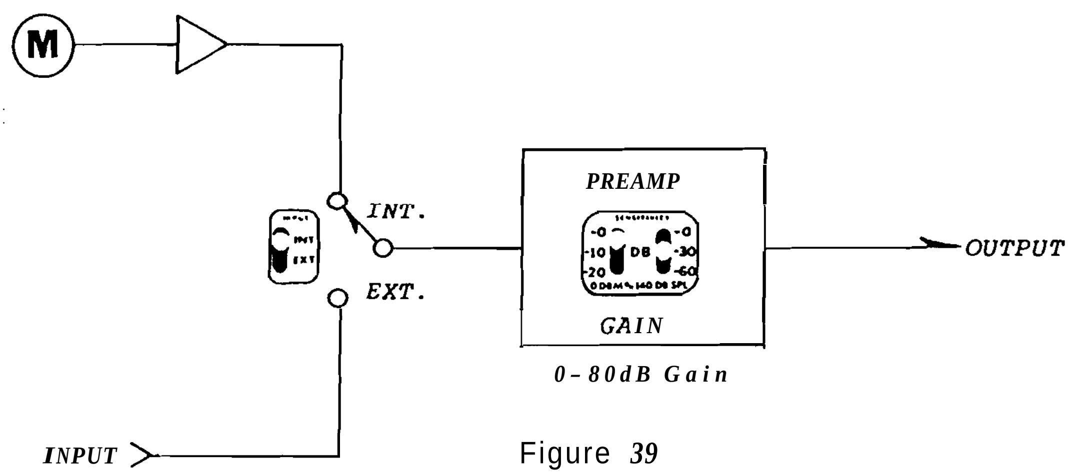
PREAMP INPUT
100 K ohms

PREAMP OUTPUT

Figure 38

Signals can be fed to the preamplifier from either of two sources using the INPUT switch. The IE-10A microphone becomes the signal source when the input switch is set to INT. External signals can be amplified when the input switch is set to EXT (see Fig. 39).

IE-10A CALIBRATED PREAMPLIFIER CIRCUIT



0-80dB Gain

Figure *39*

The 100K ohm impedance at the preamplifier input is normally adequate to accomodate most transducers and signal sources. The IE-10A preamplifier output circuit is capable of delivering a maximum of 2.0 Volts RMS into a 600 ohm load. Load impedances less than 100 ohms can be used, but with some sacrifice in the low frequency response of the preamplifier. The unit is capable of driving speakers, earphones and even direct shorts on a continuous basis without damage to the preamplifier.

IE-10A SPECIFICATIONS

MEASUREMENT RANGES

* Calibrated -110 dBm to +9 dBm using external input jack.
* Measures to +49 dBm (218 Vrms) using optional accessories.
* Calibrated 45 dB SPL to 146 dB SPL using built-in IE-10A microphone.
* Accuracy of calibrated ranges +/- 1.0 dB.

FILTERS

* Octave bandwidth ANSI S1.II 1966 (R1975) Class 1.
* Second order Chebychev.
* Selectable detector decay times
  Pink Noise mode 3.8 dB per sec.
  Monitor mode 42 dB per sec.
* Center frequencies 32, 63, 125, 250, 500, 1K, 2K, 4K, 8K, 16K, Hz.
* Center frequency accuracy +/- 3% (typ. +/- 1%).
* Relative filter flatness +/- 0.5 dB.
* Passband flatness 0.5 dB (Ripple).

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* A weighted and C weighted sound level filters.
* Filter shape and accuracy satisfies ANSI S1.4 1971 type S2A, S2C and IEC 123 (1961) for "slow" response.

DISPLAY

* Ten channel 160 LED array.
* Dynamic ranges of 45, 30 and 15 dB are selectable with resolution steps of 1, 2 or 3 dB.
* Display LEDS adjust intensity automatically for room brightness.
* Graticule has automatic "solid state" edge lighting.

PREAMPLIFIER

* 100 K ohm input impedance.
* 0-80 dB gain in 10 dB steps.
* Bandwidth 10 Hz to 40 KHz.
* Flatness +/- 0.5 dB (20Hz-20 KHz).
* THD .1% @ 2.0 Vrms for loads 2600 ohms.
* Damage level input 1000 VAC or +/- 1000 VDC.
* Output short circuit protected.

MICROPHONE

* Omnidirectional Condenser cartridge.
* Sound level measurement Type 2.
* Typical microphone/preamp response see figure below. Incidence 0°. Free-field.

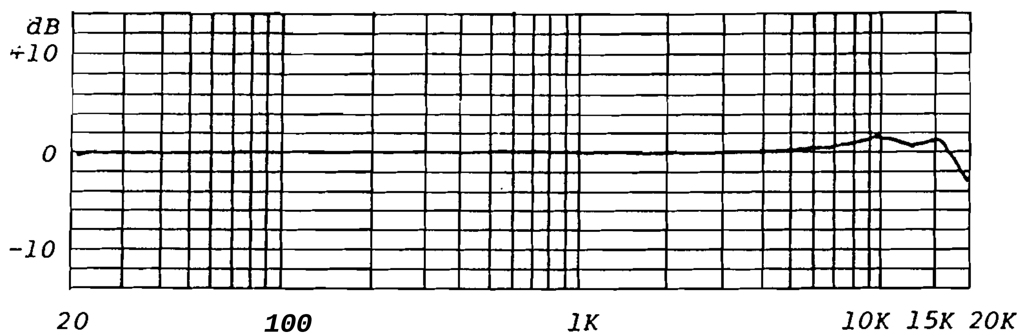

Figure 40

POWER

* BATTERY OPERATION. Nickel Cadmium Rechargeable.
* Operating time approx. 2 hours continuous @ 25°C.
* Fast charge cycle of 3 hours.
* Low battery indicator light.

* AC LINE OPERATION from AC adaptor/charger.
* 115/230 VAC 50/60 Hz.
* Charge indicator light.

ENVIRONMENTAL

* All circuits temperature compensated.
* Operating Temp. -10°C. to +50°C.
* Nonoperating Temp. -30°C. to +65°C.
* Operating Humidity 0 to 90%.
* Meets ANSI SI.4-1971 and S1.11-1966 (R1975).

MECHANICAL

* Aluminum case fusion bonded with nylon.
* Dimensions (w x h x d) 69 x 153 x 41 mm (2-3/4 x 6 x 1-5/8 in.)
* Weight: net 430 gms (15 oz.)
  shipping 1.0 kg (2 lbs.)
* Connectors: Standard phono jack.

ARCHITECT'S AND ENGINEER'S SPECIFICATIONS

The audio spectrum analyzer shall be capable of octave bandwidth, real-time analysis of the audio spectrum. The analyzer shall be capable of measuring sound pressure levels with either an ANSI "A" weighted or ANSI "C" weighted reading.

The analyzer shall have a self contained omnidirectional condenser microphone. Measurements through the microphone shall be calibrated in dB-SPL for octave bandwidth analysis, in dB(A) SPL for A weighted SPL measurements, and in dB(C) SPL for C weighted SPL measurements over the range of 40 to 146 dB-SPL.

The analyzer shall have an external signal input jack. Measurement of signals through the external input shall be calibrated from -110 dBm to + 9 dBm. The analyzer shall be capable of measuring signals up to +49 dBm (218v.RMS) using optional accessories.

The analyzer shall be capable of making octave bandwidth measurements with two selectable detector response times. The fast detector time shall be suitable for signal monitoring, and the slow detector response time shall be suitable for pink noise averaging.

The analyzer shall have a dynamic display range of up to 45 dB, and shall.have selectable resolutions of 1, 2 or 3 dB. The display brilliance shall adjust automatically for ambient lighting conditions and the graticule shall light automatically in darkened environments.

The analyzer shall be capable of both battery operation from fast-charge Ni-Cad batteries, and AC operation from 115 VAC and 230 VAC @ 50-60 Hz lines. It shall possess a battery status indicator to warn of low battery condition.

The analyzer shall have a precision preamplifier with a flatness of +/- .5 dB and gain of 0 - 80 dB adjustable in 10 dB steps, and shall have a THD of 0.1% or less for a 2 Vrms output.

The analyzer shall be hand-held and must weigh less than 16 ozs. The case of the analyzer shall be aluminum fusion bonded with nylon.

The analyzer shall be the IE-10A Audio Spectrum Analyzer manufactured by Ivie Electronics Incorporated.

SERVICE

It is the intention of Ivie Electronics to provide quality service for the IE-10A whether in or out of the warranty period. If the IE-10A should require service, please return it shipping prepaid to an Ivie Electronics service facility. Shipping the instrument in its original packaging is recommended. Repair will be made and the unit will be returned prepaid as soon as possible.

Due to the subminiaturized packaging techniques used, Ivie Electronics cannot assume responsibility for repairs made at other than an authorized service center.