~ Amplifier Performance Report ~

Report Date: July 9, 2015
Manufacturer: Fisher
Model: KX-200

Special Notes

Full "Gold-Level" restoration with regulated power supply upgrade recently completed:

Chassis ultrasonically cleaned, amp hand-polished and sealed. All coupling and bypass caps upgraded to modern "audiophile" polypropylene types. High Voltage regulated power supply upgrade with 200% increase in capacity. High capacity surge suppressor added. Filament/Bias power supply bridge rectifier replaced with custom supplied part. Phono stage was rebuilt to custom ultra-low distortion specifications. Output tube biasing circuitry optimized for modern tubes. Bias critically adjusted using a spectrum analyzer to minimize odd-order harmonic content, especially minimizing the 5^{th}, 7^{th}, and 9^{th} harmonics.

The purpose of this amplifier performance report is twofold:

First, the report will precisely quantify your amp's current performance in relation to its original manufacturer's specifications. To do this in an accurate and reliable way, AEA uses only calibrated lab-quality instruments.

The second goal is to provide diagnostics. Our experienced engineering team turns the measurement information into insights that can be used fortrouble shooting problems, as well as preventative maintenance.

Think of this report as the equivalent of a "full body scan" to assess your amplifier's health and provide expert advice on solving any problems found.

Understanding Amplifier Specs

The 5 key specs for power amplifiers are output power, frequency response, distortion, crosstalk and noise. Below are the manufacture's published specifications for each of these, along with the actual amounts we measured for each channel.

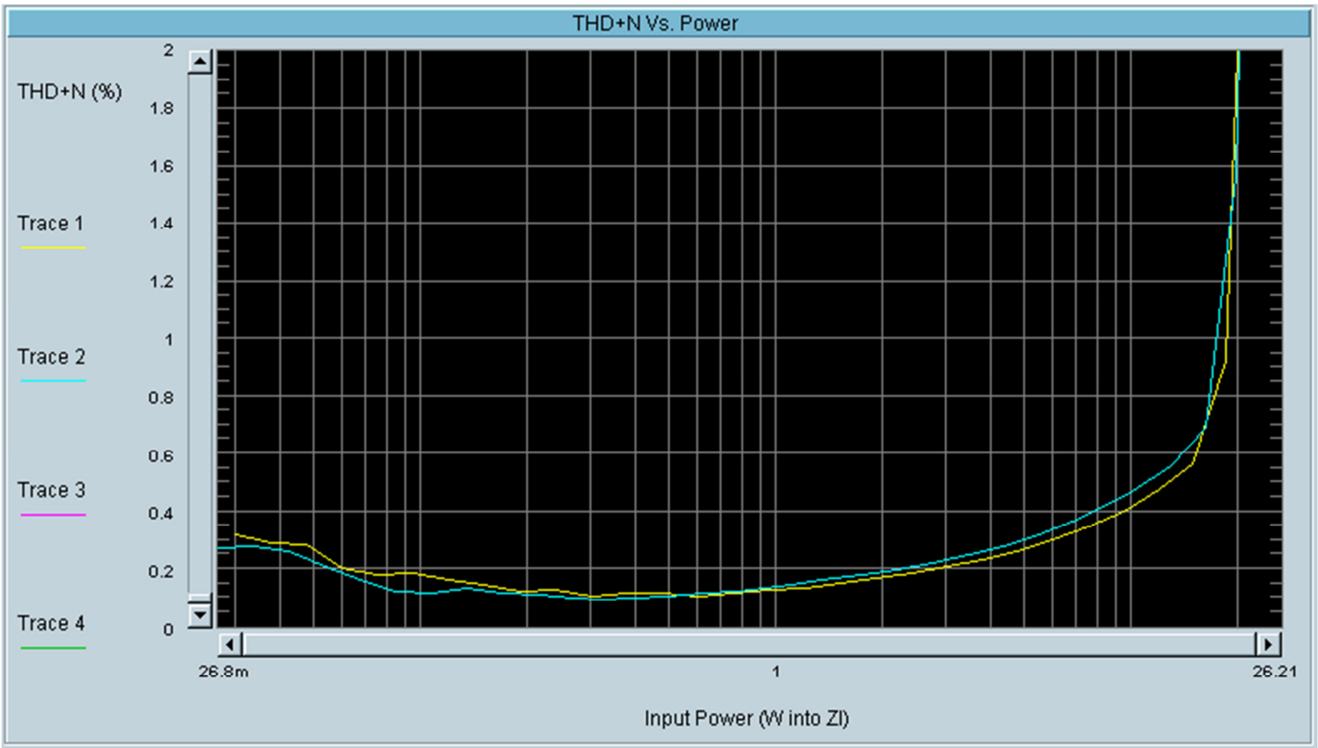
Note: In all graphs the **Left Channel** is shown in **Yellow** and the **Right Channel** is shown in **Blue**.

Maximum Power Output at 1 kHz (RMS watts per channel into 8Ω)

Power output is roughly equivalent to how loud you can pump out music. Maximum power output is the amount of power the amp can put out while remaining within its specified maximum distortion spec. (Note: Most vintage amps where rated in "Music Power" (or peak power), not RMS (average power) watts. Music Power is 1.47 times the RMS power.

Channel A (Left)	Manufacturer's Spec: 26 Watts RMS	Actual Measurement: 26 Watts RMS
Channel B (Right)	Manufacturer's Spec: 26 Watts RMS	Actual Measurement: 20 Watts RMS

The graph below shows your amplifier's distortion percentage at various output power levels. The vertical scale is increasing % distortion and the horizontal scale is increasing power (watts into 8 ohms).



How to read the graph:

THD vs Power is shown over an increasing range of power levels with both channels driven. The point at which distortion suddenly increases is the amplifier's maximum output, or clipping point. The distortion should remain well below the manufacturer's % distortion specification until after maximum rated power is reached.

Diagnostic Comments:

Adjusting output tube biasing circuitry and regulated power supply upgrade resulted in reduced distortion across all power levels right up to the clipping point. Lower bias current also optimizes the amp's performance and tube life.

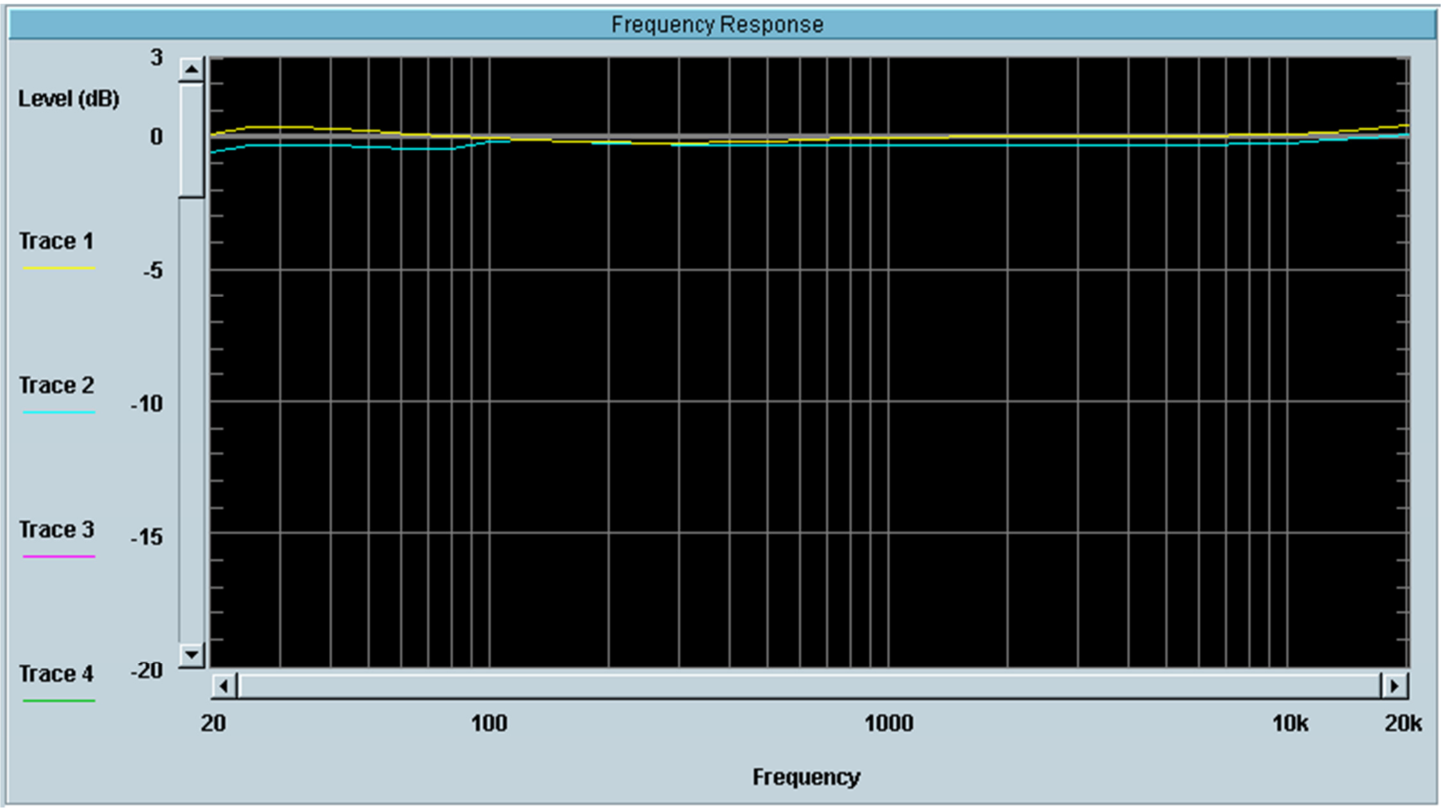
Frequency Response (at 3dB below max power 20Hz to 20KHz)

Frequency response is a measure of how well your amplifier "responds" to different frequencies in the input signal. It's measured in plus or minus dB over a fixed frequency range. The smaller the variation the better. Since the human ear can only hear frequencies between 20 cycles per second (20 Hz) twenty thousand cycles per second (20 KHz), the specification is often given only for this range of frequencies.

Channel A (Left)	Manufacturer's Spec: +- 1.0 dB	Actual Measurement: +- 1.6 dB
Channel B (Right)	Manufacturer's Spec: +- 1.0 dB	Actual Measurement: +- 1.4 dB

Frequency Response Graph

To help evaluate how well your amp responds to a range of frequencies, we have recorded its response to different sound frequencies in the graph below.



How to read the graph:

Reading the graph is actually pretty simple: It shows the range of frequencies (from low to high) horizontally and the amplifier output in Decibels (dB) vertically. The frequency range represented on this graph is 20Hz to 20,000Hz (20kHz), which is the maximum range of human hearing. The frequency response should be nearly flat — the less variation the better.

Diagnostic Comments:

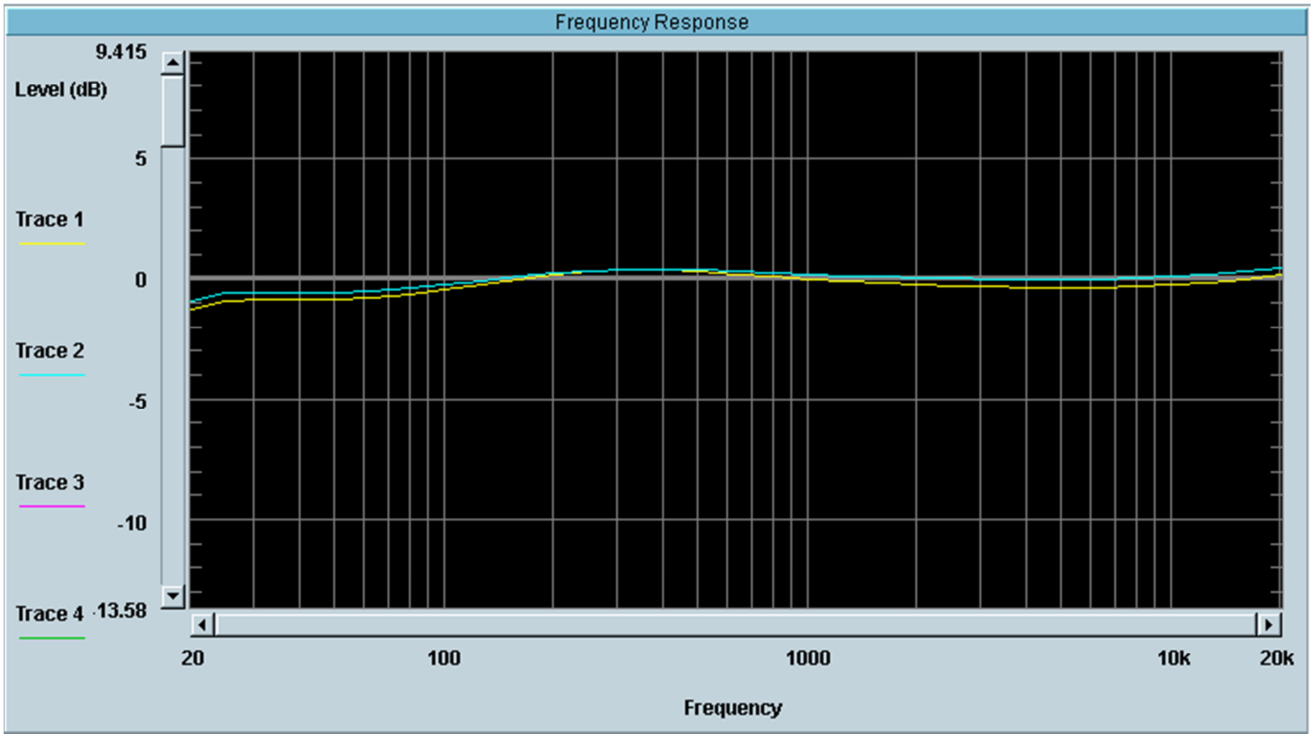
Frequency response is within specifications, and especially flat from 20 Hz to 20 KHz to within 0 .5 dB

Phono Preamp Stage RIAA Equalization Frequency Response

RIAA equalization is an industry standard specification for the recording and playback of phonograph records. It is a form of pre-emphasis used when the record is made (cut) combined with an equal and opposite de-emphasis on playback. Accurate RIAA equalization is critical to phono preamp performance.

RIAA Equalization Graph

As components such as resistor and capacitors age, their values often change. Even small changes can cause the phono stage to apply incorrect RIAA equalization, resulting in 'tonal coloration' and phase distortion. The chart below shows how well each channel of your phono preamp stage follows the precise RIAA standard over the range of 20Hz to 20 KHz.



How to read the graph:

The chart is made by applying precision RIAA pre-emphasis to the test signal input to the phono preamp stage. If the phono input stages de-emphasis equalization is in perfect compliance with the RIAA standard there should be a flat line at zero deviation. The flatter this line is the better. Any deviation present should be below the manufacturer's specification over the entire frequency range.

Diagnostic Comments:

Original phono preamp components restored with precision parts resulting in extremely close RIAA equalization compliance. Both channels are well balanced with less than 0 .5 dB difference across the entire frequency range.

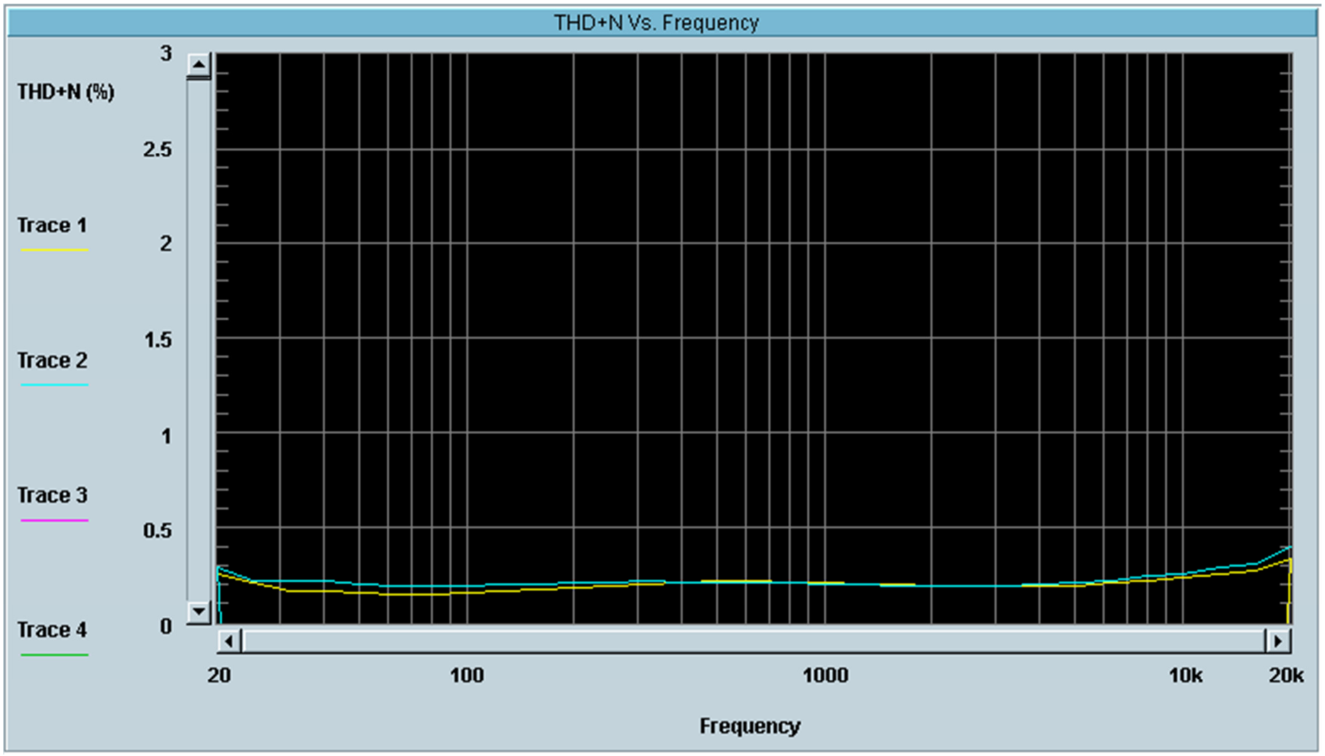
Total Harmonic Distortion + Noise (THD + N at 3 dB below max output into 8 Ohms)

Total Harmonic Distortion + Noise (THD + N) is a measure of the effect the amplifier has on the sound output (distortion) as a percent of the total output. A completely transparent amplifier would have zero percent distortion. The lower this figure, the closer the output of the amplifier will be to the original recording.

Channel A (Left)	Manufacturer's Spec: <1%	Actual Measurement: .4%
Channel B (Right)	Manufacturer's Spec: <1%	Actual Measurement: .3%

THD+N Graph

To help evaluate the distortion of your amplifier over a range of frequencies, we have recorded its percentage of distortion at different sound frequencies in the graph below.



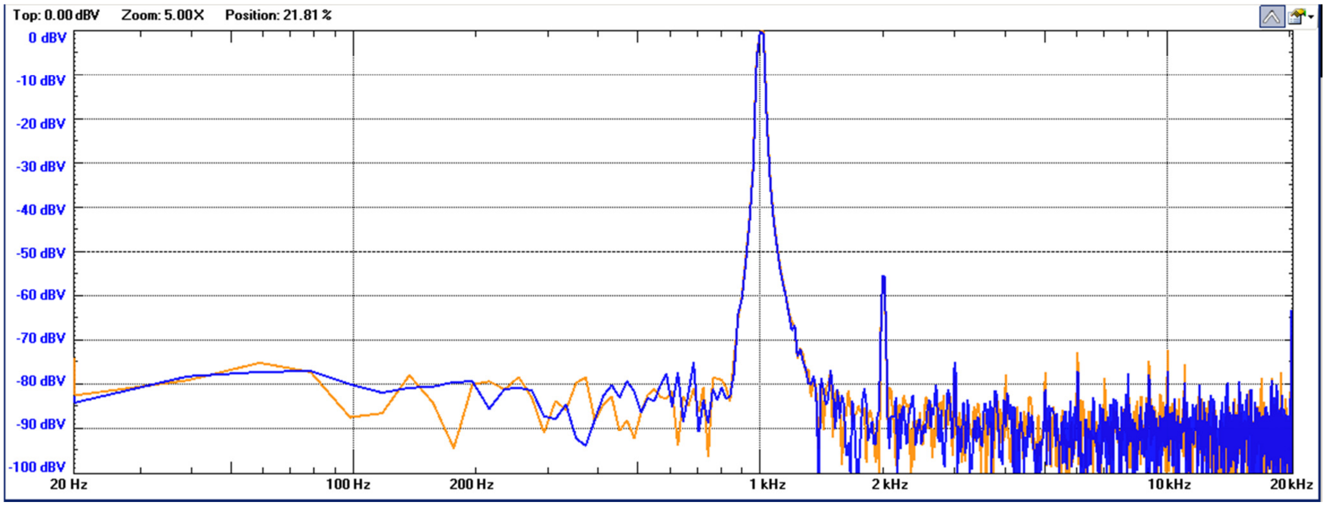
Ideally the percentage of distortion should be well below the manufacturer's specification over the entire frequency range.

Diagnostic Comments:

The improved output tube biasing circuit and regulated power supply gives the upgraded amp 50% less distortion across its entire frequency range, with a reduction of 200% between 40 Hz and 10 KHz.

Spectral Analysis of Distortion Products at 3 dB below max output into 8 Ohms

In order to analyze the harmonic content in your amp's distortion we have measured the distortion products produced by a pure 1 KHz tone at maximum power. Each harmonic is plotted by their frequency in the "Spectrum Analysis" graph below. While the total amount of distortion (THD) is important, it's actually the types of harmonics in the distortion that determine how an amplifier sounds. Odd order harmonics, especially the 5^{th}, 7^{th}, and 9^{th} harmonic, are the ones that cause the most unpleasant sounding types of distortion.



How to read the graph:

The distortion of a waveform relative to a pure sinewave can be measured by separating its constituent harmonics. This allows measurement of each harmonic's amplitude relative to the reference sine wave (fundamental). Each harmonic is a multiple of the test tone's frequency of 1 kHz. They can be seen as individual blips trailing off to the right of the test tone in the center of the graph.

Diagnostic Comments:

The amp displays low distortion with excellent harmonic content of its distortion components. Distortion products are predominately second harmonic, with higher order harmonics more than 76dB down. Channel matching is very good, with only 3dB difference in high order harmonics. This is an excellent example of a clean "tube amp" distortion spectrum with predominate second order harmonics and suppression of odd-order harmonics.

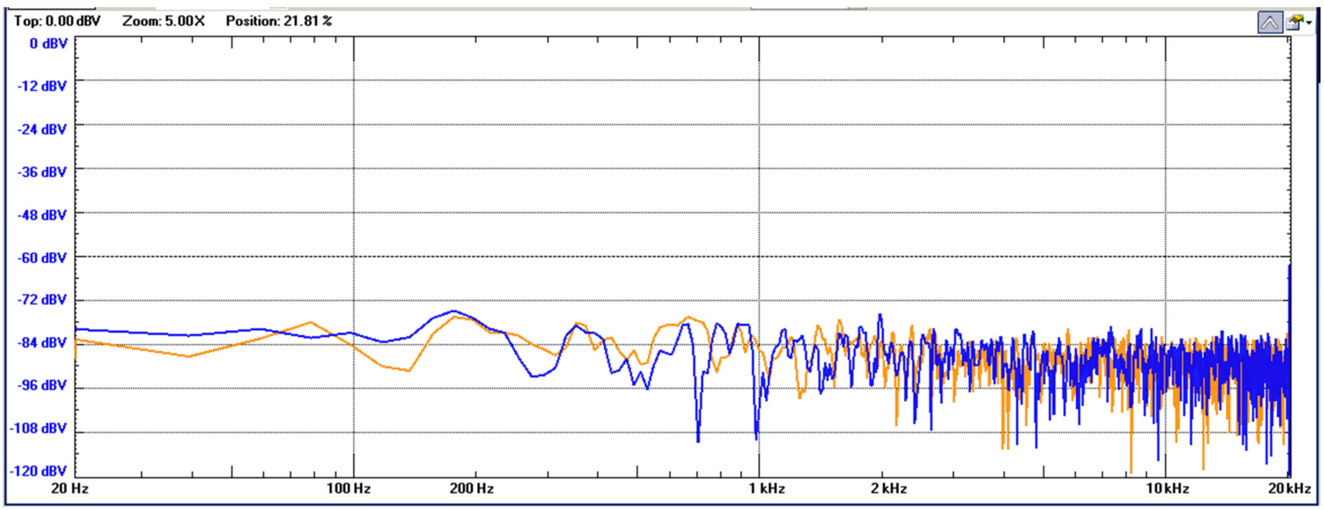
Signal to Noise Ratio (SNR) at max output into 8 Ohms

Signal to Noise Ratio is the amount of noise contained in the amplifier's output compared the music. In all amplifiers there is always a very small amount of noise from the electrons whizzing around, bumping into things. The goal is to make this background noise imperceptible, meaning a very high signal to noise ratio is a good thing.

Channel A (Left)	Manufacturer's Spec: -65 dB	Actual Measurement: -74dB
Channel B (Right)	Manufacturer's Spec: -65 dB	Actual Measurement: -74dB

Spectral Graph of Noise:

In order to analyze and help diagnose noise and hum in your amplifier we have recorded the spectrum of each channel's noise in the graph below.



How to read the graph:

The graph shows the amplitude in of each channel's noise components with the volume control set to maximum. The vertical scale is the amplitude in reference to the amplifier's Maximum Power Output in dBm over the range of 20 Hz to 20 KHz. Ideally all noise components should be well below the manufacturer's specifications.

The noise spectrum is an important diagnosis tool when evaluating vintage amplifiers. Especially important is noise in the low frequency range of 60 and 120 Hz. Excessive noise in these frequencies indicated "hum" caused by faults in the amp's powers supply. An increase in high frequency noise can be a sign of bad component such as resistors, or instability in the amplifier's output stage.

Diagnostic Comments:

This amplifier has extremely low noise and hum due to a regulated power supply upgrade. All noise components are more than 80 dB below 0 dB V, which is more than 87 dB below full output. Both channels have very similar noise spectrum, indicating matched gain and frequency response, as well as low tube noise

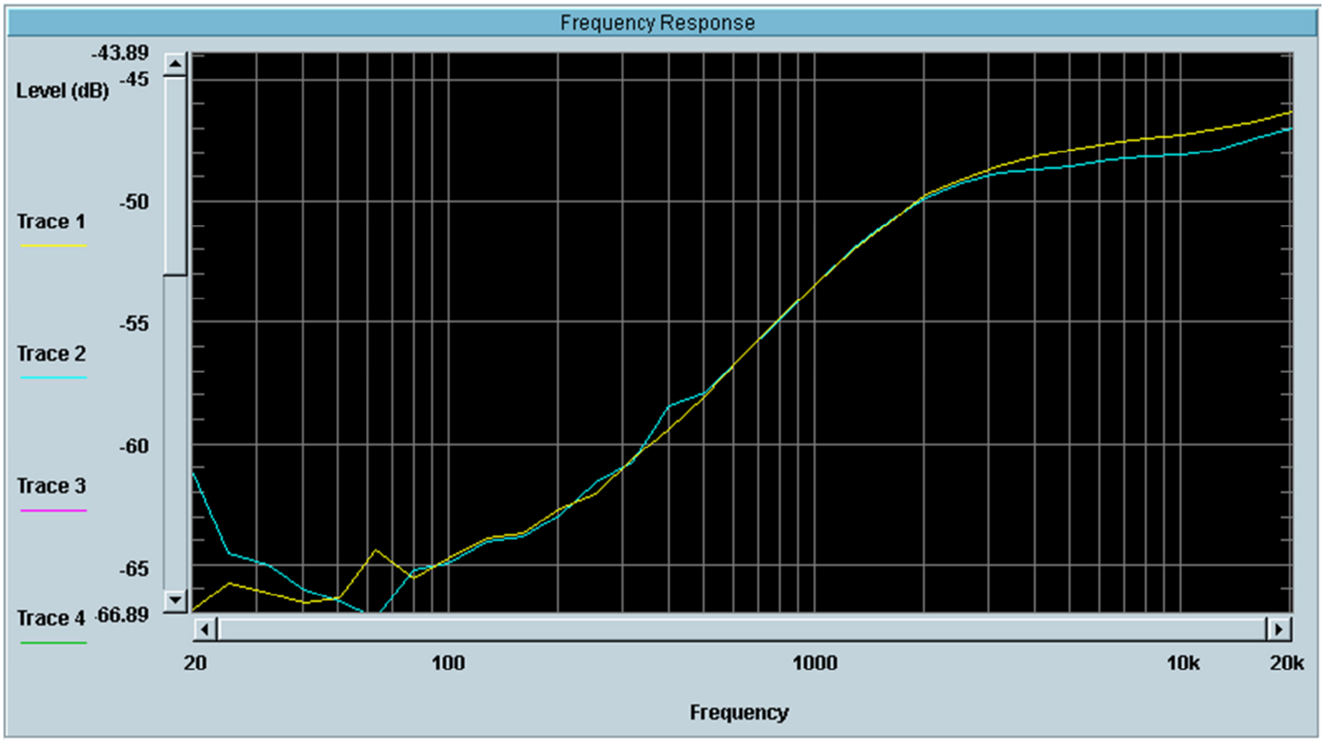
Crosstalk

We all know the left and right channels are supposed to be separate, and drive separate speakers on separate sides of the room. Crosstalk is a measure of how much undesirable left input signal is mixed with right output signal (or vise-versa). With low crosstalk it's easy to hear that the singer is a little left of center stage and the violins are towards the right. The more crosstalk there is, the harder it is to pick out the positions of the instruments within the stereo image, or "soundstage."

Channel A (Left)	Manufacturer's Spec: N/A	Actual Measurement: -26dB
Channel B (Right)	Manufacturer's Spec: N/A	Actual Measurement: -27dB

Cross Talk Graph:

Cross talk is not always specified in the manufacturer's specifications, but must be greater than -25 dB to preserve proper soundstage imaging. Due to the fact that the amount of crosstalk varies with frequency, we have plotted each channel's crosstalk by frequency in the graph below.



Crosstalk is measured in negative dB (-dB). The more negative the better.

Diagnostic Comments

Crosstalk is very low. Channel separation is improved due to ultrasonic cleaning and changes to signal routing/wiring.