Restoration Performance Report

Report Date: July 15, 2015
Manufacturer: Fisher
Model: 500-C Receiver

Special Notes:

Full gold-level restoration recently completed: Chassis ultrasonically cleaned. All coupling and bypass caps upgraded to polypropylene types. Power supply upgraded with 200% increase in capacity. The FM receiver section was also restored and critically aligned. Output tube biasing circuitry optimized for modern tubes.

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.

Secondly, the report will provide diagnostics. Our experienced engineering team turns the measurement information into insights that can be used to trouble shoot problems, as well as provide preventative maintenance for your amplifier.

Think of this report as the equivalent of a "full body scan" to assess your amplifier's heath 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. AEA uses calibrated lab-quality instruments to ensure accurate and reliable information.

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

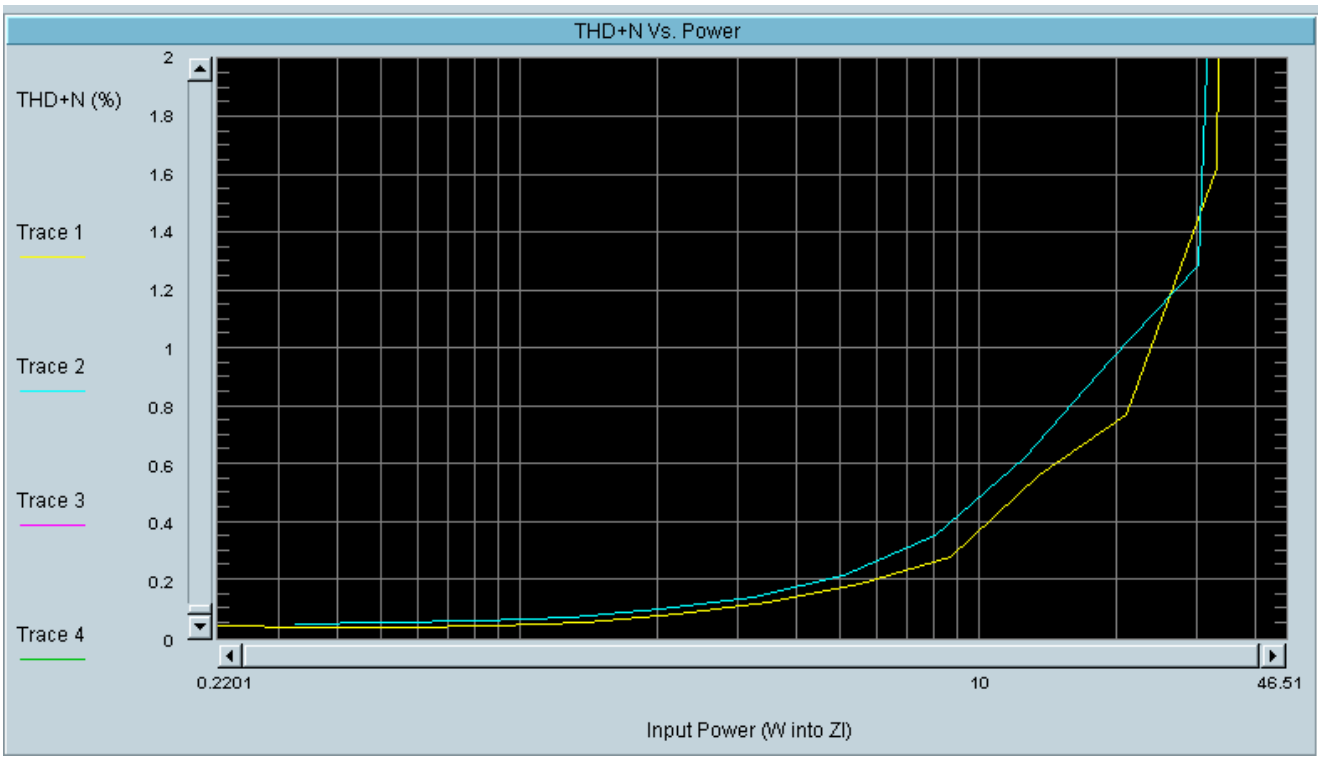
*An additional section on receiver performance specifications and alignment has been added

Maximum Power Output (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.

Channel A (Left)	Manufacturer's Spec: 24 Watts	Actual Measurement: 26 Watts
Channel B (Right)	Manufacturer's Spec: 24 Watts	Actual Measurement: 26 Watts

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:

Our new output tube biasing circuitry results 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, with only 3 watts (less than 1 dB) reduction in maximum rating.

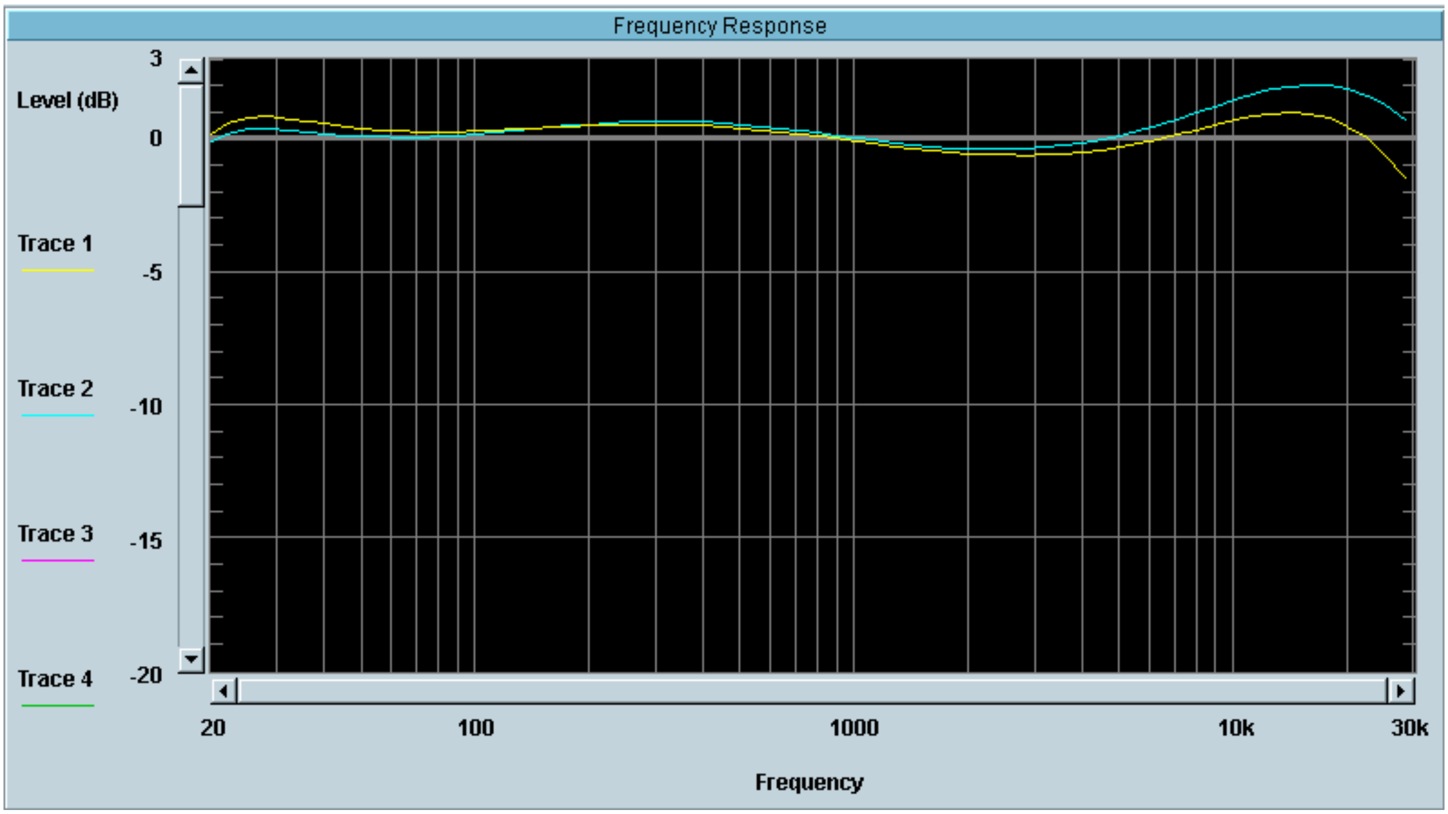
Frequency Response (at max power 20Hz to 20kHz)

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:

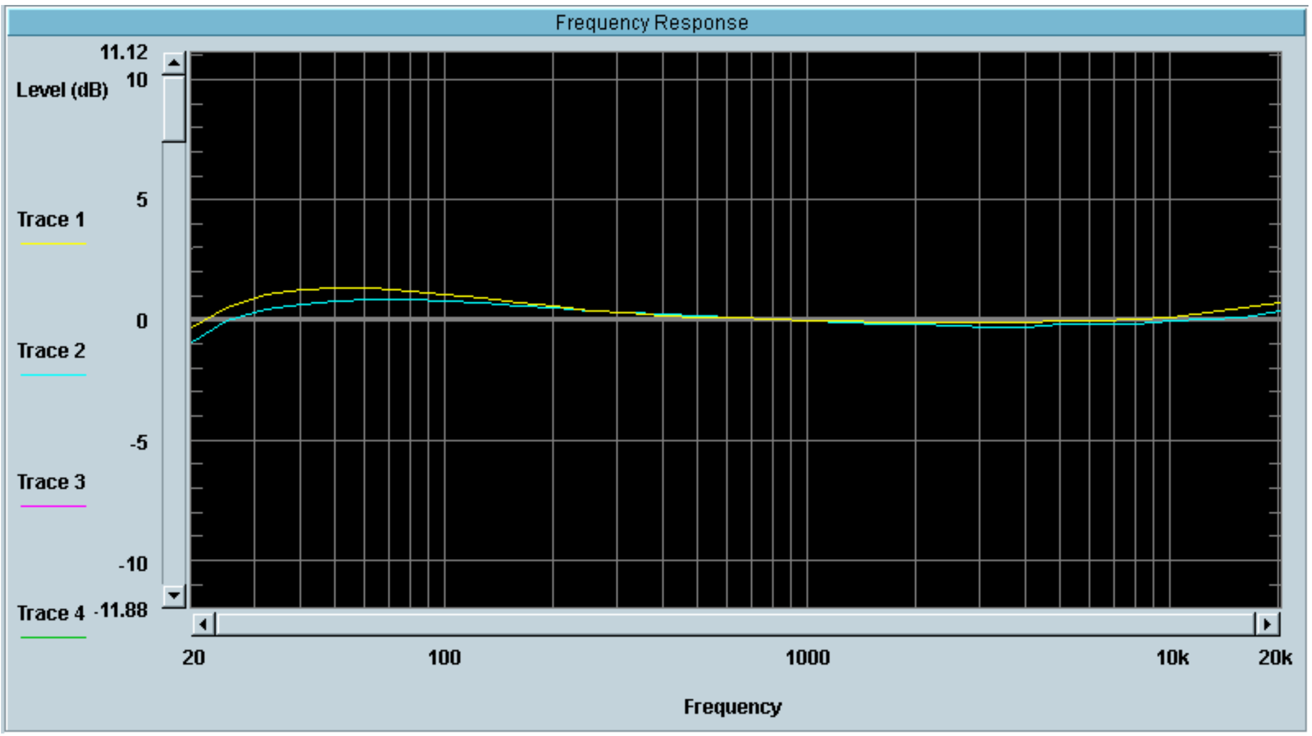
Frequency response is within specifications, and especially flat from 23Hz to 18KHz.

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 graph 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:

Individual resistors and capacitors were replaced/upgraded to allow the phono preamp to operate within 1 dB of specified RIAA equalization compliance. Both channels are well balanced with less than .5 dB difference across the entire frequency range.

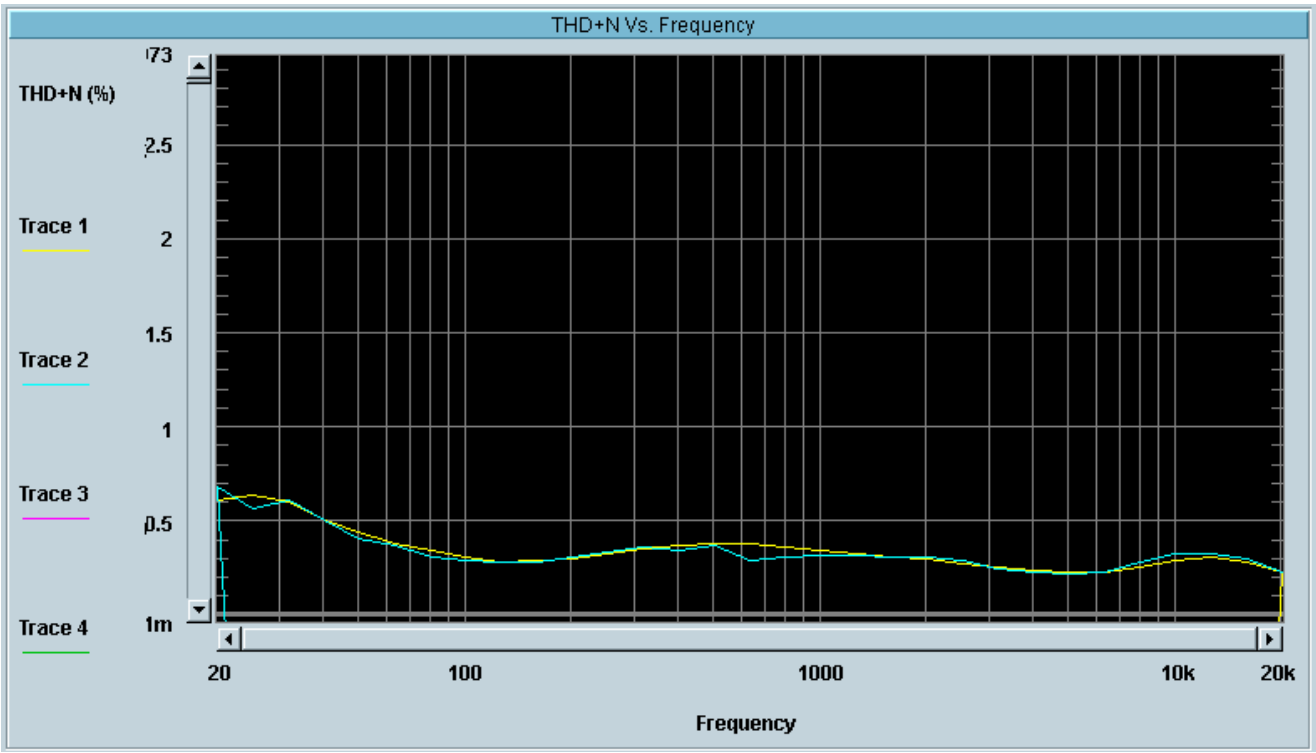
Total Harmonic Distortion + Noise (THD + N)

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: 0.5%
Channel B (Right)	Manufacturer's Spec: <1%	Actual Measurement: 0.4%

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.



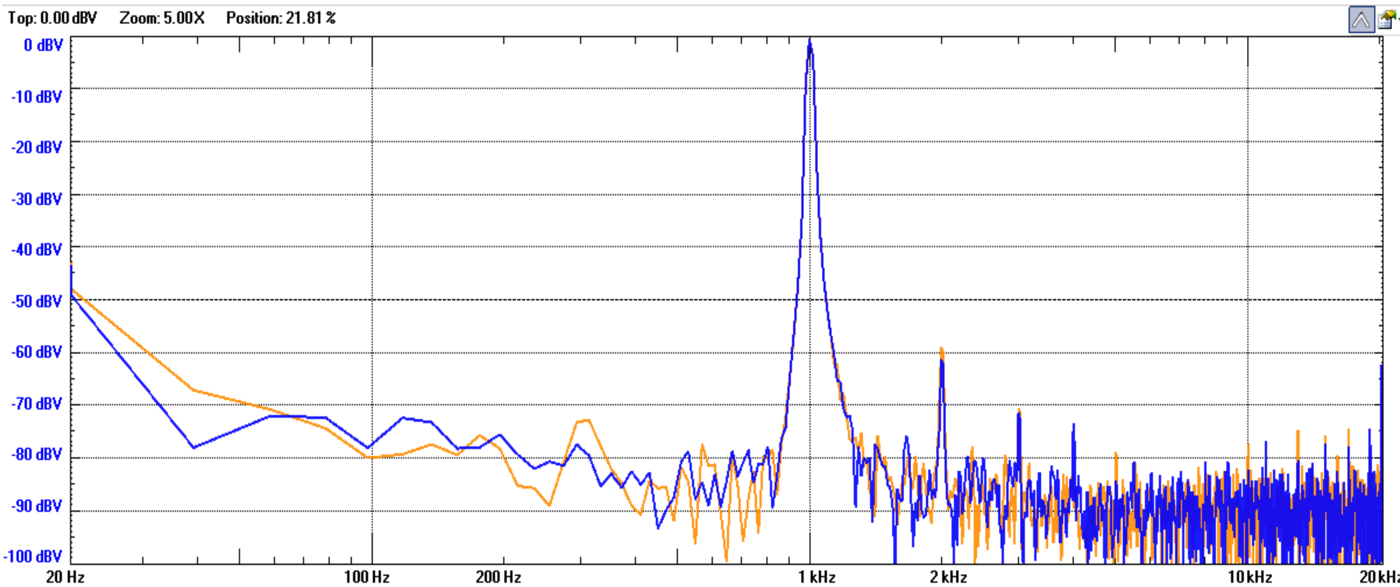
Ideally the percentage of distortion should be well below the manufacturer's specification over the entire frequency range.

Diagnostic Comments:

With an improved output tube biasing circuit added, the amp now maintains very low distortion across its entire frequency range.

Spectral Analysis of Distortion Products

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 contained in the distortion that determine how an amplifier sounds. Odd order harmonics, especially the 5th, 7th and 9th 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 left of the test tone in the center of the graph.

Diagnostic Comments:

Low distortion with excellent harmonic content of its components. Predominately second harmonic, with higher order harmonics more than 72dB down. Channel match is good, with no difference in high order harmonics. This is a very good example of the clean tube amp distortion spectrum with predominate second harmonics and suppression of high order harmonics.

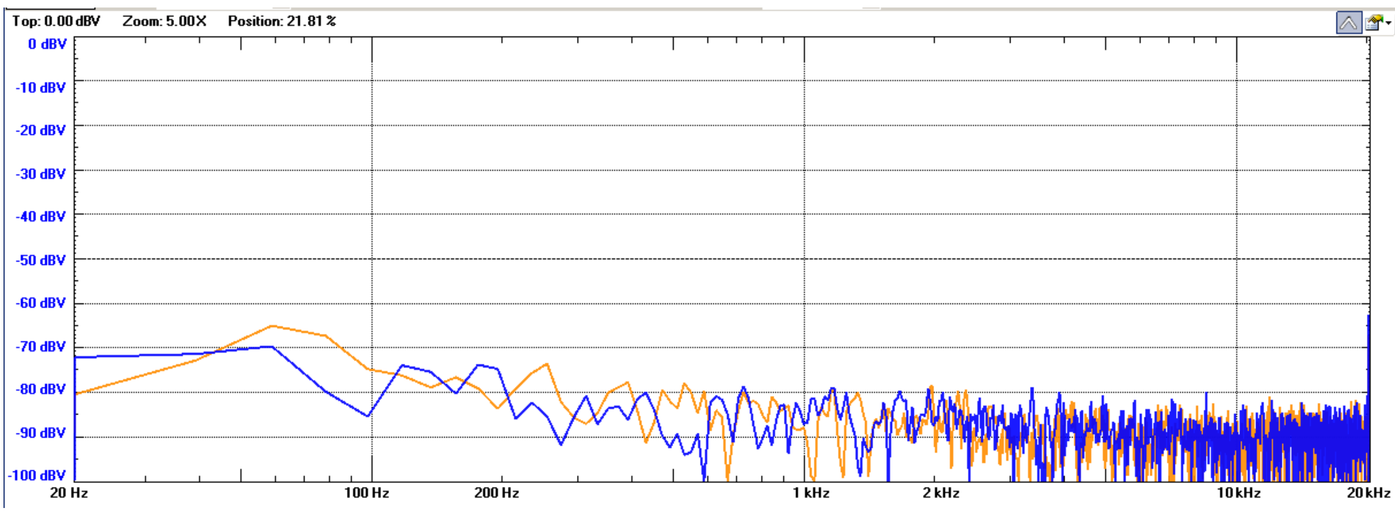
Signal to Noise Ratio (SNR)

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 the improved power supply. All noise components are more than 68dB below 0dBV, which is more than 84dB below full output. Both channels have very similar noise spectrum, indicating matched gain, frequency response, as well as matching low tube noise.

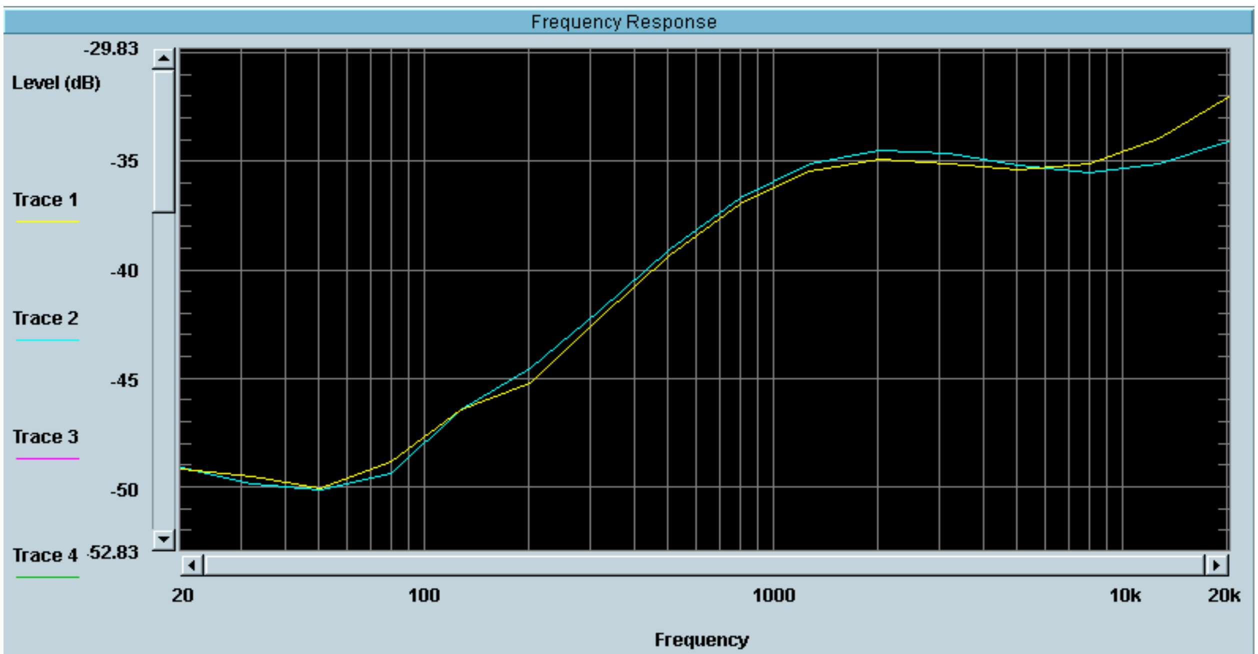
Crosstalk

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

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:

Cross talk is well below -30dB up to 15 KHz. Stereo imaging and sound stage detail are excellent.

FM TUNER SECTION PERFORMANCE REPORT

FM Receiver Sensitivity

Receiver sensitivity is one of the most important specifications of any radio receiver. It is the measure of the lowest signal level at which the receiver can detect an RF signal and properly demodulate the audio signal within the manufacturer's specifications of signal to noise, stereo separation and distortion. Sensitivity is measured in microvolts, or millionths of a volt, with lower numbers being better. Any measurement below 2 microvolts is excellent.

Manufacturer's Spec: 1.8 microvolts

Actual Measurement: 1.45 microvolts

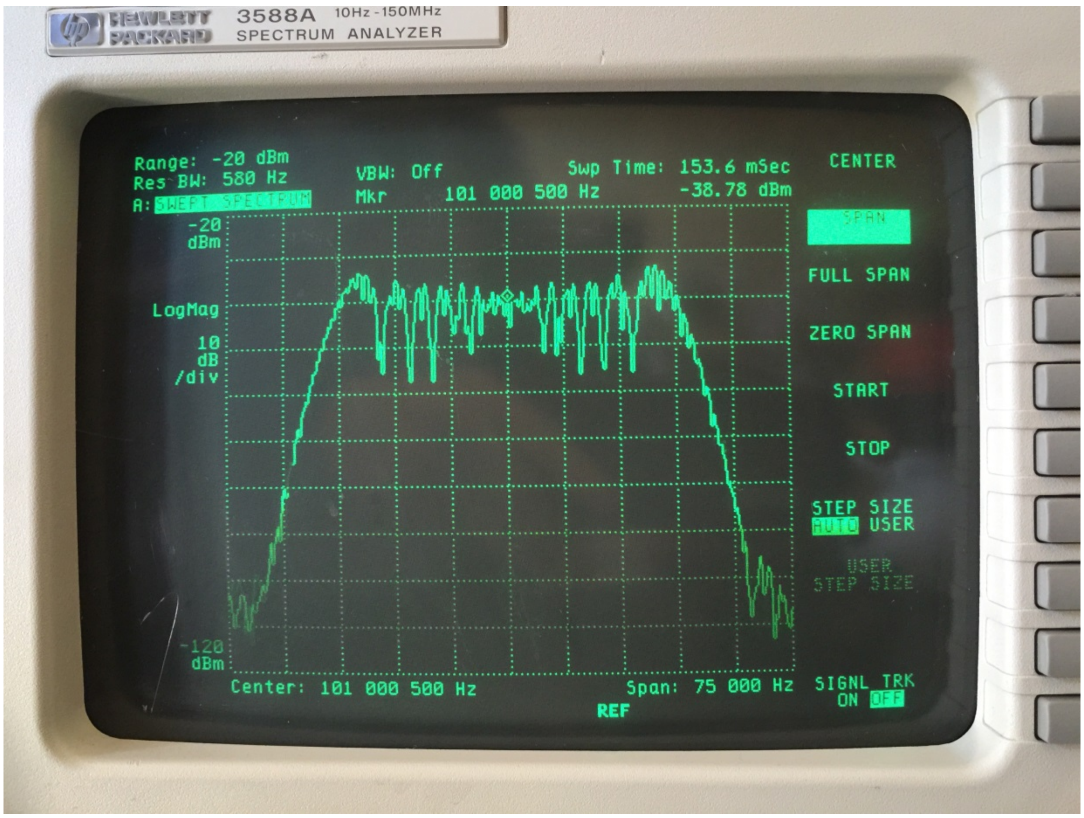
Other Key Receiver Performance Metrics:

Metric	Manufacturer's Spec:	Actual Measurement:
Signal to Noise Ratio	70 db	73.5 db
FM Stereo Selectivity	60 db	62 db
Spurious Response Rejection (at 101 MHz)	90 db	92 db
Capture Ratio	2.5 db	2.7 db
FM Harmonic Distortion	.5%	.40%
Stereo Channel Separation (at 1 kHz)	35 db	37 db
Image Rejection (at 101 MHz)	65 bd	66 db
Dial Calibration	.2%	.2%

FM Receiver IF Bandwidth Alignment

Proper alignment of the receiver involves tuning it's many Intermediated Frequency (IF) amplification stages with great precision. Proper alignment of the IF stages is critical to overall performance and effects all of the above sited performance metrics. The graphs below show the actual measurements we made of the receiver's various IF and demodulator stages using a Hewlett Packard 3588A RF Spectrum Analyzer. Using this type of equipment allows us to not only precisely align the receiver, but to also verify its performance with great accuracy.

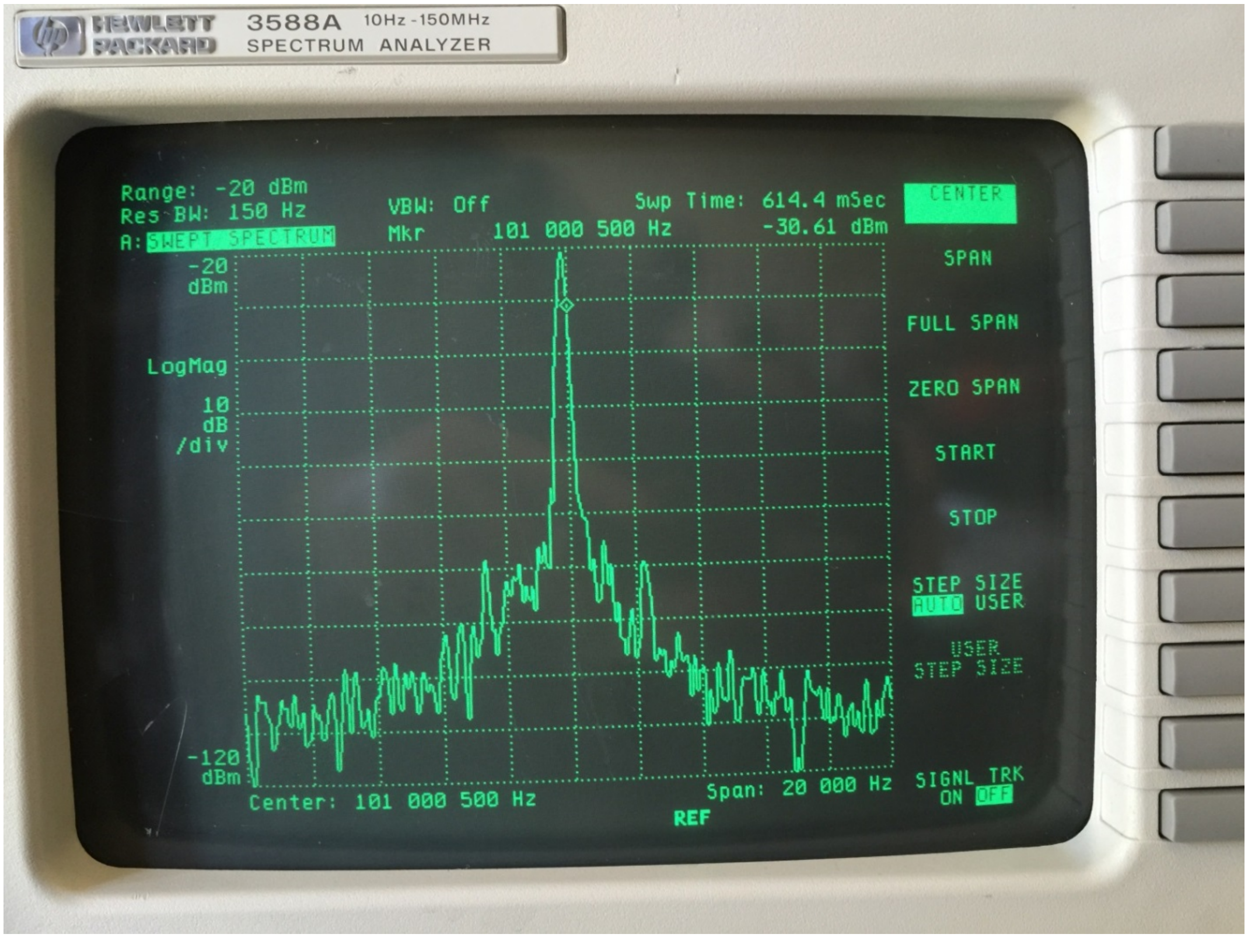
10.7 Mhz IF Bandwidth Alignments and Band-pass Graphs



How to read the graph:

The IF band pass plot should be very symmetrical about the center frequency, with a flat center and a slightly raised sholder increasing by 10 db. This increase at the outer edge of the band pass is a reflection of proper alignment to allow FM broadcast pre-emphasis to properly pass through the receiver's IF

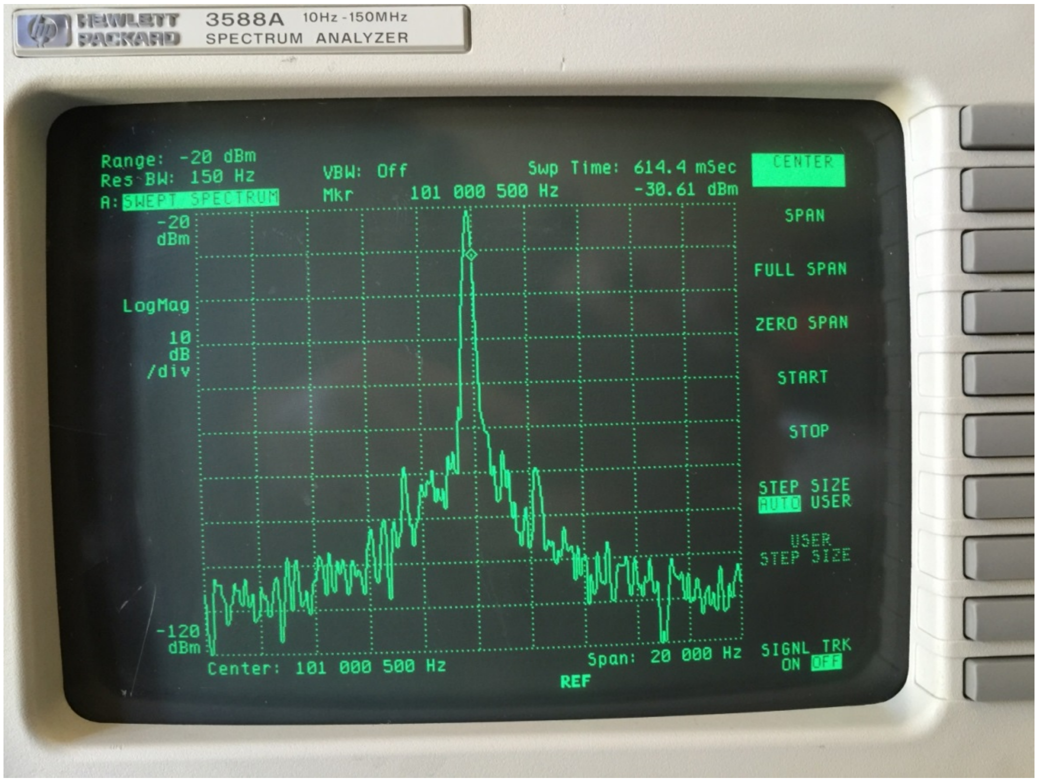
IF Image Rejection and Signal to Noise Ratio



How to read the graph:

The difference between the peak amplitude of the IF signal and the noise floor on either side determines the receiver's IF signal to noise ratio. This difference should be grater that 60 db. (The graph is measuring 10 db per each vertical division). The small peaks to either side of the main signal are "image artifacts" created by the IF mixer stage and should be more than 60 db below the peak measurement level.

IF Image Rejection



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About the Fisher 500-C

The Fisher 500-C is renowned as being among the best performing stereo FM receivers ever made.

Avery Fisher founded the Fisher Radio Company in 1945 to produce high fidelity AM radio receivers and audio amplifiers. In 1954 Fisher went on to introduce the word's first high fidelity FM/AM receiver, becoming the world leader in FM receiver technology. The Models 500-C and 800-C, introduced in the early 60's, share the same FM receiver circuitry, which was the last and most advanced of Fisher's tube designs. It is also the most sensitive FM receiver ever produced for home use.

Many people are surprised to learn that these receivers actually have better technical specifications than almost any modern solid state radio. When properly aligned they have a remarkable sonic quality, with excellent sonic detail, stereo separation and extended frequency response. Plus their ability to tune in weak stations is legendary.

The 500-C's high-performance design makes it an excellent FM receiver even by today's standards, with exceptional sensitivity and accurate stereo multiplex demodulator. It is also an outstanding integrated amplifier with 30 watts (RMS) per channel. Added to this is very robust construction design using some of the highest quality materials available in the early 1960's.

However, proper FM receiver alignment requires special well-calibrated test gear, as well as a thorough technical understand of FM Stereo receivers. Our experienced engineers are true experts in radio, having received advanced commercial FM radio and TV station engineering licenses from the FCC. Their experience, combined with our Hewlett Packard and Megro laboratory quality FM receiver test equipment assures accurate alignment, and gives us the unique ability to perform the necessary tests to certify that your restored receiver meets or exceeds all factory specifications.