Fredenstein
Professional Audio

HD
REFERENCE

Operating Manual

Fredenstein HD Reference Preamplifier

The Fredenstein HD Reference microphone preamplifier utilizes a completely new approach to microphone level amplification. Many in the recording industry are now using 96 kHz or 192 kHz sampling rates while tracking, but still using equipment, which cannot provide the frequency response or bandwidth provided by modern A/D converters. The HD Reference overcomes these limitations and yields a new sound quality. Especially for wider bandwidth sources, like acoustic instruments, voices, and drums, the HD Reference is simply unequaled. It is the preferred choice for classical recordings as well.

The HD Reference was preceded by the HD Pre which was designed for the 500 Series racks, but that format does have limits regarding available voltage and current plus imposes some restraints on the available physical area. Never the less, the HD Pre set new levels of performance in all of the important parameters pertaining to mic pre-amplifiers. The HD Reference surpasses the HD Pre due to higher voltage power supplies +/-24V rather than +/- 16V, higher current (?? vs +/- 150mA), and even more discrete transistors (from 54 in the HD Pre to 64 in the HD Reference).

The HD Reference also goes a step further by allowing a full featured Remote Control called The Commander that can access every function on the front panel. The HD Reference and Commander are connected with a conventional XLR cable, that can be routed though a patch bay if necessary. With 920kHz bandwidth available, it makes little sense to risk losing that fidelity with a mic driving 100 feet or more of mic cable. With the HD Reference placed close to the microphones and short mic cables in use, the engineer can realize the benefit of bandwidth.

The HD Reference also has a few added features, such as a display that shows gain in dB next to the knob that allows one to set gain in accurate 1dB steps, which is great for setting up stereo pairs. We also added more choices to the High Pass Filter (Off, 39Hz, 82Hz) and more choices to the Input Impedance (200K, 1K, 300, 232).

In terms relating to audibility, the HD Reference is very very fast, clean and true to the source, with very low noise. And for the technically inclined, it does this without negative feedback and, maintains outstanding performance at any and all gain settings, which is rare indeed.

Besides incorporating a fully discrete signal path and a Class-A balanced output stage, the HD Reference uses a revolutionary current amplification circuit, which neutralizes internal transistor capacitance (Miller Effect) that limit frequency response and slew rate in conventional voltage amplifiers. As a result, the HD Reference features an unprecedented bandwidth of over 900 kHz.

The HD Reference may also be unique in the world of mic pre-amps in needing moderate sized heat sinks that one might expect to see in a small power amp. The output stage is also really Class A, running on 48 volts and can drive +29 dBm (60 volts peak to peak). And this implies appreciable idle current, and some heat generated.. No problem driving long lines and still sounding fine though, thanks to that available current...

The HD Reference does not use input or output transformers. These would prevent the pre-amp from having the amazing specifications and performance that it is capable of. The F601A Mic Pre has both an input transformer and output transformer that can be inserted or bypassed. The F609, F676, F200, V.A.S and Artistic Mic Pre's all have transformers and each has special applications in where they excel and compete with well known vintage pieces.

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Installation:

Electrical Safety Warnings:
Do not open the enclosure, hazardous voltages are present inside!
There are no user serviceable parts inside.
Refer servicing to qualified personnel.
Do not expose this appliance to rain and moisture.
Do not block any ventilation openings. Do not install near heat sources.
Protect the power cord from being walked on or pinched. Do not defeat the safety purpose of the polarized or grounding plug and connect to a properly grounded mains socket.
According to WEEE Directive (2012/19/EU) this product must not be disposed with household waste. This product should be taken to a licensed EEE collection center for recycling.
If you need to replace the mains fuse, make sure the replacement has the same rating , 2AT 250V, slow blow (2 Amp) in the IEC socket on the HD Reference.
If you need to replace the mains fuse, make sure the replacement has the same rating , 1AT 250V, slow blow (1 Amp) in the IEC socket on the Commander.

The HD Reference does get hot. This is a result of it using 4 Class A amplifiers on 48 Volt rails, which, in terms of heat generated, is like having a 15 watt light bulb in a 1U box.

Please provide for some space directly above and below for ventilation.

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The input impedance of the HD Reference is natively 200 kOhms (200,000 Ohms) and can be reduced to 1KOhm (1000 ohms) or 300 Ohms by activating the LOW-Z functions. With both 1K and 300 pressed, the input impedance is approximately 230 Ohms. The initial 200 kOhm input impedance avoids loading the microphone output transformers and yields, in some cases, sonically superior results. The lower impedance settings tend to increase the damping of dynamic and ribbon microphones. We suggest that while you are learning this preamp, that you listen while changing impedance settings. What to listen for, you ask? Passive microphones such as dynamics and ribbon mics may sound tighter, snappier, dryer or more direct with lower impedance settings, but on the other hand, you may be more accustomed to those mics sounding a certain way and that is why you chose to use them, so in those cases probably the higher impedance settings may sound more familiar. Consider the artistic possibilities and the new flavors you can get from your mic collection.

With some microphones, the transformer inside them comes into play because they may be optimized for a particular range of impedance's. In those cases, it is likely that either the 1K or 200K settings may be most appropriate. Generally this translates to differences in the high frequency response and the “brightness” and the quality of the sibilance (“natural” is usually preferred). Lastly, some active microphones might conceivably distort a little prematurely into the 300 ohm setting,. On the other hand, consider that most active mics are designed so that the capsule should distort from sheer SPL first, and there is at least a few dB headroom in the electronics beyond that, so that scenario is unlikely. In any case, the engineer can switch between the settings to find the desired result without any fear of damaging the microphone.

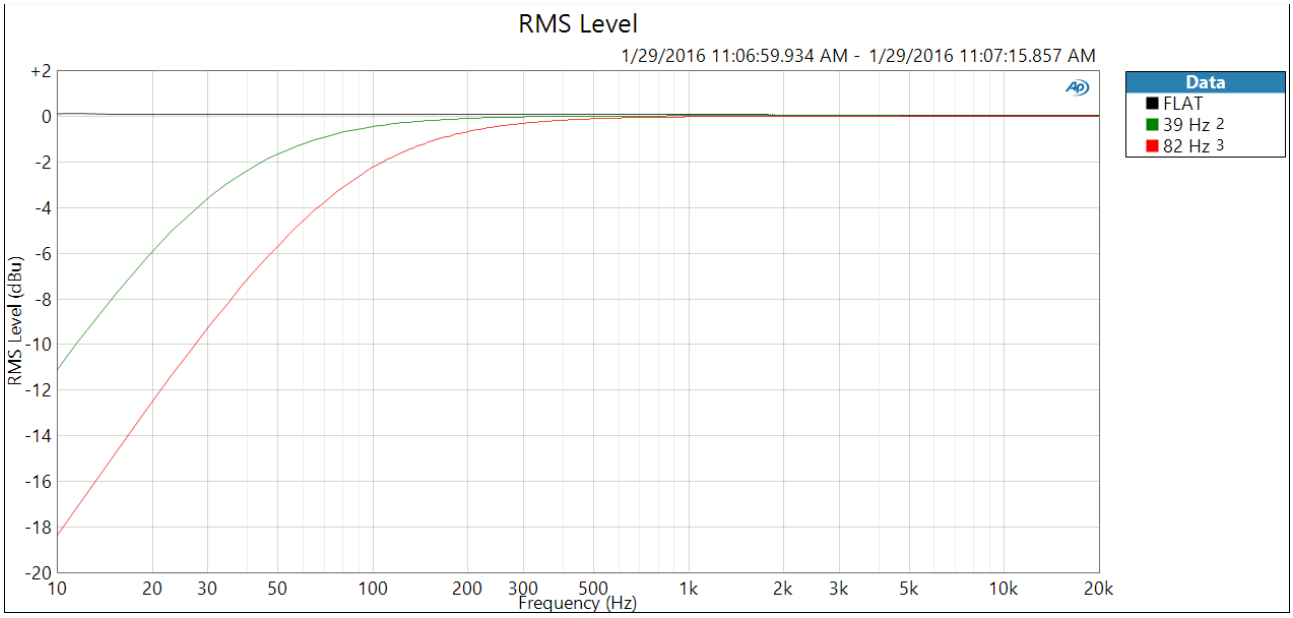
Just to complicate matters, the length and capacitance and quality of the microphone cable may be the biggest factor for the microphone and its transformer to deal with. This too represents an impedance that the mic needs to drive, and this is an impedance that becomes lower at high frequencies. For example, a long cable might reduce the benefit of the 200K setting. A typical 10 meter cable capacitance may reduce the impedance to 10 kOhms at 10kHz and 5 kOhms at 20 kHz. Phantom powered output amplifiers of microphones do not have a lot of voltage or current to work with and is part of the reason why using the HD Reference to drive the long line is preferred. Another reason is that a line level signal is more immune to RF and interference than a much lower level mic level signal. Sometimes corrosion on XLR connectors can cause a “diode effect” that can block a low level signal, but a larger signal may clear the blockage, and of course that is a simplified description, but hints at one more reason where a remote controlled mic-pre may be an advantage.

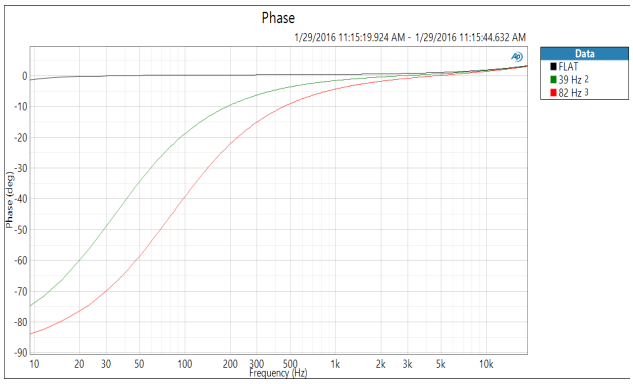
One final note regarding the HD Reference input impedance. Like virtually all mic pre's that include Phantom Power, a pair of 6.8 kOhm resistors are bridged across the input to feed enough current to power the microphone. In the HD Reference, these resistors are removed from the circuit when Phantom Power is not required, which makes possible the unusually high 200 kOhm setting. However, when Phantom Power is needed then the maximum impedance is lowered to about 13 kOhms, due to those resistors, but it is still a high impedance by mic-pre standards. Phantom power also lowers the 1K and 300 Ohm settings but proportionately much less.

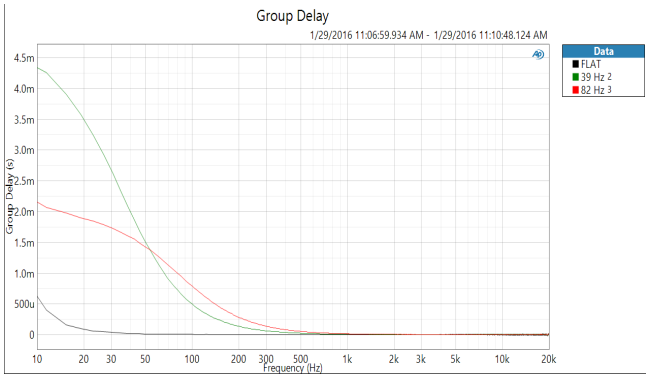
The HD Reference includes a high pass filter or low cut filter with 2 select-able frequencies, 39 Hz and 82 Hz. The filter is before any active electronics and can certainly help reducing pops and plosives when used for vocals, but we might suggest that physical pop filters or angling the mic

when possible. The most common use for high pass filters is to reduce unwanted rumble from air conditioners or from outside sounds when acoustic isolation tends to be be less than perfect. High pass filters can also help reduce leakage from other sources when the the instrument has minimal low frequency information, and the leakage mostly exists as low frequencies. Sometimes, we use high pass filters to sculpt the sound and clear some space for other instruments, but this technique is probably better done in the mix and better done with flexible or specifically chosen filters. It is just safer, because once one filters out the lows, they are gone permanently. The microphone's high pass filter and most mic-pre's high pass filter, were probably never intended to be an artistic EQ, but were intended to be simple problem solvers.

We might characterize the high pass filters in the HD Reference as relatively gentle and safe. The filters are 6 dB/oct types with minimal phase shift and low group delay distortion. Steep filters tend to introduce more phase shift which basically means the low frequencies may arrive milliseconds later than mid frequencies. This can be less than ideal with percussive instruments like drums unless the object was to lessen the impact and realism. But steep low pass filters can be more effective at removing garbage below a certain frequency. For the HD Reference, the filters were chosen with the idea that users would use a pre-amp of this quality to record in better spaces and that the HD Reference would be a natural choice for percussion instruments like drums and piano. In fact, with the right mic, it may well be the first choice with any acoustic instrument that is intended to invoke realism or sound natural.







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Unfortunately, standard audio test equipment is unable to cover the complete range of the HD Reference. The frequency response of the HD: 10Hz to 50kHz within 0.1 dB at ALL gain settings, -3dB at 2Hz and 900 kHz. At most gain settings, it becomes even flatter.

Figure 1: Frequency response. At first glance, it may look like the HD Reference is down 13-16 dB at 2 Hz, which might not be so bad because the graphs are still dead flat at 10 Hz, but there are 3 lines virtually on top of each other and one is the graph of the Audio Precision APx515 measuring itself. Only the +60 dB gain setting (red line) shows any visual departure from the others (-0.5 dB at 5 Hz, -2.5 dB at 2Hz). With 40 dB gain, you can see the HD Reference measured as flat as the AP within 0.1 dB from 2 Hz to 80 kHz, which were the frequency limits of the AP. Actually it stays very flat to about 10 times that. Even 10 Hz and 100 kHz square waves still look respectably square.

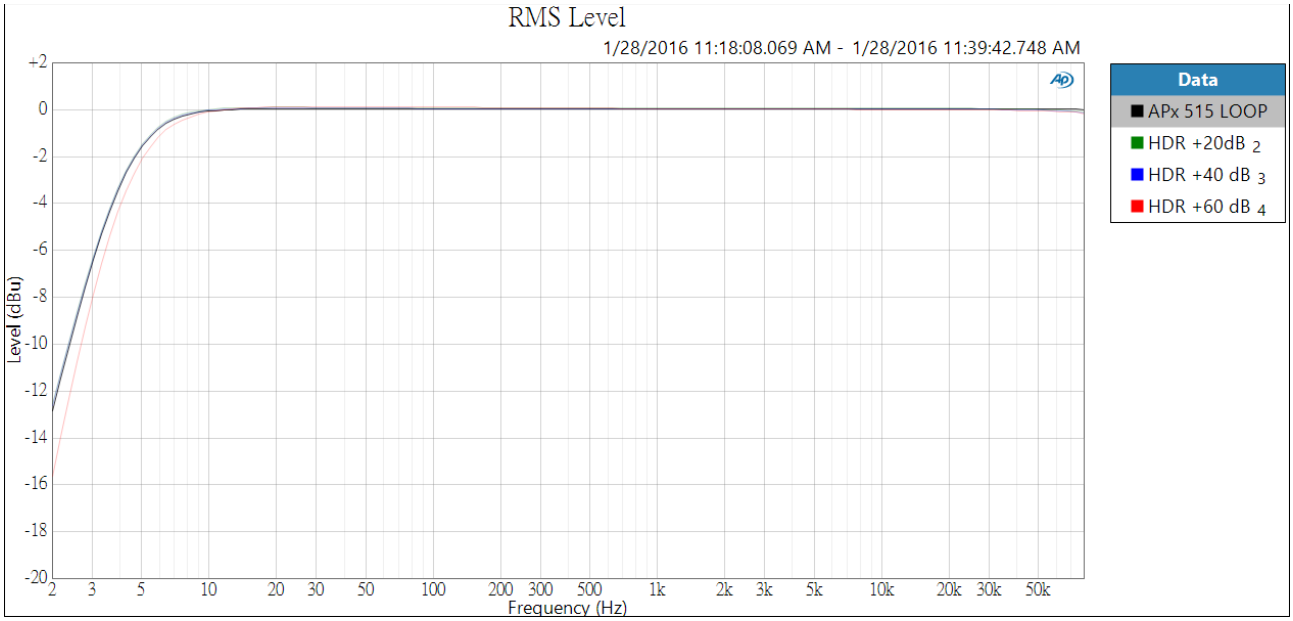

Figure 1

Figure 2: Noise floor at 64 dB gain. The most remarkable quality in this graph is the flatness. All amplifiers are guilty of 1/F noise which shows up as increased noise at low frequencies. The 1/F noise corner of the HD Reference is typically 10Hz which ranks among the best. Very flat HF too.

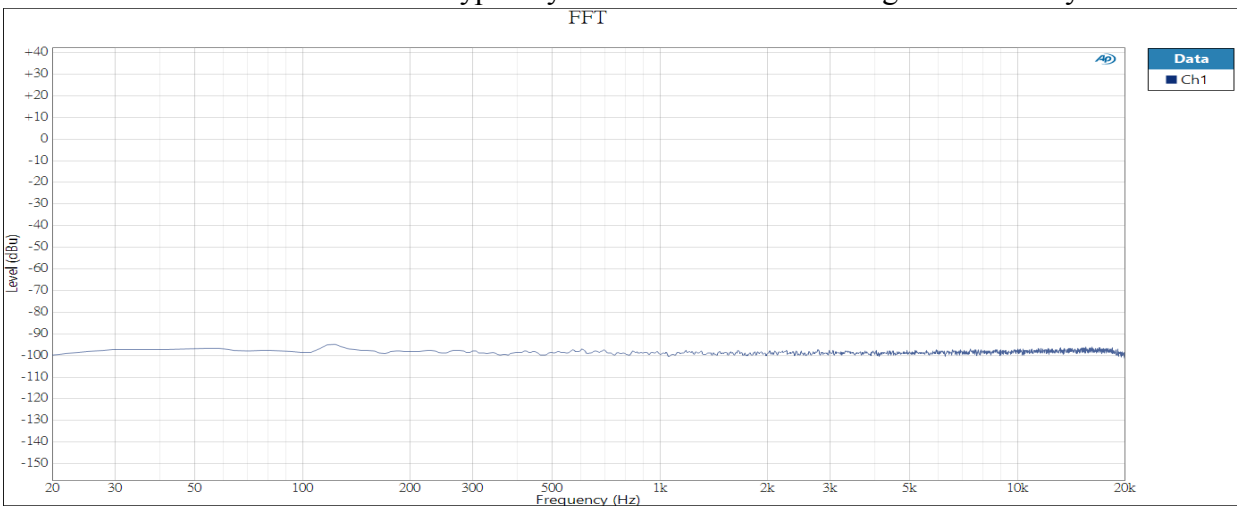

Figure 2
Figure 3: Total Harmonic Distortion. This graph shows the 1 kHz THD as the input signal is stepped over a 86 dB range. Two gain settings are shown, 0 dB and +40 dB. Even with 40 dB of gain, distortion is typically near -100 dB which translates to 0.001%. You can see a smooth gradual climb after the output passes +5 dBu on the +40 dB gain setting.

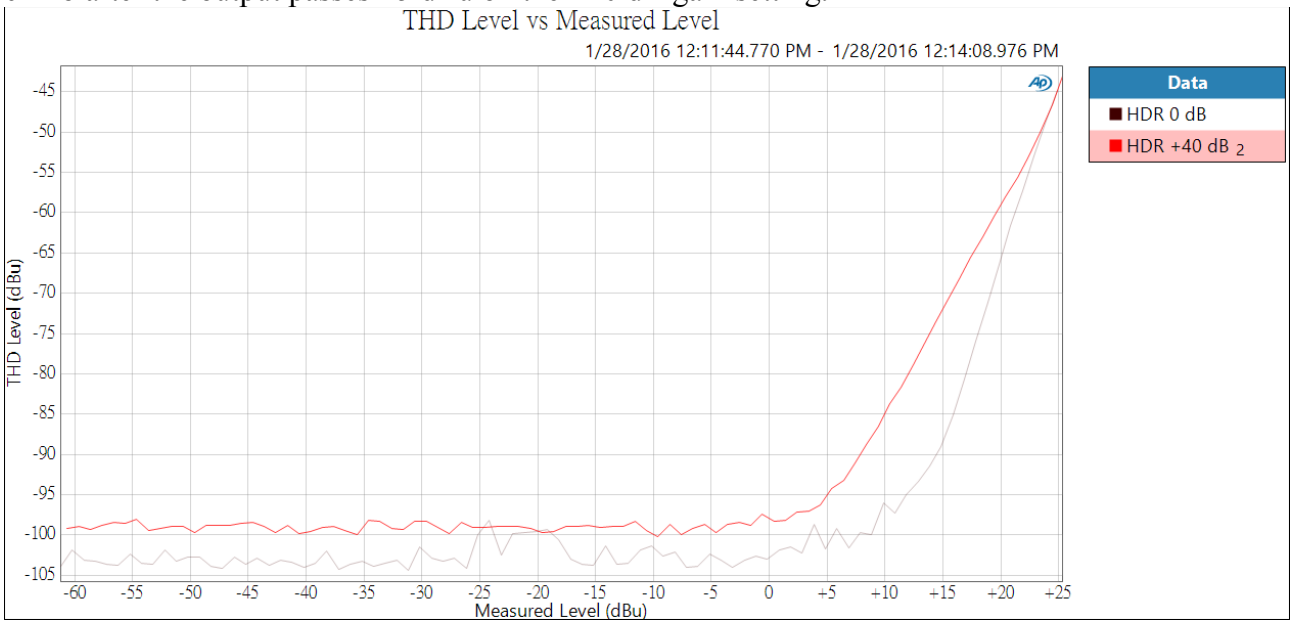

Figure 3

Figure 4: THD&N Ratio.
Changing the measurement to “percentage” and allowing for “noise”. With the noise floor, the actual THD&N becomes 0.003% near +10 dBu for the 40 dB gain setting, and 0.001% near +15 dBu output level for the 0 dB setting. The rising slope towards the left simply shows that when the input signal is very low, that the noise floor represents a relatively a larger percentage of the output. We can point out, that if you compare other graphs of this type, most show a lowest point between +20 dBu and +25 dBu, then rise suddenly and sharply as the device nears hard clipping. Notice the gentle rise in the HD Reference. Tube circuits also often tend to have this kind of curve.

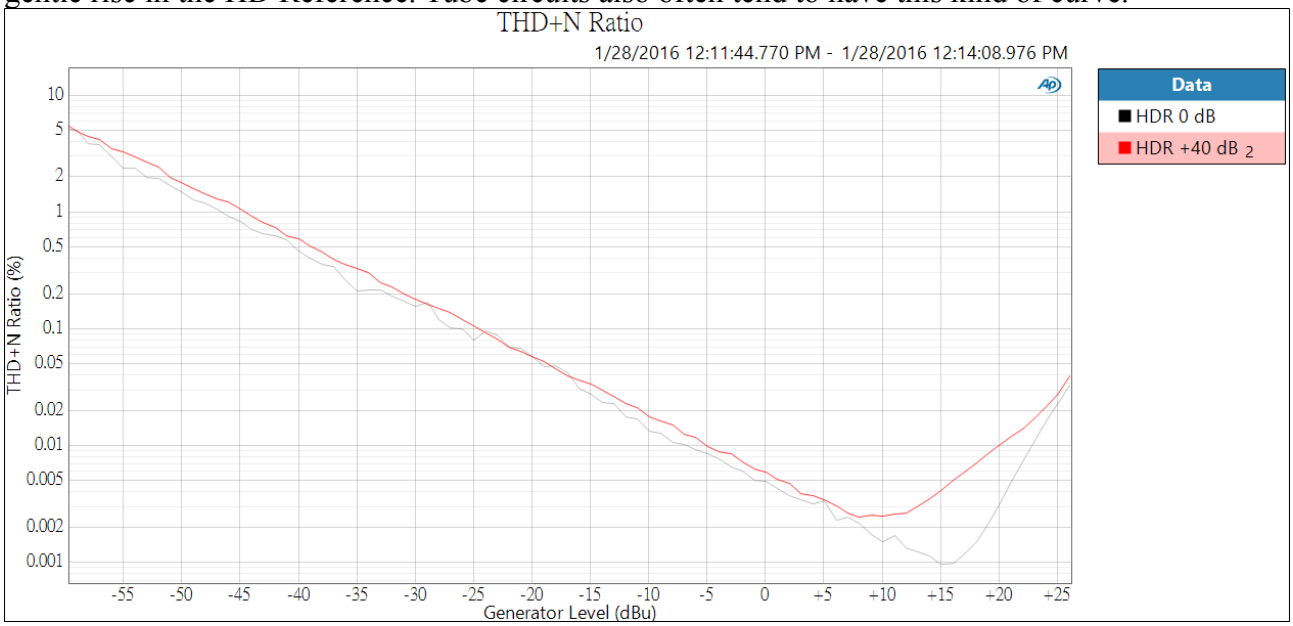

Figure 4
Figures 5, 6, 7 show the harmonic levels at various output levels with the 40 dB gain setting and a 250 Hz input (chosen for a centered graph). Figure 4 at 0 dBu output, Figure 5 at +10 dBu output, Figure 6 at +20 dBu output which is near where many A to D converters overload. Notice 2nd harmonic at 500 Hz and 3rd at 750 Hz and nothing above 7th. Tube circuits often display similar harmonic signatures. The idea that tubes only generate even harmonics and solid state generates odd harmonics is just a myth. It all depends on how they are biased. Most properly designed tube circuits show similar amounts of 2nd and 3rd below clipping, often somewhat more 3rd. Similarly, transformers usually display mostly 3rd and 5th harmonics at low frequencies and high levels, but are sometimes biased them to bring in some 2nd. These graphs show a nice onset and harmonic balance. Figure 8 shows two tones, 200 and 2 kHz, at 0 dBu input (each at -6 dB), to illustrate the virtually invisible IM distortion at that level.

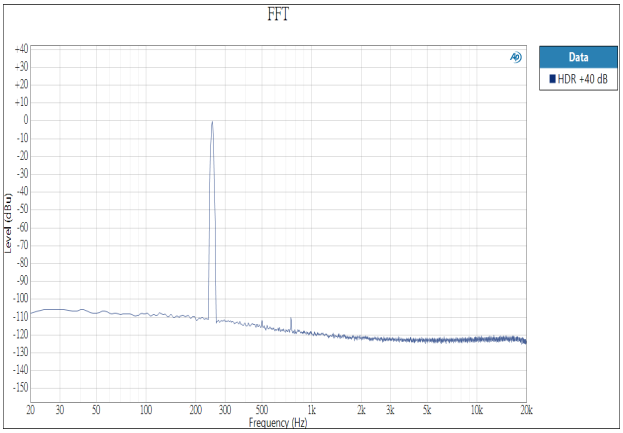

Figure 5

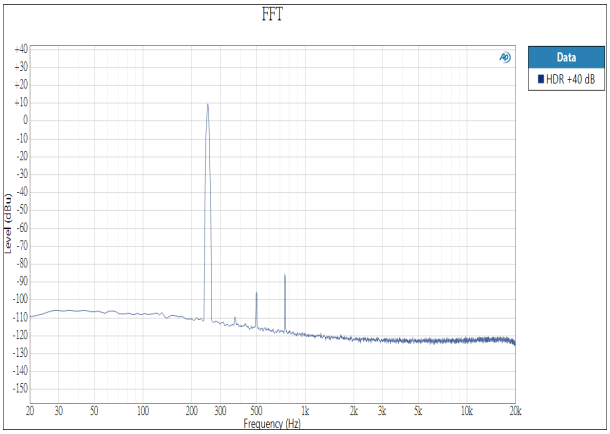

Figure 6

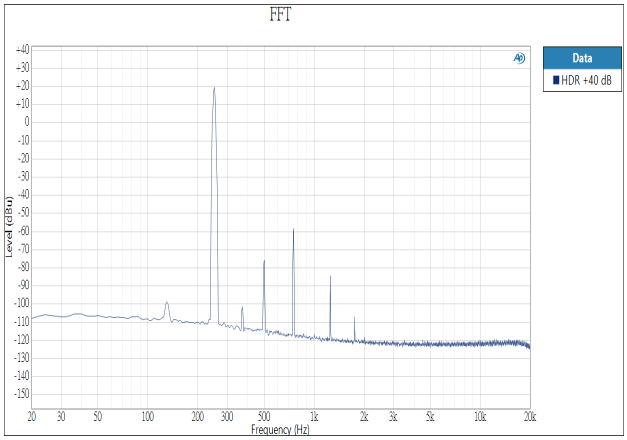

Figure 7

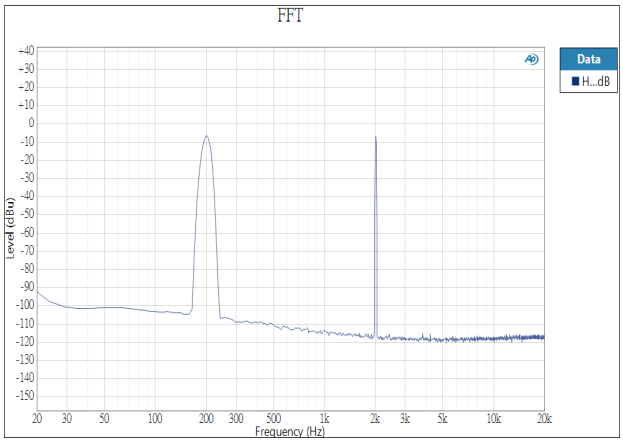

Figure 8

OK, that is enough of geeky graphs, but sometimes a picture is worth a thousand words. Even though the frequency response goes amazingly high, don't expect that the HD Reference will be “bright” because the frequency response is also very flat, but it may be brighter than a preamp with a rolled off top end. Also, while you can get some pleasant color and character from this pre, it depends on how hot the output is driven, and it may be subtle, depending on the source or instrument. It wasn't designed to have a dramatic heavy signature sound and it certainly isn't a fuzz-box. You can also see how at lower levels it becomes super clean.

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Controls and Operation:

Rotary Control:

GAIN : Gain Control from
0 to 64 dB in 1dB steps
Pressing the Gain Knob Mutes the output and the Gain Display Blinks

Output Peak Level Indicator: -18dB to +20 dB, 2 dB steps (0dB = +4dBu)

Switches:

P48 : +48 Volt Phantom Power when lit

POL : Reverse Output Polarity when lit

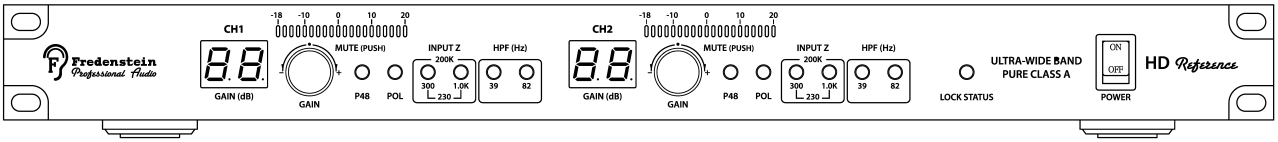
LOW Z 300 300 Ohms Input Impedance when lit

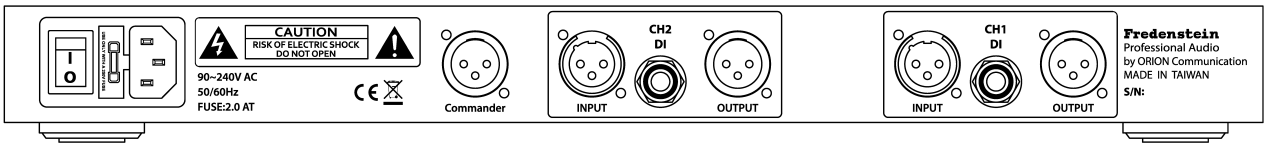
LOW Z 1K : 1000 Ohms Input Impedance when lit

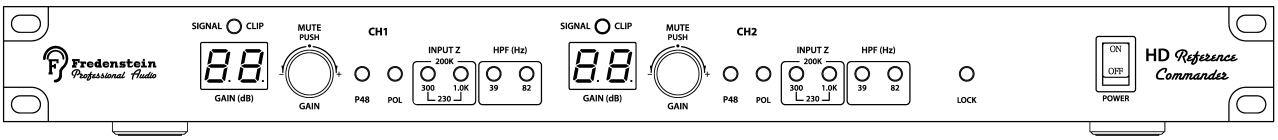
With neither 1K and 300 pressed, the input impedance is approximately 200 Kohms
Note: With P48 engaged 200K becomes approximately 13 Kohms.

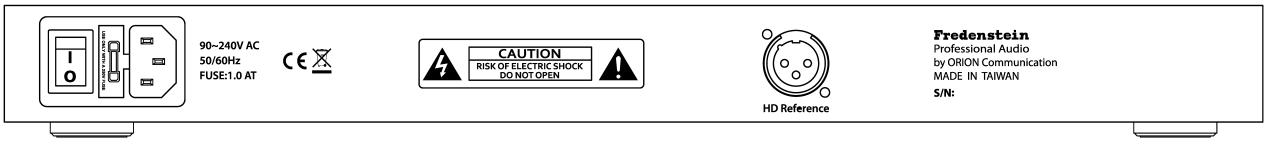
Low Cut 39 : reduces the lower frequency response to 39 Hz

Low Cut 82 : reduces the lower frequency response to 82 Hz









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Gain Control:
Rotary Encoder sets the Gain in 1 dB steps which are displayed next to the knob. Pushing the Knob activates an immediate MUTE. This control as with all others can be remote controlled

POL – Polarity Control:
Pushing the POL switch selects the polarity, when lit (blue), the output polarity is reversed. Otherwise the true, non-reversed, polarity is selected (normal operation).

Low Z 1K – Low Input Impedance:
When lit (green), the input impedance changes from 200 kOhms to 1000 Ohms. Some dynamic- and ribbon-microphones are most linear driving a low input impedance.

Low Z 300 – Low Input Impedance:
When lit (green), the input impedance changes from 200 kOhms to 300 Ohms.

P48 Phantom Power:
Most FET condenser microphones as well as some other microphones with built-in amplifiers require +48V Phantom Power. Setting the P48 switch (red light) enables +48V through the balanced microphone line. Please check your microphone documentation if you are not 100% sure. Enabling P48 on microphones not designed for P48 might cause severe damage to the microphone. The DI input is not supplied with Phantom Power.

Low Cut 39Hz:
A 39 Hz low cut filter is activated when lit, avoiding unwanted low frequencies while tracking.

Low Cut 82Hz:
A 82 Hz low cut filter is activated when lit, avoiding unwanted low frequencies while tracking.

DI – Direct Input:
The most common use for the DI input is to connect instruments like guitars directly to the HD Reference. The input impedance is greater than 2 MOhms to insure compatibility with most instrument pickups. After inserting a balanced (Tip-Ring-Sleeve) or an unbalanced (Tip-Sleeve) plug, the balanced microphone input through the box or rack is automatically disabled.

The Gain range for the DI is from 0 to +40. Turning the Gain knob past +40 will have no effect. When a 1/4” plug is inserted into the DI jack, the HD Reference automatically switches in the DI pre-amplifier and lights up a LED at the bottom right of the Gain Display. If a Commander is used it will also use that LED to display that the DI is plugged in

There is also an indicator called LOCK STATUS, which lights up if the LOCK button is pushed on the Commander. If this is lit, all controls on the HD Reference are frozen and can only be controlled from the Commander. This is to prevent tampering.

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(Will not apply to next revision with a single PCB) There is another LED on the Gain Display between the 2 digits that is used to indicate if a pre-amplifier board is set to an invalid address. This is an internal setting that should be properly set by the factory. Channel 1 needs to be set with both dip switches set to "ON". Channel 2 needs to be set with 1 to "OFF" and 2 set to "ON". "ON" is towards the back of the PCB and "OFF" towards the front edge.

Technical Data:

Frequency Response	:	2 Hz – 700,000 Hz, - 1 dB
		1 Hz – 920,000 Hz, - 3 dB
Distortion	:	< 0.0082 at +4 dBu Output Level (31 dB Gain)
Input Noise (EIN)	:	< -128.5 dB (150 Ohms Source Impedance 64db Gain)
		<-130 dB A Weighted
Input Impedance	:	> 200 kOhms or 1000 or 300 Ohms selectable
CMRR	:	> 60 dB at 54 dB gain
DI Impedance	:	> 2 MOhms
Max. Input Level	:	+ 20 dBu,
Output Impedance	:	600 Ohms
Max. Output Level	:	+ 30dBu
Max Input Signal	:	+20 dBu
(DI or Microphone Input)		+ 0dBu

Note: It bears pointing out that the HD Reference may be unique in the actual combination of the ultra-wide bandwidth, along with the extremely low noise floor, impressive distortion specifications plus the spectacular impulse response. Some designs sacrifice bandwidth or distortion to keep the noise low, others have low distortion or flat high frequency response only for the low gain settings. And sometimes the published test numbers and listening test results just do not seem to agree.

Beyond the one dimensional numbers, there are graphs and FFT plots that are even more impressive to those familiar with testing high-gain audio amplifiers. For example, the distortion remains low and flat well beyond 20 Khz, unlike most pre-amplifiers. Similarly the noise floor is flat and doesn't appreciably increase in the lowest octaves (1/f noise). Also rare is that both the specifications and the audible performance stay remarkably constant across the full 64 dB gain range. Pre-amplifiers that depend on negative feedback to achieve good specifications (and sound) at low gains, reduce that corrective feedback to get high gains. The HD Reference does not need or use negative feedback.

While these specifications are impressive, this mic pre-amplifier's purpose is to facilitate recording music and, in the final analysis, a recording engineer generally judges the level of electronic art "by ear" and not with a test bench. The topology and feature set of the HD Reference were chosen for reasons related to recording inspired performances and capturing music as perfectly as possible and the nice numbers are just a byproduct.

What is an unfortunate byproduct is the heat. With positive and negative 24 volt rails, we have 48 volts and 4 true Class A amplifiers capable of driving 600 ohms. Class A amplifiers dissipate the same heat whether there is no signal or the signal is fully driven. In the case of the HD Reference, this means about 16 watts (8 watts per channel) of heat, so there are heat-sinks inside, ventilation slots in the top and bottom panels and a serious recommendation in the beginning of this operating

manual to have some space above and below in the rack. Think about how hot a 15 watt incandescent lightbulb gets.

The Commander Remote Control

The Commander Remote Control unit looks very similar to the HD Reference and notably ALL of the controls are included. Only the meters are missing on the Commander, as there is no audio involved in this box to meter. In the control room, one typically uses the meters of the recording device. However, the Commander does have a two color LED to show signal presence when lit GREEN or near clipping (+24 dBm) when RED. Generally, if the LED is lit GREEN and not flashing RED, you are probably in the safe zone as far as the HD Reference, but you still probably want to avoid overloading the recording device, so those meters are worth watching. However, the best thing is to use your ears and if it is seeming like there may be some unwanted warmth and mid range build up, probably turning the Gain down will help. Alternatively, maybe you want some warmth and color, so increasing the Gain should get you there, but you may have to turn down the gain elsewhere or insert a compressor after the HD Reference to prevent overloading an analog to digital converter.

The Commander does have one button that the HD Reference does not, but does have a corresponding indicator. This is the LOCK button. If the HD Reference pre-amp is located some distance away, it is possible that someone might push a button accidentally (like P48) or just tampers with sett

Fredenstein includes a pair of short 3 meter mic cables with the Commander remote. We encourage you to place the HD Reference in close proximity to the microphones and use mic cables that are as short as possible. Long cables can introduce appreciable capacitance into the chain. In extreme cases, this might attenuate high audio frequencies. In less extreme cases cable capacitance can affect phase response at 20K and can be a difficult load for some microphones to drive and maintain the optimum wave-shapes. To get full benefit of the very wide bandwidth and fast impulse response of the HD Reference , we do suggest short low capacitance mic cables. Good shielding and low micro-phonics can also be important, depending on the gain needed and whether phantom power is used. This is why we include a pair of good quality short cables with the Commander.

The control cable for the HD Reference can be a typical balanced mic cable. The jacks are labeled “Commander” at the preamp and “Preamp” at the Commander remote control. The communication technology is similar to 2400 baud modems that we used in the 90's to connect computers to phone lines. The signal can be patched through a conventional patch bay and run significant distances. The signal is transformer isolated, balanced and low level to avoid cross-talk to audio lines. And like a phone line signal it is bi-directional, so one cannot route it through digital snakes that are intended to convert and pass a signal in one direction. The main thing to avoid is routing this signal to the console because, frankly, it just sounds like an old computer modem.

The gain control encoders may seem a little slow with the Commander connected. This is because each step is communicated to the preamp and the message acknowledged. This ensures accurate data sent and near zero chance of a fault in communication. You can be confident that when the Commander remote is displaying a setting that the setting is exactly the same on the HD Reference. And if the LOCK button is pressed on the Commander, you can be confident that nobody can mess with the settings of a HD Reference that may be out of sight.

Contact Info:

Fredenstein Professional Audio

by Orion Communication
7F-1, No. 582, Ruei Guang Rd.
Neihu District
Taipei 114
Taiwan

Phone : + 886-2-2657-2618
Email : info@fredenstein.com
Web : www.fredenstein.com