A Discussion of the dbx 786 Precision Microphone Preamplifier

White Paper

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Introduction

The dbx 786 Precision Microphone Preamplifier is the latest dbx Blue Series product to hit the market. This paper discusses the design criteria, parts selection, and special circuitry required in the 786 to make it a world class product.

Design Philosophy

To build a world class microphone preamplifier, we needed to start from the ground up and design premium parts into our circuits. The signal path includes parts such as: gold plated Neutrik® XLRs, Jensen® JT-16-A audio input transformers, gain switching relays with rare earth magnets and gold contacts in a hermetically sealed nitrogen environment, temperature stable metal-film capacitors, premium 0.1% and 1% resistors, and a proprietary Jensen® audio output transformer. But, it doesn't end with the signal path, just look at a 786 and you will see: 1/4" machined aircraft aluminum front panel, machined solid aluminum knobs, and heavy gauge stainless steel chassis.

We at dbx are always hard at work coming up with innovative circuitry to improve the performance of our current and new products. The 786 is no exception. There are several patented circuits and new technologies in the 786 which lead to its exceptional and transparent performance.

And, of course, a product of this magnitude has required countless hours of listening and beta testing in several studios. There has been well over one year's worth of development time put into the 786 tweaking, upgrading, listening, and improving the design.

Signal Path

The signal enters through gold-plated input XLRs, and then passes through the +48V Phantom, Super Low Z, Pad, and Phase Invert circuitry. All of these functions are controlled remotely by relays, allowing the signal path to be as short and clean as possible. The signal is then bridged to the gain circuitry through a Jensen® JT-16-A microphone input transformer, the best microphone transformer that Jensen makes. The JT-16-A affords a very high input common-mode rejection ratio (CMRR) up to 300 volts, which means the 786 will have no problem eliminating induced common-mode signals from sources such as RF transmitters or SCR controlled light dimmers. Other "electronically balanced" input stages which do not employ a transformer, can only reject common-mode signals of up to a few volts. The JT-16-A also allows us to get rid of awful-sounding electrolytic capacitors which are commonly used to isolate phantom power from the gain circuitry.

The heart of the 786 is its "M8" Microphone Preamp module. Electronics of the M8 are potted in a zinc-aluminum alloy housing for maximum heat transfer and shielding. The M8

contains proprietary electronics that perform the gain function of the 786 and also contains DC servo circuitry which nullifies any DC offsets that are present, again allowing us get away from using any DC blocking electrolytic capacitors. The 786 is entirely DC-coupled, input to output. Gain of the M8 is controlled by an 11 step Gain switch which sequences a bank of relays, keeping the signal path as short and as clean as possible. The bottom line is the M8 microphone preamp module amplifies signals to a clean, distortion and noise-free level. Overall gain of the Gain control is +15dB to +65dB in 5 dB steps.

After the Gain control, the signal is fed through a Fine gain control, whose circuitry runs off of high voltage +/-24 volt rails, enabling signal levels of up to +30 dBu. Translation – gobs of headroom. The Fine gain control is sweepable to provide an additional -5 to +5 dB of gain. Maximum overall gain of the 786 is 70 dB, which comes in handy for amplifying ambient sounds and other low level signals without any added noise.

A unique feature of the 786 is the high frequency shelving equalizer. This equalizer is frequency sweepable using the Spectrum control from 5 kHz to 40 kHz, while the Detail Control is sweepable from -∞ to +16 dB. Patented EQ filters allow the shelving band to "morph" between a typical shelving filter operation and that of a low-pass filter when the Detail control is in the -∞ position. Slope is switchable between a gentle 6 dB/octave to a more aggressive 12 dB/octave. A 12 dB/octave setting can let you create a sense of "air" without stridency caused by too much boosting of upper midrange frequencies. If your intent is to have the cleanest pre-amplified signal without the need for EQ, when the HF EQ switch is not engaged, the EQ is hard-wire bypassed from the signal path.

And finally comes the output stage. Most equipment that incorporates a transformer in the output stage will have a fair amount of distortion at high levels and low frequencies. The 786 uses a patented circuit in conjunction with a proprietary oversized output transformer, designed by Jensen, which overcomes these distortion problems. The output stage is a discrete-based power amplifier capable of driving hundreds of feet of cable to +30 dBm without any problems, allowing the 786 to be used on stage and drive long cables to FOH, to a studio control room, or to a remote truck.

Power Supply

The over-designed power supply is very robust and is capable of supplying high current to the 786 without hesitation. A toroidal power transformer is enclosed in a mu-metal can which yields 30 dB of electrostatic and magnetic shielding. The power supply is completely enclosed in a steel chassis and is easily removed for field service if needed.

dbx Type IV™ Conversion Output Option

When recording directly to DAT, computer via a soundcard, digital multitrack, CDR, or various other digital media, dbx offers an digital output option card for the 786. Featuring the dbx Type IV™ Conversion System which captures the most dynamic range and true essence of the signal, the card supports AES/EBU (XLR jack) or S/PDIF (RCA jack) formats. The A/D converters have a 24-bit wordlength at a sample rate of 44.1 kHz or 48 kHz. Dithering to 16 or 20 bits is possible with TPDF and dbx SNR²™ options. The card is capable of syncing

either as a master clock or as a slave clock via BNC input and output jacks. dbx Type IV™ with Tape Saturation Emulation (TSE™) is standard which prevents dreaded digital overload when approaching "digital 0." Noise shaping is available with two factory presets to lower the perceived noise floor for wider dynamic range.

Circuit Performance

There are several factors that go into making a microphone preamplifier sound transparent. The first step is to have a razor flat frequency response throughout the audio band (20 Hz to 20 kHz). As shown in Figure 1, the 786 has an extremely wide bandwidth of 2 Hz to 200 kHz, which is essential so phase shifts in the audio band are minimized.

Another measure of a world class preamp is that it responds well to low and high-frequency square wave inputs. We put a 20 Hz square wave into a microphone preamp that doesn't have good square wave response and also into the 786. Figure 2 shows the preamp that has poor low frequency square wave response. The square wave is sagging and not flat on the top and bottom portions of the waveform resulting from awful-sounding electrolytic capacitors in the signal path. You can see that the capacitors are causing the circuit to not respond properly to the square wave signal because of the high-pass filter effect of these capacitors resulting in insufficient low-frequency response. This gives the bottom-end a smeared sound since low frequencies cannot be accurately reproduced and also results in decreased low-frequency headroom. Figure 3 shows the response of the 786 to the same low-frequency square wave input. Note that the output is a square wave without sagging or peaking. This means that the 786 can accurately reproduce low frequency signals without smearing the sound.

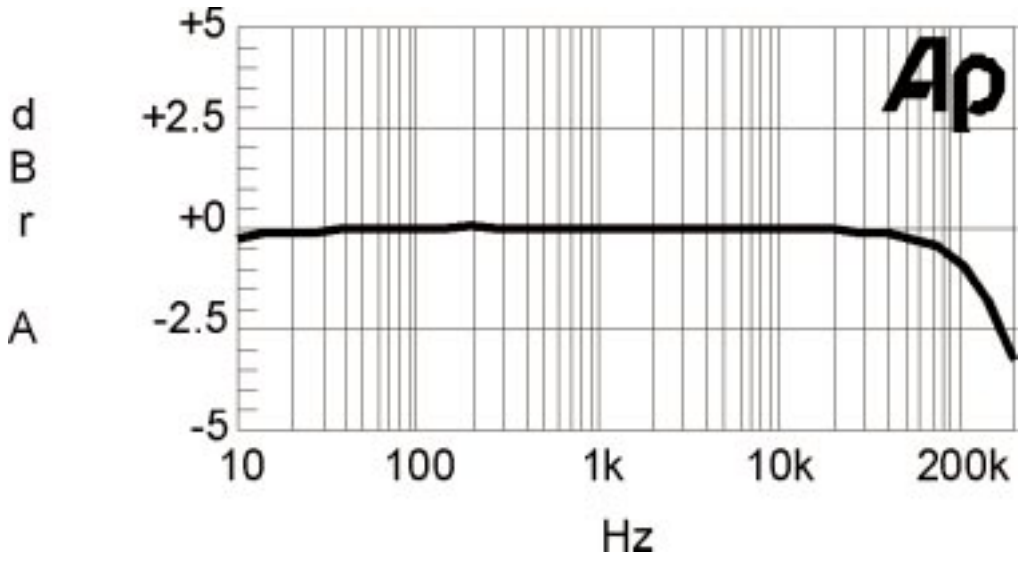

Figure 1. Frequency response of the dbx 786. Note the -3dB point on the low frequency side extends beyond the limits of the Audio Precision test equipment. The low end -3dB point is at 2 Hz.

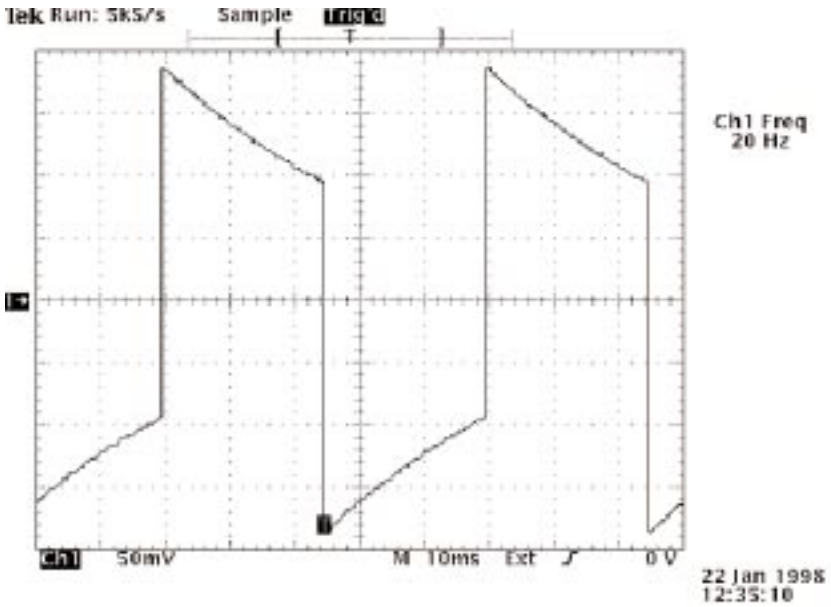

Figure 2. A Microphone preamplifier with poor low-frequency square wave response.

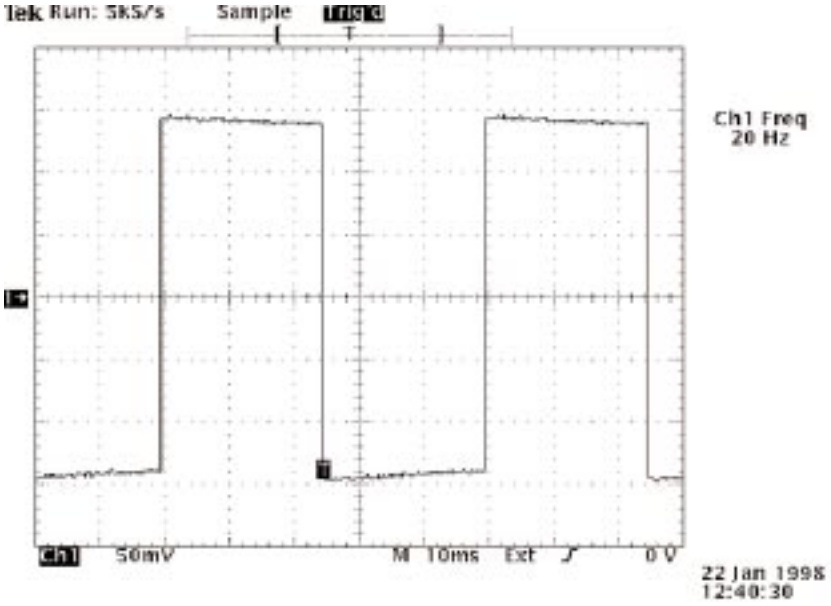

Figure 3. dbx 786 microphone preamplifier showing excellent response to a square wave input.

Another important design criteria is the phase response of the preamp. It is very desirable to avoid phase shifts throughout the audio band. Phase shifts can cause the audio signal to sound muddy and undefined. The 786, through careful selection of components, maintains phase integrity, exhibiting an impressive "deviation from linear phase" specification of 2˚ or less across the audio band as shown in Figure 4.

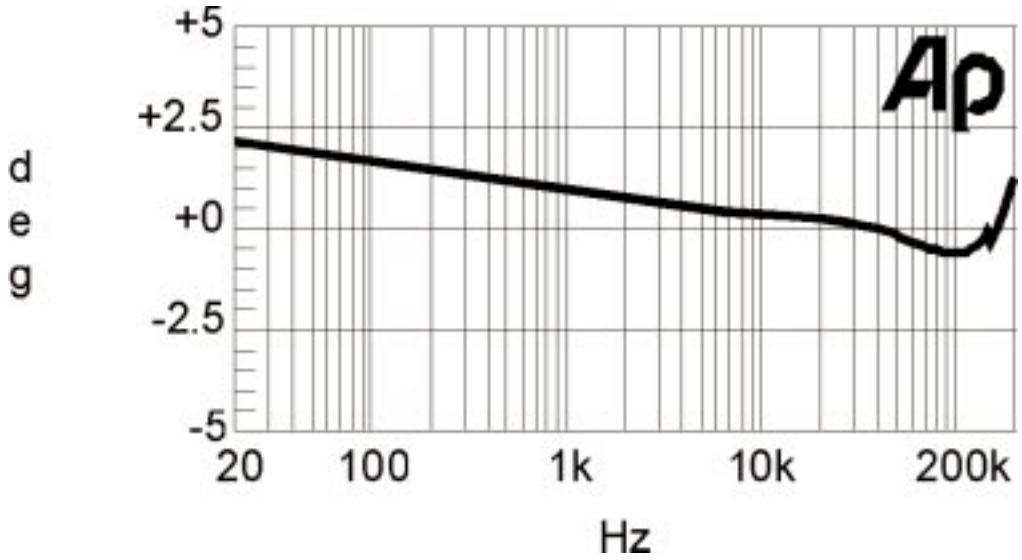

Figure 4. dbx 786 deviation from linear phase.

And finally, the preamp must have ultra low distortion and noise for transparent amplification. Figure 5 show the THD + Noise response when a -20 dBu signal is fed into the unit and amplified by 40 dB. An important thing to note here is the extremely low distortion (0.02%) at 20 Hz. As mentioned earlier, units that have output transformers typically have 2 orders of magnitude more distortion at low frequencies and at high signal levels. A combination of an oversized output transformer coupled with a patented distortion-nulling circuit enables the 786 to have these ultra-low distortion characteristics.

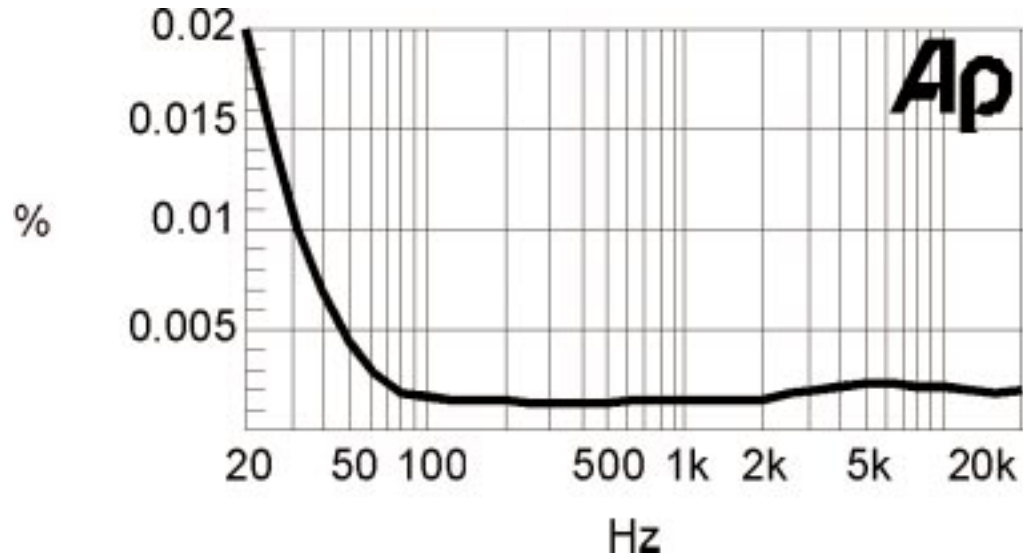

Figure 5. dbx 786 THD + Noise with -20 dBu input signal, +40 dB gain.

Conclusion

Through careful component selection, new circuit technologies, and considerable amount of bench testing and listening, we have developed an extremely quiet and clean precision microphone preamplifier capable of preserving the sonic character of the microphone which signal it amplifies.

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